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SPECIAL SESSION: ADVANCES IN NEUROLINGUISTICS

(Generously funded by the National Science Foundation)

Research on human sentence processing seeks to understand the moment-to-moment processes that enable competent speakers of a language to produce and comprehend sentences. The task requires an interdisciplinary approach, one that draws upon the expertise and tools developed in several disciplines. The CUNY 2010 Special Session focuses on recent advances in neurolinguistic tools for exploring the neural mechanisms underlying language processing. Invited speakers will present cutting edge research that uses a range of methodologies—electroencephalography (EEG), functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG), transcranial magnetic stimulation (TMS), and near infrared spectroscopy (NIRS)—and will emphasize how results from different methodologies (including those from various behavioral techniques) can be linked.

INVITED SPEAKERS

• Ina Bornkessel-Schlesewsky (University of Marburg) & Matthias Schlesewsky (Gutenberg University)
• Matt Davis (MRC Cognition and Brain Sciences Unit, Cambridge, UK)
• Colin Phillips (University of Maryland, College Park)
• Kuniyoshi Sakai (University of Tokyo)
• Michael Tanenhaus (University of Rochester)
SPONSORS

Center for the Study of Language and Information, Stanford University
National Science Foundation
The Center for Language Sciences, University of Rochester
The Linguistics Program of the CUNY Graduate Center
  Linguistics Department, New York University
  Psychology Department, New York University
  Faculty of Arts and Science, New York University
**REVIEW PANEL**

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<th>Amit Almor</th>
<th>Fernanda Ferreira</th>
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<td>Gerry Altmann</td>
<td>Victor Ferreira</td>
<td>Pia Knoeferle</td>
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<td>Douglas Bemis</td>
<td>Susanne Gahl</td>
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<td>Jonathan Brennan</td>
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<td>Peter Gordon</td>
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<td>David Caplan</td>
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<td>Dan Grodner</td>
<td>Alec Marantz</td>
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<td>Manuel Carreiras</td>
<td>Martin Hackl</td>
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<td>Sarah Creel</td>
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<td>Matthew Crocker</td>
<td>Yi Ting Huang</td>
<td>Pat OSeaghdha</td>
<td>Tessa Warren</td>
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<td>Roberto de Almeida</td>
<td>Matt Husband</td>
<td>Neal Pearlmutter</td>
<td>Tom Wasow</td>
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<td>Gary Dell</td>
<td>Florian Jaeger</td>
<td>Thomas Pechmann</td>
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<td>Dikker Suzanne</td>
<td>Yuki Kamide</td>
<td>Martin Pickering</td>
<td>Masaya Yoshida</td>
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<td>Thomas Farmer</td>
<td>Nina Kazanina</td>
<td>Maria Pinango</td>
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<td>Evelina Fedorenko</td>
<td>Andy Kehler</td>
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<td>Eva Fernandez</td>
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<td>Gerard Kempen</td>
<td>Hugh Rabagliati</td>
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**VOLUNTEERS**

| Douglas Bemis      |
| Jon Brennan        |
| Suzanne Dikker     |
| Kim Leiken         |
| Inna Livitz        |
| Hugh Rabagliati    |
THE JERROLD J KATZ YOUNG SCHOLAR AWARD

In memory of our friend and distinguished colleague, the Jerrold J. Katz Young Scholar Award is awarded for the paper or poster presented at the CUNY Sentence Processing Conference which best exhibits the qualities of intellectual rigor, creativity, and independence of thought which were exemplified in Dr. Katz’s life and work. Any author listed as the first author on a presentation, who is pre-doctoral or up to three years post-PhD, and who is not yet tenured, will be eligible for consideration. The amount of the award is $500.

PREVIOUS RECIPIENTS

T. Florian Jaeger (University of Rochester) and Neal Snider (Stanford University), jointly, for their paper entitled “Implicit learning and syntactic persistence: Surprisal and cumulativity”, presented at the 20th Annual CUNY Conference on Human Sentence Processing, La Jolla, CA, March 2007.

Scott Jackson (University of Arizona) for his paper entitled “Prosody and logical scope in English”, presented at the 19th Annual CUNY Conference on Human Sentence Processing, New York, NY, March 2006.


Andrew Nevins (Massachusetts Institute of Technology), for his paper entitled “Syntactic and semantic predictors of tense: An ERP investigation of Hindi”, presented at the 17th Annual CUNY Conference on Human Sentence Processing, College Park, MD, March 2004. Nevins’ coauthors were Colin Phillips and David Poeppel.

Britta Stolterfoht (Max Planck Institute of Cognitive Neuroscience), for her poster entitled “The difference between the processing of implicit prosody and focus structure during reading: Evidence from brain-related potentials”, presented at the 16th Annual CUNY Conference on Human Sentence Processing, Cambridge, MA, March 2003. Stolterfoht’s coauthors were Angela D. Friederici, Kai Alter, and Anita Steube.


AWARD FUND

To make a contribution to the Jerrold J. Katz Fund, please send a check made out to CUNY Graduate Center (with the notation “Jerrold J. Katz Fund” in the memo line) to: Dianne C. Bradley (Katz Award Fund), Ph.D. Program in Linguistics, CUNY Graduate Center, 365 Fifth Avenue, New York, NY, 10016-4309.
## THURSDAY PROGRAM

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<th>Session I</th>
<th>Chair: Thomas Wasow</th>
<th>Location</th>
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<tr>
<td>8:00 - 8:45 am</td>
<td>Registration, Coffee, and Light Breakfast</td>
<td>Greenburg Lounge</td>
<td>Tishman Hall</td>
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<tr>
<td>8:45-10:30 am</td>
<td>Session I</td>
<td>Thomas Wasow</td>
<td>Tishman Hall</td>
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<tr>
<td>8:45 am</td>
<td>Opening remarks</td>
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<tr>
<td>9:00 am</td>
<td>The neural processing of pronouns, names and definite NP anaphors</td>
<td>Amit Almor and Timothy Boiteau</td>
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<tr>
<td>9:30 am</td>
<td>The structure-sensitivity of memory access: evidence from Mandarin Chinese</td>
<td>Brian Dillon, Wing Yee Chow, Matt Wagers, Taomei Guo, Fengqin Liu and Colin Phillips</td>
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<tr>
<td>10:00 am</td>
<td>Constraining Focus Interpretation in Discourse</td>
<td>Christina Kim, Christine Gunlogson, Michael Tanenhaus and Jeffrey Runner</td>
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<tr>
<td>10:30 - 11:00 am</td>
<td>Coffee Break</td>
<td>Victor Ferreira</td>
<td>Tishman Hall</td>
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<tr>
<td>11:00 am</td>
<td>Why or what next? Eye movements reveal expectations about discourse direction</td>
<td>Hannah Rothe and William Horton</td>
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<tr>
<td>11:30 am</td>
<td>What do listeners’ eyes reveal about communicating false beliefs?</td>
<td>Heather Jane Ferguson and Richard Brebeny</td>
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<tr>
<td>12:00 pm</td>
<td>Contrast and linguistic mention: out of sight but still in mind</td>
<td>Lynsey Wolter, Kristen Skovbroten and Michael Tanenhaus</td>
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<tr>
<td>12:30 - 2:00 pm</td>
<td>Lunch Break</td>
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<tr>
<td>2:00 pm</td>
<td>Invited Talk: Six blind men and an elephant: Making sense of cross-technique mismatches</td>
<td>Colin Phillips</td>
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<tr>
<td>2:45 pm</td>
<td>Invited Talk: &quot;Mind the gap!&quot; On the interdependence between eye movements and neurophysiological responses during real time language comprehension</td>
<td>Ina Bornkessel and Matthias Schlesewsky</td>
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<tr>
<td>3:30 - 4:00 pm</td>
<td>Coffee Break</td>
<td>Liina Pylkkänen</td>
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<td>4:00 pm</td>
<td>Linguistic knowledge, world knowledge, and &quot;semantic&quot; effects on sentence processing</td>
<td>Jon Willits and Maryellen MacDonald</td>
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<tr>
<td>4:30 pm</td>
<td>The interface of language and perception: when motion meets animacy.</td>
<td>Gina Humphreys and Silvia Gennari</td>
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<tr>
<td>5:00 pm</td>
<td>An investigation into the computational complexity of quantifying expressions</td>
<td>Oliver Bott and Fabian Schlotterbeck</td>
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<td>5:30 pm</td>
<td>Domain-General Mechanisms in the Construction of Meaning</td>
<td>Doug Bemis and Liina Pylkkänen</td>
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<tr>
<td>6:00 - 8:00 pm</td>
<td>Poster Session I</td>
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<td>Time</td>
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<td>8:00 - 9:00 am</td>
<td><strong>LATE REGISTRATION</strong></td>
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<td>8:00 - 9:00 am</td>
<td><strong>COFFEE AND LIGHT BREAKFAST</strong></td>
<td><strong>GREENBURG LOUNGE</strong></td>
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Klinton Bicknell and Roger Levy  
Reanalysis strategies in temporarily ambiguous sentences - a scanpath analysis  
Titus von der Malsburg and Shravan Vasishth  
The lexical predictability effect: Distributional analysis of fixation durations  
Adrian Staub                                                                 |
| 10:30 - 11:00 am | **COFFEE BREAK**                                                      | **GREENBURG LOUNGE** |                                                                                                     |
| 11:00 - 12:30 pm | **Session II** Chair: John Trueswell                                   | Tishman Hall      | Assignment of Grammatical Roles in the Online Processing of Mandarin  
Verb primacy and kindergarten-path effects in wh-processing: Evidence from English and Japanese  
Mechanisms of sense resolution in young children  
Yi Ting Huang, Xiaobei Zheng, Xiangzhi Meng and Jesse Snedeker  
Akira Omaki, Imogen Davidson White, Takuya Goro, Jeffrey Lidz and Colin Phillips  
Hugh Rabagliati, Eleanor Chestnut, Rebecca Fine, Leora Petashnick, Liina Pylkkänen and Gary Marcus                                                                 |
| 12:30 - 2:00 pm | **LUNCH BREAK**                                                        |                   |                                                                                                     |
| 2:00 – 3:30 pm | **Session III** Chair: Peter Gordon                                    | Tishman Hall      | Structure sensitive and insensitive retrieval of subjects in Brazilian Portuguese  
Individual differences in sentence comprehension: A retrieval interference approach  
Using Visually Co-Present and Linguistic Information to form Common Ground in patients with Hippocampal Amnesia  
Pedro Alcocer, Colin Phillips, Aniela Improta França and Marcus Maia  
Julie A. Van Dyke, Clinton L. Johns and Anuenue Kukona  
Rachael Rubin, Sarah Brown-Schmidt, Melissa Duff, Daniel Tranel and Neal Cohen                                                                 |
| 3:30 - 4:00 pm | **COFFEE BREAK**                                                      | **GREENBURG LOUNGE** |                                                                                                     |
| 4:00 - 5:30 pm | **Session IV** Chair: Alec Marantz                                      | Tishman Hall      | Invited Talk: Syntax in the Brain  
Invited Talk: Rising to the challenge: Brain imaging studies of successful sentence comprehension  
Kuniyoshi Sakai  
Matt Davis                                                                 |
| 5:30 - 7:30 pm | **POSTER SESSION II**                                                  | **GREENBURG LOUNGE** |                                                                                                     |
# SATURDAY PROGRAM

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<td><strong>Session I</strong> Chair: Matt Traxler</td>
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<td>9:00 am</td>
<td>From Seeing to Saying: Perceiving, Planning, Producing</td>
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<td>Stefanie Kuchinsky and Kathryn Bock</td>
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<td>Maureen Gillespie, Neal J. Pearlmutter and Stefanie Shattuck-Hufnagel</td>
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<td>Short Term Memory</td>
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<td><strong>Session II</strong> Chair: Matt Wagers</td>
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<td>11:00 am</td>
<td>Context-Sensitive Information Density affects Syntactic Production</td>
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<td>T. Florian Jaeger, Roger Levy and Victor Ferreira</td>
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<td>11:30 am</td>
<td>Local syntactic coherences violate structural binding domains in on-</td>
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<td><strong>Session III</strong> Chair: Michael McElree</td>
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<td>2:15 pm</td>
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<td>Michael Tanenhaus</td>
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<td>3:00 pm</td>
<td>Effects of morphological segmentation on sentence processing</td>
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<td>Cintia S. Widmann and Randy Lowell</td>
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<td>Implicit Metrical Prosody Affects On-Line Ambiguity Resolution</td>
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<td>Mara Breen and Charles Clifton</td>
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<td>Anti-local contexts increase the success, not the speed, of dependency</td>
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<td>completion</td>
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<td>Matthew Wagers</td>
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<td>5:00 pm</td>
<td>When grammatical errors do not matter: An ERP study on the effect</td>
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<td>of foreign-accent on syntactic processing</td>
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<td>Adriana Hanulikova, Merel van Goeh and Petra van Alphen</td>
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<td>Reconsidering ERP evidence for early syntactic encapsulation</td>
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<td>James Magnuson, Shin-Yi Fang and Jia Li</td>
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1.1 Filler-Gap Dependency Resolution in 20- and 30-month-olds: The Role of Morphosyntax
   Annie Gagliardi and Jeff Lidz

1.2 Abstract Representation of Passive Structures in Young Children: Evidence from Syntactic Priming
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1.3 Routes to referential access in children’s and adults’ language comprehension
   Pirita Pykkönen, Sarah Schimke, Juhani Jarvikkivi, Saveria Colonna and Barbara Hemforth

1.4 German childrens use of prosodic cues in resolving participant roles in transitive constructions
   Thomas Grünloh, Elena Lieven and Michael Tomasello

1.5 Word Production in Spontaneous Speech: Availability and Communicative Efficiency
   Matt Post and T. Florian Jaeger

1.6 Lexical neighbors: Speakers' friends, listeners' FOES. A study of vowel quality in spontaneous speech
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1.7 ‘Frequent frames’ in german child-directed speech – a limited cue to grammatical categories
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1.8 What Lexical and Perceptual Primes Tell About Cross-linguistic and Across-the-board Sentence
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1.9 Psycholinguistics in the field: Accessibility-driven Production in Yukatek Maya
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1.10 Working memory span modulates effects of pitch accenting on discourse memory
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1.11 The role of syntactic parameters in second language processing: evidence from event-related potentials.
    Adam Zawiszewski and Itziar Laka

1.12 Focus Particles and Spoken Sentence Processing in Dutch: Evidence from ERPs
    Diana V. Dimitrova, Laurie A. Stowe, Gisela Redeker and John C.J. Hoeks

1.13 Semantic scope effects of genericity on pronominal anaphora
    Francesca Delogu, Francesco Vespignani and Massimo Poesio

1.14 Reversing Causal Coherence through Linguistic Cues: Evidence from Event-related Potentials
    Ming Xiang, Abigail Swain and Gina Kuperberg

1.15 The Eyes are Faster than the Brain
    Peter C. Gordon, Patrick R. Plummer and Wonil Choi

1.16 Acoustic and syntactic influences on the neural processing of prosodic boundaries
    Scott Jackson, Meera Patel and Susan Garnsey

1.17 The limits of independent semantic composition: ERP evidence from Chinese
    Wing Yee Chow and Colin Phillips

1.18 Accomodating Talker Variability in Online Speech Processing
    Alison Trude and Sarah Brown-Schmidt

1.19 Common ground representations are more than all-or-nothing: Gradient effects of common ground in
    on-line language understanding
    Sarah Brown-Schmidt

1.20 Anticipating moved objects: event-plausibility matters, but not always…
    Gitte Joergensen and Gerry Altmann

1.21 Plausibility effects when reading one- and two-character words in Chinese: Evidence from Eye
    Movements
    Jinmian Yang, Adrian Staub, Nan Li, Suiping Wang and Keith Rayner
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THE NEURAL PROCESSING OF PRONOUNS, NAMES AND DEFINITE

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This work investigated the neural basis of one of the central properties of anaphoric processing, which is that anaphoric references to salient antecedents tend to employ more general expressions than the antecedent. Most frequently, such anaphors assume a pronominal form, a tendency which has been previously attributed to either an underlying rule, or to pronouns being light expressions that are easier to process, but at the same time are sufficient to identify an already salient referent.

We conducted two fMRI experiments that examined whether pronouns involve less neural processing than repeated names (Experiment 1) and definite NPs (Experiment 2). Previous behavioral and ERP results have suggested that, when the antecedent is salient, both names and definite anaphors are similarly dispreferred (Gordon, 1993; Burkhardt&Roehm, 2007). Here we tested whether this is reflected in similar patterns of neural activation for the two forms relative to pronouns. Previous research has also shown that names and definite NPs are similar in that processing either form is easier when the antecedent is not the most salient discourse referent. In order to test whether this is reflected in patterns of neural activation, we included both a condition in which full anaphors had salient antecedents, and a topic shift condition in which they had non-salient antecedents.

In both experiments, participants (forty in Experiment 1, twenty seven in Experiment 2) were scanned in a Siemens 3T MRI while they read three-sentence discourses presented one sentence at a time. Salience was manipulated by the order, recency, grammatical position and form of the previous mention. Items appeared in one of three conditions as follows (Experiment 1/Experiment 2):

1. Victor/The host wanted to dine with Stephanie/the businesswoman.
2. He arranged to have dinner at a nice restaurant.
3. Pronoun: In the end, he thought the dinner went well.
   Salient-Full: In the end, Victor/the host thought the dinner went well.
   Non-Salient-Full: In the end, Stephanie/the businesswoman thought the dinner went well.

We focus here on differences in BOLD signal between the two full conditions and the pronoun condition during Sentence 3. Overall, the Pronoun condition resulted in lower levels of activation than both full conditions in both experiments. Table 1 summarizes the activation in the full conditions relative to pronouns (z>2.3, p<.05). Most generally, parietal regions were critical to the processing of discourse reference, and pronouns resulted in less activation in these regions than either fuller form. This is consistent with the role of parietal regions in working memory and suggests that pronouns are easier to process in terms of working memory requirements. Also, the left mid temporal lobe was more involved in the processing of full anaphors with non-salient antecedents, indicating a role for semantic processing, known to be associated with this region, in discourse topic shifts. Finally, repeated names but not definite NPs invoked greater activation than pronouns in the left frontal language areas. This shows that despite the behavioral similarities in processing names and definite NPs relative to pronouns, the underlying processes are likely different.

Table 1. Regions activated in the full conditions than in the Pronoun condition (z>2.3, p<.05 cluster threshold in FSL)

Experiment 1 (Names).
Salient-Full > Pronoun: Inferior Frontal Gyrus (Left), Inferior Parietal Lobule (Left)
Non-Salient-Full > Pronoun: Inferior Frontal Gyrus (Left), Precuneus (Right + Left), Mid Temporal Gyrus (Left)

Experiment 2 (Definite NPs).
Salient-Full > Pronoun: Precuneus (Right + Left), Inferior Parietal Lobule (Left)
Non-Salient-Full > Pronoun: Precuneus (Right + Left), Inferior Parietal Lobule (Right + Left), Mid temporal Gyrus (Left)

References
THE STRUCTURE-SENSITIVITY OF MEMORY ACCESS: EVIDENCE FROM MANDARIN CHINESE

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Recent work on the mechanisms used to query linguistic structure online highlights a basic distinction between content-addressable and ordered search processes [1]. Convergent evidence from time course analysis measures such as speed-accuracy tradeoff (SAT) [1-2] and measures of retrieval interference [3-4] implicate the use of content-addressable memory access during online sentence comprehension. However, these results considered dependencies that could be predicted by their left-most element or were not structurally constrained, and thus they did not provide strong contexts for ordered search processes to be deployed. Using both speed-accuracy tradeoff and ERP measures, we provide evidence from Mandarin Chinese reflexives that suggests that structured search processes are also used during online dependency formation.

We examined the Mandarin Chinese long-distance reflexive ziji, which is a constrained retrospective dependency that a) cannot be recognized until the right-most dependency element (ziji) is encountered, b) involves possibly unbounded dependencies (unlike English reflexives), and c) is subject to structural constraints. This combination of properties makes structured search useful for resolving the antecedent-anaphor dependency. Constrained retrospective dependencies thus represent a crucial test case for evaluating candidate memory access methods. We designed two experiments to test the processing of ziji when its antecedent was local (within the same clause, (2a)) or long-distance (in a dominating clause, (1a)). Importantly, antecedents for ziji must be in animate NPs. We tested participants on these sentences using multiple response SAT methodology [1-2] (Experiment 1, n=20), as well as ERP methodology (Experiment 2, n=24). If the antecedents for ziji are retrieved using a parallel-access mechanism, then there should be no dynamics differences in the resulting SAT functions: access time should be constant across any linear or hierarchical distance. A dynamics difference would suggest a structured search mechanism.

Experiment 1. The best-fitting SAT functions attributed a slower rate parameter to (1) than (2): (2a) had an advantage of 270ms over (1a) over the course of dependency completion (Wilcoxon test p < 0.03). This indicates that local antecedents were accessed more rapidly than long-distance ones. A control comparison with non-anaphoric NPs in sentence-final position (1-2b) showed no such difference. Across ziji and control comparisons, there was a general preference for main clause animate subjects (as measured by asymptotic accuracy in the SAT function), suggesting the rate advantage for local antecedents derives neither from a general preference for local antecedents nor difficulty in binding from the long-distance antecedent.

Experiment 2. Long-distance antecedents elicited larger anterior negativities than local antecedents starting at 400ms post-stimulus (LME model, p = 0.025), despite the general preference for long-distance antecedents. Anterior negativities have been linked to memory retrieval operations in filler-gap dependencies [5]. These results corroborate the findings in Experiment 1, suggesting the effect is related to working memory retrieval processes.

This pattern of results is not predicted by a system that uniformly employs parallel-access retrievals [1-2], but they are expected if structured search processes are used in constructing ziji antecedent-anaphor dependencies.

1a/b Li-jiaoian biaoming napian-baoda [zai tuandui weineng fahui shuizhun de-shihou] digu-le ziji/nawei-jiqiushou
Coach Li say [that report [when team not perform well time] underestimate ziji/batsman]
  “Coach Li says that that report underestimated self/the batsman when the team was doing poorly.”
2a/b huiyilu biaoming Li-jiaoian [zai tuandui weineng fahui shuizhun de-shihou] digu-le ziji/nawei-jiqiushou
Autobiography say [coach Li [when team not perform well time] underestimate ziji/batsman]
  “The autobiography says that Coach Li underestimated self/the batsman when the team was doing poorly.”

CONSTRaining FOCUS INTERPRETATION IN DISCOURSE

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Interpreting sentences with focus-sensitive items like “only” depends on context to appropriately restrict the domain of alternatives [1]. What information constrains how listeners restrict interpretive domains? In three eye-tracking experiments [2], we examine the following factors: (a) Whether target was previously mentioned (Mention/No mention), (b) Whether target sentence contained “only” (Only/No only), (c) Whether target item was conceptually similar to mentioned items (Same/Different category), (d) Discourse relation relating target sentence to preceding discourse (Parallel/Narrative).

In all experiments, an initial sentence introduced a context, and a subsequent sentence identified a target from a 4-item display (3) that participants clicked on. If any of these factors contribute to restricting focus alternatives in subsequent sentences, listeners should be better able to predict the upcoming focused element and identify the corresponding referent.

Experiment 1 compared sentence pairs like (1b)-(2) (Mention) with pairs like (1a)-(2) (No Mention). The target referent was identified earlier when previously mentioned. Further, there was a Mention-Only interaction: at 200-400ms, there were more target fixations in Only vs. No Only trials, for Mention (p<.001) but not No Mention (p=.35). In Mention-Only trials listeners disambiguated the target before the input disambiguated it—after hearing only the initial sound of the target word, listeners strongly expected previously mentioned items to constrain possible referents. Experiment 2 extended Experiment 1, including target referents that were discourse-new but in the same conceptual category as mentioned items. Participants heard sequences (4)-(5) where the target was mentioned (5a), unmentioned same-category (5b) or unmentioned different-category (5c). Mention again facilitated target identification (p=.01). Additionally, same-category targets were disambiguated earlier than different-category targets (p<.05), revealing listeners have a stronger expectation for conceptually related items to be focused. Thus both direct and indirect mention strongly constrain the alternatives a subsequent sentence is interpreted with respect to.

In Experiments 1-2, all sentence pairs were related by a parallel discourse relation [3]; thus it may be that the strong mention-bias is induced by “only,” or conversely that “only” piggybacks on the existing parallel relation. In fact, previous research has often found powerful processing effects of discourse parallelism [4]. Experiment 3 asks if the sentence-level mechanism for restricting alternatives is contingent on the larger discourse structure. Experiment 1 conditions were embedded in contexts providing strong cues to either a parallel discourse (6)-(7a) or a temporal narrative (6)-(7b). Without “only,” participants’ expectations were predictable from context type: mentioned items were preferred in Parallel contexts, and dispreferred in Narrative contexts. With “only,” participants showed a strong mention preference regardless of context type. Thus the interpretive bias due to focus particles like “only” can override typically powerful effects of world knowledge.

In sum, Experiments 1-2 suggest items like “only” provide strong cues that the alternatives are restricted by previous mention. Future research building on Experiment 3 will sort out the division of labor among lexical, structural, and discourse factors in constraining focus interpretation.

(1) Mark has… a. some mugs and some books. b. some apples and some books. (2) Jane (only) has some apples. (3) apples (target); axes (competitor); candles, sneakers (distractors) (4) Mark has some apples and some oranges. (5) Jane only has… a. some apples. b. some pears. c. some sneakers. (6) Natalie created an elaborate beach backdrop for the school play. (7) a. The director liked the dolphins and the waves/seals. Everyone else (only) liked the seals. b. Last week, she finished the dolphins and the waves/seals. Yesterday she (only) painted the seals.

WHY OR WHAT NEXT? EYE MOVEMENTS REVEAL EXPECTATIONS ABOUT DISCOURSE DIRECTION

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Previous research provides evidence for expectation-driven processing within sentences at phonological, lexical, and syntactic levels of linguistic structure (Kamide et al. 2003; Levy 2008; inter alia). Less well-established is whether comprehenders also anticipate pragmatic relationships between sentences. To address this, we evaluate a unit of discourse structure—the intersentential coherence relation—which comprehenders must infer to hold between sentences in order for a discourse to make sense (Mann & Thompson 1988; Kehler 2002; Asher & Lascarides 2003). In a novel paradigm, we trained subjects to associate regions of their visual field with particular coherence relations. Subsequently, listeners’ anticipatory eye movements during critical sentences confirmed that the relationship between the current sentence and an upcoming sentence is subject to expectation-driven processing. This study extends the work on prediction beyond sentence-internal structure, and provides a new methodology for examining the cues that comprehenders use to establish relationships at the discourse level.

Implicit-Learning Training: To establish specific region-relation mappings, we adapted an infant category-learning paradigm in which an item is shown entering the bottom of a Y-shaped tube and then emerging from the left or right output end, depending on its classification (McMurray & Aslin 2004). To train comprehenders to implicitly identify specific discourse relations, we asked subjects to figure out how a virtual “tube” classified stories. For each item, a ball entered the tube, a two-sentence passage played, and subjects selected the output end where they thought the ball would re-appear. The emerging ball then provided feedback as to the correct classification. Post-training items showed that a third of subjects learned the correct classification—that one output end corresponded to Explanations like (1), in which the second sentence answers the question ‘why’ relative to the first, and the other corresponded to Occasion passages like (2), in which the relevant question is ‘what next’.

Eye-tracking: The second phase consisted of a speeded-response task with the same classification tube. Subjects listened to the first sentence of a passage (3a, 4a) and clicked on the ball when it appeared at one of the two tube output ends in order to hear the second sentence (3b/b’, 4b/b’). Crucially, the first sentence contained a coherence-biasing cue (Kehler et al. 2008): either a ‘why’-biasing implicit-causality verb (3a) or a ‘what-next’-biasing transfer verb (4a). While listening to the first sentence and waiting for the ball to re-appear, subjects looked to the region corresponding to the verb-indicated relation, although the timecourse of the effect differed by verb type and post-training test performance. Subjects who were successful during training looked to the ‘why’ region as early as 400-600ms after implicit-causality verbs (i.e., before the current proposition was complete), whereas less-successful subjects failed to show the same pattern until 2000ms after the verb. Both groups looked to the ‘what-next’ region ~1000ms after transfer verbs.

To our knowledge, this is the first demonstration of online expectation-driven processing at the level of discourse structure, extending claims of such processing beyond sentence-internal levels and showing that pragmatic reasoning about upcoming discourse relations need not wait until the end of the sentence.

1. ‘Why’ relation implicit-learning training item: Leo takes the bus to work. He doesn’t have a car.
2. ‘What next’ relation implicit-learning training item: Melissa ran towards Trevor. They embraced.
3. Critical item with ‘why’-biasing implicit causality verb in first sentence:
   a. first sentence: Arthur scolded Patricia in the hallway.
   b. ‘why’ continuation: She had put thumbtacks on the teacher’s chair.
   b’. ‘what next’ continuation: He then sent her to the principal’s office.
4. Critical item with ‘what-next’-biasing transfer verb in first sentence:
   a. first sentence: Heidi shipped Eric a package.
   b. ‘why’ continuation: She thought he would like some cookies from home.
   b’. ‘what next’ continuation: He wrote her a thank you note.
WHAT DO LISTENERS' EYES REVEAL ABOUT COMMUNICATING PRIVILEGED BELIEFS?

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When we anticipate (or explain) the actions of others, we typically do so on the basis of our understanding of their current mental states, such as their knowledge, beliefs and intentions. Given the frequency with which this sort of thinking occurs in everyday life, one might think that we can perform this task effortlessly. Contrary to this intuition, emerging psycholinguistic research has shown that predicting the behaviour of others can be more difficult than simply considering our own perspective [2, 4] and that inferring someone else’s perspective is subject to interference from our own point of view [6]. Indeed, this process can be made even more difficult in scenarios where we hold conflicting or privileged information about the world [1, 5].

We report an interactive visual world study, where two communicators watched short videos on separate computer monitors and subsequently described the events to each other. Videos depicted a series of transfer events, which began with an actor moving an object (e.g. an umbrella) into one of two boxes (labelled A and B). Next, the actor either lifted the object out of the box then replaced it into the same box (the No-move condition), or moved it into the alternative box (the Move condition). Forty pairs of communicators took part in the experiment; we tracked ‘listeners’ eye-movements around the final visual scene, time-locked to related auditory descriptions provided by the ‘speaker’ (confederate). The speaker’s description typically began: ‘The umbrella is in box...’. Critically, on half the trials a screen blocked the speakers’ (but not the listeners’) view part-way through the video, therefore establishing a discrepancy in the knowledge held by the two communicators on Move trials.

Eye tracking analyses revealed that following the object noun (e.g. ‘umbrella’) onset, listeners were more likely to fixate the object’s ‘real’ location when it had been presented in the No-move compared to the Move condition (Fs > 20.48, ps < 0.001). More interesting is the finding that listeners’ anticipatory eye-movements showed a significantly stronger bias to the object’s ‘real’ location when that knowledge had been shared between the two communicators compared to when listeners held privileged knowledge of the object’s location (Fs > 13.36, ps < 0.001). However, in privileged knowledge trials (Move condition), listeners showed no significant anticipatory bias to either potential object locations (ts < 1).

These results demonstrate that during interactive communication, we rapidly integrate contextual cues, including other peoples’ perspectives, to direct expectations about forthcoming language reference. This process of perspective-taking has the effect of influencing the location and strength of visual biases in an online task. Although our results argue against an absolute egocentric bias (since listeners were not biased towards the object’s ‘real’ location), they do demonstrate some interference from the knowledge of the actual location. We will discuss these results in terms of a ‘pull of reality effect’ [3], which we see here operating independently of any lower-level language-driven effect established in [2].

References:
CONTRAST AND LINGUISTIC MENTION: OUT OF SIGHT BUT STILL IN MIND

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Psycholinguists often appeal to different aspects of context by distinguishing, e.g., between linguistic and visual context. Unfortunately, experimental tools for distinguishing between types of context are limited and may even obscure important differences. For example, in the visual world paradigm, referents of anaphoric expressions are typically also visually co-present. We conducted three experiments separating effects of discourse representations from visually salient context, addressing three questions: Does the “contrast set” evoked by a scalar adjective have a discourse status, affecting interpretation across sentential boundaries? If so, is it caused by linguistic mention or the comprehender’s visual experience? Finally, does mention have a privileged status when comprehenders identify contrast sets?

When hearing a referring expression containing a scalar adjective (e.g. “the big candle,” henceforth “scalar NP”) listeners expect the referent to belong to a set of objects contrasting in size (Sedivy et al. (1999)). Our experiments asked whether this “contrast set” affected subsequent discourse. There are three possible findings about sentences like (1), uttered in a visual context containing two contrast sets, with a light H* pitch accent on “small:” a bias at “small” towards the mentioned contrast set, the unmentioned contrast set, or neither. A lack of bias would indicate that contrast sets are used for on-line reference resolution and have no discourse status. A bias towards the unmentioned contrast set would be consistent with Gundel et al.’s (1993) familiarity hierarchy, which predicts definite descriptions refer to objects that are uniquely identifiable but not represented in short-term memory. A bias towards the mentioned contrast set would suggest that this contrast set is contextually salient, facilitating subsequent reference to members of that set and/or inhibiting reference to other objects.

In Experiments 1A & 1B after hearing a scalar NP, participants made significantly more looks during the next adjective to the other member of the mentioned contrast set than to a member of another contrast set. This bias was observed in trials like (1), establishing the basic effect, and (2), where participants did not manipulate the referent of the first scalar NP. The bias was not present in trials like (3), where participants moved a member of a contrast set described without a scalar adjective, or in trials like (4), where participants moved a member of a contrast set described with a noun and locative modifier. Thus, the cross-sentential bias is caused by linguistic mention of a scalar adjective.

Experiment 2 included trials like (5). Participants permanently removed a member of one contrast set from the visual display. At “small” in (5), the only contrast set in the visual context is the unmentioned contrast set. Nonetheless, participants continue to make more looks to the member of the mentioned contrast set than to a member of the unmentioned contrast set. These results demonstrate that contrast has a special discourse status and linguistic mention has a privileged status with respect to contrast. More generally, our “trash” paradigm should prove useful for future studies examining hypotheses about the role of linguistic mention.

(1) Put the big candle above the diamond; now put the small [candle/tie] below the circle.
(2) Put the circle above the big candle; now put the small [candle/tie] below the diamond.
(3) [Context: The big candle is in the yellow square.] Put the object in the yellow square above the circle; now put the small [candle/tie] below the star.
(4) Put the candle that’s near the yellow square into the blue square; now put the small candle/tie into the red square.
(5) Put the big candle into the trash; now put the small [candle/tie] into the yellow square.

References
SIX BLIND MEN AND AN ELEPHANT: MAKING SENSE OF CROSS-TECHNIQUE MISMATCHES

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As the psycholinguist’s empirical arsenal becomes more diverse, we increasingly encounter situations where results from one technique appear to be in conflict with results from other techniques. Although initially disheartening, these mismatches can prove to be very helpful for understanding the link between underlying mechanisms and our experimental measures. In this talk I will discuss a number of examples of such mismatches, with a focus on apparent discrepancies between findings from electrophysiology (EEG, MEG) and other behavioral and neural measures (e.g., eye-tracking, self-paced reading, speed-accuracy tradeoff, fMRI). The cases to be discussed include the following: (i) Contrasting conclusions about the special status of syntactic information reached in ERP and behavioral studies. This discrepancy is largely terminological. (ii) Contrasting evidence on the timing of linguistic processes drawn from different techniques: relative to the very fast timing estimates derived from measures such as eye-tracking, the timing of some electrophysiological components can appear rather sluggish. I suggest that these discrepancies are smaller than they may initially appear. (iii) Contrasting evidence on the localization of key language processing mechanisms: experimental paradigms that elicit the classic N400 component in ERPs elicit brain activity that shows conflicting localization when measured using MEG and fMRI. Understanding this discrepancy can help to clarify the neuroanatomical circuitry involved in integrating top-down and bottom-up information. (iv) Relative timing measures derived from ERPs and SAT measures can suggest contradictory conclusions. This contrast can help to clarify how the task demands of specific techniques impact timing profiles. (v) Differing theoretical conclusions drawn from ERPs and other measures on the degree of coupling of syntactic and semantic processing. Taken together, the contrasting results from different measures prove to be a strength rather than a limitation of methodological diversity.
"MIND THE GAP!" ON THE INTERDEPENDENCE BETWEEN EYE MOVEMENTS AND NEUROPHYSIOLOGICAL RESPONSES DURING REAL TIME LANGUAGE COMPREHENSION

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Over the past decades, research on the temporal properties of real time language comprehension has drawn primarily upon data from two methods: the monitoring of eye movements (EMs) and the measurement of event-related brain potentials (ERPs). However, progress in psycholinguistic modelling has been impeded by the fact that these two very widely used methods often appear to yield diverging results (cf. Sereno & Rayner, 2003). Hence, a lot of discussion has centred around the issue of which method is to be preferred over the other, rather than focusing on the – scientifically more substantive – question of how the relationship between EM and ERP findings should be envisaged.

In this talk, we present the first systematic investigation of concurrent EM-ERP measures at the sentence level. Our findings suggest that natural reading differs from both auditory and rapid serial visual presentation, likely due to differences in attentional allocation. In addition, we discuss the possibility of parafoveal preview in natural reading as one major source of the apparent mismatch between EM and ERP findings.

We conclude that the modality of information uptake plays a much bigger role in determining the psycholinguistic and neurolinguistic correlates of language processing than previously envisaged.
LINGUISTIC KNOWLEDGE, WORLD KNOWLEDGE, AND "SEMANTIC" EFFECTS ON SENTENCE PROCESSING

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The large effect that semantic knowledge has on comprehension has been used to argue for an interactive model of sentence comprehension, whereby world knowledge of objects and events is used online during sentence processing (Ferretti et al., 2001). Alternatively, these semantic effects may stem from linguistic knowledge about words and their patterns of co-occurrence, without online input from world knowledge (Jones & Mewhort, 2007; Landauer & Dumais, 1997). We test this claim by investigating whether language structure is rich enough to account for common semantic effects in sentence processing.

Study 1 contained corpus analyses examining whether distributional statistics – like calculated words’ co-occurrence probability and their distributional similarity in terms of degree of shared contexts – could predict key semantic effects in sentence processing. In Study 1A, we show that these statistics account for a range of noun-verb semantic plausibility effects (i.e., Garnsey et al., 1999). In Study 1B, we show that these statistics can be used to predict noun-verb thematic relations (Gruber, 1965). In Study 1C, we show that these statistics can be used to predict even highly-specific semantic relationships like the obligation of specific noun type for a given verb (e.g., sword for behead, Koenig et al., 2003).

Critically, follow-up analyses revealed that the patterns of co-occurrences underlying many of these relationships are quite different from patterns typically attributed to world knowledge. For example, rather than overlapping characteristic features, words’ distributional similarities are often driven by overlap in potential states or relations. That is, distributional patterns in language reflect things we tend to talk about rather than default semantic properties. In Study 1D, we show that despite being unlike world knowledge categories, the category structures emergent from language statistics can be used to predict nouns’ taxonomic, script-based (Ross & Murphy, 2001), and ad-hoc categories (Barsalou, 1984), as well as verbs’ lexical semantic categories (Levin, 1992).

Study 2 used a semantic priming paradigm to demonstrate that words related in language statistics (highly co-occurring or distributionally similar) prime each other more than pairs that are similar in their world knowledge features. In each study, 96 participants saw trials with a prime, followed by a target word, with a 250 ms SOA. They made a semantic judgment about the target (e.g., “is it a living thing?”). In Study 2A, adjective-noun pairs describing discourse-relevant states (rotten-carrot) primed each other better (yielded shorter RTs to targets) than those that define characteristic features (crunchy-carrot). Study 2B and Study 2C show similar effects for verb-noun and noun-noun pairs, where items likely to co-occur or be similar in discourse (inflated-balloon; baby-dog) yielded reliably more priming than pairs related by characteristic features (floated-balloon; cat-dog).

The corpus and behavioral results show that language’s distributional statistics are rich enough to support a large number of semantic effects relevant to sentence processing and that language-based statistics differ markedly from world knowledge. Moreover, comprehension processes, as measured by priming, reflect linguistic relationships more closely than world knowledge relationships. We discuss the roles of linguistic knowledge, world knowledge, and their interaction in comprehension.


THE INTERFACE OF LANGUAGE AND PERCEPTION: WHEN MOTION MEETS ANIMACY.

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Embodied cognition approaches argue that sentence comprehension involves the partial re-enactment of the action described, and therefore engages sensory-motor representations shared with action and perception [1]. Such shared representations however may arise due to feature overlap between words and non-linguistic representations, rather than sentential meaning composition, which appears to engage additional processes absent in action perception [2]. Here we use fMRI to investigate whether sentence comprehension elicits perceptually-based representations derived from composed meaning rather than words.

We manipulated motion and animacy (motion-non-motion, animate-inanimate, 2x2 design) (see example (1)). Previous perception studies indicate that distinct portions of occipito-temporal cortex selectively respond to motion (V5 region) or humans (superior temporal gyrus) [3]. Thus embodied approaches predict similar modulations in these regions by language and perception. Two tasks were conducted in the scanner. The visual perception task presented participants with visual events varying in motion and animacy as in (a-d) plus moving dots. These conditions were used to define the regions sensitive to visual motion, human or object motion perception (localizers). The sentence comprehension task used the blank-screen paradigm and presented a scene for 2 sec. containing a standing mechanic, a plane and a building. After the screen went blank, a sentence was auditorily presented. Participants indicated when the sentence did not match the picture. This design thus encourages visual representations, as previously demonstrated [4]. Stimuli were matched by frequency and length.

In perception, V5 was found to be active for all stimulus conditions, and human and object motion elicited distinct regions in posterior temporal regions. However, there was no effect of language in V5. Moreover, sentences modulated activity within all visually identified temporal regions, indicating that language does not elicit region-specific responses to humans or objects. Interestingly, all visually-defined temporal regions, as well as prefrontal regions that were inactive in perception, show the same pattern of activation: an interaction between animacy (human vs. object) and motion (motion vs. non-motion). Human motion sentences elicited as strong activity as human non-motion sentences. However, object motion sentences elicited stronger activity than object non-motion sentences. This suggests that within perceptual areas, human sentences elicit equally strong levels of activity regardless of motion, whereas object sentences only elicit strong activity in conjunction with motion.

Results suggest that sensory-based representations in language do not have the specificity found in visual perception even when reference to a visual scene was encouraged. Instead, language activates a network of posterior and pre-frontal regions that although partially overlap with perception, are distinctively modulated by sentence composition. We argue that the potential for motion inherent to humans, particularly in subject position, caused similarly high activation levels for human motion and non-motion sentences, whereas object sentences follow the motion vs. non-motion pattern found in posterior temporal cortex in previous verb studies [5]. This suggests strong conceptual and language-specific influences of animacy in sentence processing that do not match action perception.

Example (1) (a) The mechanic will walk towards the plane (human motion), (b) The mechanic is standing near the plane (human non-motion), (c) The plane will taxi towards the building (object motion), (d) The plane is parked near the building (object-non-motion).

References
Sentences with quantifiers are hard to understand though, intuitively, quantifiers differ with respect to how difficult they are. To find out how different quantifiers affect online comprehension, we investigated their complexity in a self-paced reading study. We derived predictions on the basis of two recent semantic accounts. One is Szymanik (2009) following van Benthem (1986) formalizing computational complexity in terms of model checking devices. For instance, no can be modeled by a finite acyclic automaton with two states (one accepting, one rejecting) rendering it a very simple quantifier. Besides their general architecture, minimal automata (= quantifiers) differ with respect to the number of states. Our first hypothesis (H1) is: the more states a quantifier requires the more difficult it is. Geurts & van der Slik 2005 and Geurts et al. 2009 claimed that two other factors influence complexity: monotone decreasing quantifiers (less than/at most) should be harder to understand than monotone increasing quantifiers (more than/at least) (H2) and superlative quantifiers (at least/at most) should be more complex than comparative quantifiers (more than/less than) (H3). H2 and H3 predict differences between more than 3, at least 4, less than 4 and at most 3. By contrast, H1 doesn't predict any differences between them since all are acyclic finite automata with five states. Basically testing these quantifiers, Geurts and colleagues provide evidence for H2 and H3 from reasoning tasks and acquisition but don't find online differences. The lack of effect may, however, be due to comparing RTs of whole sentences with considerable lexical differences across conditions.

To avoid this potential problem, we investigated scope-disambiguated doubly quantified German sentences like (1)–(7) and measured RTs of the second quantifier Q2. Q2 should reflect complexity of Q1, because Q1’s meaning can only be computed after Q2 has been composed with the verb. Hypotheses H2 and H3 were tested comparing cardinal quantifiers (1) – (4). H1 was tested by comparing cardinal quantifiers to exactly one (three states) and to no (two states). We varied the numeral of the cardinal quantifiers systematically between items (cf. (1)-(4): 3/4/4/3 (=five states) vs. 5/6/6/5 (=seven states) vs. 7/8/8/7 (=nine states)). The definite description (7) was included as a control.

42 participants read 42 items. One third was followed by questions like (8) querying for quantitative relations expressed by the sentence. These were answered 83% correct. On Q2, the definite description (1664ms) lead to significantly faster RTs than both no (1854ms) and exactly one (1887ms) which in turn had significantly faster RTs than the cardinal quantifiers. The differences in RT between the latter were far from significant (more than 2082ms, at least 2094ms, less than 2150ms and at most 2081ms). Furthermore, the RTs after cardinal quantifiers increased with the number of states of the automaton.

Our findings fully support hypothesis H1. Like Geurts et al. (2009), we didn’t find evidence for hypotheses H2 and H3 in comprehension. Given the current situation in semantics with hardly any measures of computational complexity the automata account offers a promising starting point.

    At most three (five/seven) teachers praised each of their pupils.

(2) Weniger als vier (sechs/acht) Lehrer | lobten | jeden ihrer Schüler.  
    Less than four (six/eight) teachers praised each of their pupils.

(3) Mindestens vier (sechs/acht) Lehrer | lobten | jeden ihrer Schüler.  
    At least four (six/eight) teachers praised each of their pupils.

(4) Mehr als drei (fünf/seben) Lehrer | lobten | jeden ihrer Schüler.  
    More than three (five/seven) teachers praised each of their pupils.

(5) Genau ein [exactly one] Lehrer | lobte | jeden seiner Schüler.  
    One teacher [exactly one] praised each of his pupils.

(6) Kein [no] Lehrer | lobte | jeden seiner Schüler.  
    No teacher praised each of his pupils.

(7) Der [the] Lehrer | lobte | jeden seiner Schüler.  
    The teacher praised each of his pupils.

(8) Sample question (following sentence (5)): Is it possible that there is another teacher who praised only half of his pupils?

DOMA\-NI\-GE\-NERAL MECHANISMS IN THE CONSTRUCTION OF MEANING

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Fundamentally, language is a vehicle for conveying and constructing complex meanings out of simple pieces. Consequently, characterizing the core mechanisms responsible for this combinatorial process should be a central goal in the cognitive neuroscience of language. However, to date, there has been little research directed at the heart of this problem with past work focused mostly on phenomena such as complex syntactic constructions [1], semantically unexpected expressions [2], and semantic mismatches [3]. Therefore, in the present research, we introduce a novel paradigm investigating the processing evoked by a straightforward, minimal combinatorial context – a simple adjective-noun phrase. We used magnetoencephalography to track brain activity during the comprehension of a noun, both in the presence and absence of a combinable adjective. Previous research suggests that the ventro-medial prefrontal cortex (VMPC) is involved in semantic composition [3] while the left anterior temporal lobe (LATL) plays a central role in syntactic structure building [4]. If these regions subserve basic linguistic combinatorial processing, we expect to see an increase in their activity during the combinatorial condition.

Exp. 1: 20 subjects were asked to judge whether a colored shape matched a preceding verbal description. We used a 2x2 design with Task (Composition, List) and Number of words (One, Two) as factors. Subjects had to determine either if the following shape matched the entire description (Composition) or any part of it (List). Processing of the noun showed significantly more activity in the LATL from 200-300ms and the VMPC from 300-500ms for the Two-word Composition condition (‘red boat’) compared to the other conditions (‘xhl boat’, ‘cup boat’). This suggests that the VMPC and LATL subserve operations active during basic linguistic combination. Furthermore, the temporal ordering of the effects conforms to a broad class of models positing initial syntactic operations prior to semantic composition [5].

Exp. 2: The extent to which language processing relies upon domain-general mechanisms has recently been speculation upon [6], though little direct empirical data has yet been uncovered. Recent research has focused on parallels between syntactic and musical parsing, though primarily within incongruous situations [7]. By substituting analogous non-linguistic stimuli for our previous verbal descriptions, we were able to approach this problem more directly. Our task still required conceptual integration of both shape and color from the phrasal replacements and extraction of shape alone from the control condition. Therefore, if increased activity observed during linguistic combination reflects domain-general operations, we expect to see similar increases for this comparison. 19 subjects were shown either a colored shape and asked to determine if the following picture was of the same shape and color or a silhouette on a colored background and asked to judge if the following picture was of the same shape, with color being irrelevant. We found significantly more VMPC activity during the processing of Colored shapes as compared to Silhouettes, but no LATL effects. This suggests that syntactic processes are comparatively language-specific, while semantic operations reflect a more domain-general conceptual combination mechanism.

References:
BETWEEN WORD REGRESSIONS AS PART OF RATIONAL READING

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Although between-word regressive eye movements are induced by many types of processing difficulty in sentence comprehension, they are generally not accounted for by current models of eye movement control in reading (with the notable exception of E-Z Reader 10, Reichle et al., 2009). This inability of current models to account for between-word regressions may relate to their assumption that word recognition is a discrete all-or-nothing process, usually completed before moving on to the next word. Conversely, given that reading depends on noisy sensory input, a rational reader would maintain uncertainty about the identity of previous words, and update that uncertainty as the identities of future words become better known. Since this means uncertainty can increase about previous words, regressive saccades may be performed for the same reason as progressive saccades - to gather visual information about current positions of uncertainty (for evidence, see Levy, Bicknell, Slattery, & Rayner, 2009). The only way to prevent such erosion of confidence in previous regions is to ensure an initially high level of confidence – i.e., long first-pass durations. A superior strategy, however, could be shorter first-pass durations combined with regressive saccades executed when and if confidence in previously read input falls. In this paper, we test this intuition in a formal model of reading as a process of performing Bayesian inference under noisy visual input, and show that behavioral policies utilizing between-word regressions outperform those without.

Model. Our model of reading performs Bayesian inference to determine the contents of a sentence, using a probabilistic language model as the prior distribution and noisy visual input obtained over a sequence of timesteps as evidence. At each timestep, a policy decides whether to continue to fixate the current position, initiate a saccade, or stop reading, on the basis of current uncertainty about each character of the sentence. Visual input is given by sampling a 26-dimensional Gaussian (cf. Norris, 2006) with an asymmetric visual acuity function. There is a short delay before executing an initiated saccade and motor error is positively related to distance. The policy has two parameters, alpha and beta, which determine the criteria for initiation of progressive and regressive saccades respectively.

Experiment. To test the intuition that policies utilizing between-word regressions outperform those without them, we compare performance across a range of policy parameterizations, including non-regressive policies (beta = 0). For each parameterization, we simulate reading on the Schilling corpus (Schilling et al., 1998) and measure the number of timesteps taken to read the sentence and the probability of the correct sentence under the model’s final beliefs (‘accuracy’). For the model’s knowledge of language, we used a bigram language model trained on the British National Corpus.

Results. Our key result is that for each non-regressive policy, there is a regressive policy that achieves greater accuracy in less total reading time. This suggests that between-word regressive saccades can be seen as a rational strategy to cope with the reality of noisy visual input in reading. It addition, it demonstrates the feasibility of testing hypotheses about reading with a noisy-input Bayesian reading model.

References
Meseguer et al. (Mem & Cog, 2002) used a temporary attachment ambiguity of an adverbial phrase to test the Selective Reanalysis Hypothesis (Frazier, Rayner, Cog Psych, 1982), which maintains that during reanalysis in garden-path sentences the eyes are driven by the parser to intelligently seek out relevant information (cf Mitchell et al., JML, 2008). Their results, based on traditional eyetracking measures and transition probabilities, lend support to Selective Reanalysis. However, these measures can be problematic: Aggregates of several fixation strategies may furnish a fragmentary and ambiguous picture of the underlying fixation sequences. As Meseguer et al. point out: “To identify the type of overt reanalysis strategy that readers use requires the examination of the pattern of regressive eye movements”.

Here, we present a re-examination of the Meseguer et al. data set that uses a similarity measure for scanpaths (Malsburg & Vasishth, CUNY, 2009) and mixture of Gaussian models for identifying clusters of regression patterns. Using non-metric multidimensional scaling (Kruskal, Psychometrika, 1964) we fit maps of regression patterns on which similar patterns are located in similar areas. Expectation maximization was used to fit 200 cluster models which differed in free parameters and numbers of Gaussians (Fraley, Raftery, J Am Stat Ass, 2002). When we analyzed a two-dimensional map (stress 17%), a model with three clusters was optimal (Bayesian information criterion). Prototypical regression patterns for each cluster were identified by selecting the pattern that maximized the similarities to all other members.

Readers produce three main regression patterns after reading the disambiguating material: (a) regressing to the disambiguating region, (b) regressing to the beginning of the sentence, (c) regressing to the beginning followed by re-reading of the whole sentence or parts of it. Only the last strategy occurs significantly more often in the garden-path condition. When using a 3-dimensional map (stress: 12%), more structure is revealed and 14 clusters are detected. Again, pattern (c) was more likely to occur in the garden-path condition; also (c) was by far the most frequent pattern. Other patterns had a non-significant tendency towards the garden-path condition: (d) regressions to the disambiguating word (p=0.10), (e) regressions to the main verb (the true attachment site of the adverbial phrase in the garden-path condition, p=0.14), (f) re-reading the main clause (p=0.19). Also one pattern occurred more often in the non-garden-path condition: (g) re-scanning of the adverbial phrase (p=0.14).

Thus, the dominant strategy for recovering from garden-paths was re-reading the sentence. Patterns where the eyes selectively revisit previous material do exist but they are not clearly associable with the garden-path condition.

These results suggest that, in the Meseguer et al experiment, recovery from garden-paths consisted of rebuilding structure from the beginning of the sentence (presumably while inhibiting aspects of the initial parse) instead of directed restructuring of the parse. More generally, we demonstrate how scanpaths can be analyzed directly (instead of or in addition to reductions such as transition probabilities) to answer questions which crucially depend on eye-movement patterns. We make freely available a software for carrying out analyses of the type presented here (http://www.ling.uni-potsdam.de/~malsburg/scasim).

High-attachment condition: AdvP attaches to VP1
El Profesor [VP1 dijo [CP que los alumnos [VP2 se levantaran del asiento]] [AdvP cuando los directores entraron en la clase.]]

Low-attachment condition: AdvP attaches to VP2
El Profesor [VP1 dijo [CP que los alumnos [VP2 se levantaran del asiento [AdvP cuando los directores entraran en la clase.]]]]

The teacher said that the students had to stand up from their seats when the directors (came INDIC / come SUBJ) into the room.
THE LEXICAL PREDICTABILITY EFFECT: DISTRIBUTIONAL ANALYSIS OF FIXATION DURATIONS

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A word’s predictability, as measured by cloze probability, reliably affects the time the eyes spend on the word in reading [1-3], with shorter fixations when a word is a predictable sentence continuation than when it is unpredictable (e.g., teeth in examples (1a) and (1b), respectively). Indeed, computational models of eye movement control in reading [4-5] treat cloze probability as one of the two critical variables (together with word frequency) that determine fixation durations.

The present research addresses the question of how the predictability effect is manifested in distributional terms. Recently, it has been shown that the effect of word frequency on the mean of fixation duration measures is due both to a shifting of each subject’s fixation duration distribution to the right for low frequency words, and to an increase in skew, as evidenced by significant effects on both the μ and τ parameters of the ex-Gaussian distribution [6]. If the predictability effect is similar to the frequency effect in distributional terms, this would suggest that these two variables affect common processing stages or mechanisms. But if the predictability effect is confined to either the μ parameter or the τ parameter, this would suggest a qualitatively distinct effect on lexical processing.

Distributional analysis requires collecting more observations per subject than are usually obtained in eye movement experiments. Readers’ (N = 31) eye movements were monitored as they read 128 sentences, based on materials used in [1]. Each of 64 critical words, which varied across a wide frequency range, appeared twice in the experiment; in one sentence the context rendered the word highly predictable, while in the other the word was a plausible but unpredictable continuation. There were highly significant predictability effects on both first fixation duration (14 ms) and gaze duration (22 ms). Linear mixed effects modeling revealed that word frequency also had significant effects, but there were no reliable interactions between frequency and predictability, consistent with previous work. A range of additional variables, such as target word repetition and linear position in the sentence, were found not to have significant effects. Thus, the experiment reinforced the conclusion that frequency and predictability are the critical predictors of word reading time, and that the effects of these variables are additive rather than interactive.

Surprisingly, the distributional analysis revealed that the predictability manipulation had a pronounced effect on shift, but little or no effect on skew: The first fixation effect was entirely an effect on the μ parameter, and the gaze duration effect was primarily an effect on the μ parameter. Thus, mean fixation duration is longer for an unpredictable word not because this word occasionally induces a prolonged inspection, but because an increment is added to most or all trials. Implications of this pattern for the theoretical interpretation of the predictability effect will be discussed.

1. a) The dentist told me to brush my teeth after every meal.
   b) He lost three teeth and had a black eye after the fight.

ASSIGNMENT OF GRAMMATICAL ROLES IN THE ONLINE PROCESSING OF MANDARIN PASSIVE SENTENCES IN FIVE-YEAR-OLD CHILDREN

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In both offline and online tasks, English-speaking children have been shown to have difficulty with passive utterances.1,2 What do these errors tell us about the architecture and development of language processing? The overlap in passive and active forms causes a temporary ambiguity in thematic role assignment since it is unclear whether initial arguments will be agents or themes, see (1). Thus because passives occur less frequently, a statistical parser may initially misanalyze them as actives. Consequently successful interpretation would depend upon revision following morphological disambiguation (~en in 1b). Critically, this ambiguity is less pronounced in languages like Mandarin where morphosyntactic markers can identify the thematic roles of arguments early in an utterance. How does the presence of this cue affect the comprehension of passives in children?

We explored the real-time interpretations of Mandarin active and passive sentences using the visual-world eye-tracking paradigm. Thirty-four Mandarin-speaking adults and 56 Mandarin-speaking five-year-olds heard critical utterances which varied in the type of case marker (BEI vs. BA) and the status of NP1 (expressed vs. pronoun), see (1) and (2). Participants’ eye-movements were measured to displays featuring expressed nouns (SEAL), likely agents (SHARK) and themes (FISH).3 If the acquisition of these morphosyntactic markers is sensitive to their frequency in the input, then comprehension of BA should precede BEI in children. Similarly, if passive utterances require a more sophisticated grammar, then comprehension of BEI should be delayed in children. If, however, difficulties in comprehending passives stem from a bias to assign the agent role to NP1, we would expect performance on BEI to be better in the pronoun condition because the disambiguating marker appears before the first thematic role can be assigned to a particular referent.

Eye-movements were analyzed as a difference score of looks to potential agents minus looks to potential themes. This analysis revealed that both adults and children used markers to incrementally assign thematic roles. Following the onset of BA, they looked to themes in the expressed NP1 condition and looked to agents in the pronoun condition. Similarly, following the onset of BEI, they looked to agents in the expressed NP1 condition and looked to themes in the pronoun condition. This led to critical interactions between marker and NP1 status during regions following the onset of NP2 (all p’s < .01). Analysis of actions revealed that ultimate interpretations were also influenced by these variables. Both adult and children correctly inferred the relevant arguments in both BA conditions and in the pronoun BEI condition (all p’s < .01). However, while adults correctly inferred the agent in the expressed BEI condition (p < .01), children in contrast demonstrated no clear preference for agents or themes (p > .60). This suggests that children had difficulty interpreting BEI when it required revision of a bias to treat the first noun as the agent.

These findings suggest that developmental difficulties in the comprehension of passives may stem from children’s incremental thematic processing and their failure to revise initial interpretations. They also suggest that listeners efficiently use language-specific cues to make probabilistic predictions of grammatical role assignments.4

(1) EXPRESSED NP1 CONDITION.  
  a. Seal BA it quickly eat  (TRANSULATION: The seal is quickly eating it)  
  b. Seal BEI it quickly eat  (The seal is quickly eaten)  

(2) PRONOUN NP1 CONDITION.  
  a. It BA seal quickly eat  (It is quickly eating the seal)  
  b. It BEI seal quickly eat  (It is quickly eaten by the seal)

VERB PRIMACY AND KINDERGARTEN-PATH EFFECTS IN WH-PROCESSING: EVIDENCE FROM ENGLISH AND JAPANESE

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Previous studies on children’s PP-attachment processing (e.g., [1]) show that children incrementally resolve ambiguities according to verb properties (‘verb primacy’), and fail to revise their initial analyses when presented later with conflicting cues (‘kindergarten-path effects’) [1,2]. Such verb primacy effects may reflect the fact that English verbs are processed before PP-attachment ambiguity arises. Here, we examine whether the verb primacy effects persist in wh-constructions where a fronted ‘where’ precedes the verb. Results from three Question-after-Story experiments in English and Japanese show that a) wh-attachment decisions are affected by the first verb (Exp1, 2), and b) verb primacy persists when an overt PP conflicting with the wh-phrase precedes the verb, leading to a novel kindergarten-path effect (Exp3).

Each experiment consisted of 8 cartoon stories with images of four different locations. In each story a character visits all four locations, one of which is host to the main clause event (e.g., saying in (2)) and another to the embedded clause event (e.g., butterfly-catching). Participants answered a target question after the four critical stories. Exp1 tested English-speaking adults’ and 5-year-olds’ comprehension of (2) and (3), which vary in the main clause predicate (say vs. tell someone). 24 adults and 18 5-year-olds preferred the embedded clause construal (A:100%, 5yr-olds:91.7%) in (2) (replicating [3]), but preferred the main clause construal in (3) (A:64%, 5yr-olds:81.4%). This indicates that lexical properties of say vs. tell affect wh-attachment preferences in adults and children alike.

To test whether the first-verb effect in Exp1 is restricted to main clause verbs, we examined the same construction in Japanese, where verbs appear in the opposite order of English due to head-finality (J:embedded-main, E:main-embedded). Exp2 tested two conditions: an ambiguous condition (4) translated from (2), and a forced main clause construal condition (5) where the selectional properties of the embedded verb block the embedded construal. 24 Japanese 5-year-olds preferred the embedded construal (93.5%) in (4) while preferring the main clause construal (77.5%) in (5). This suggests that properties of the first verb drive wh-attachment decisions, regardless of its structural position.

Exp3 disambiguated the Japanese sentence (4) by adding an overt locative PP that preceded either the embedded or main clause verb (6). Given the order of the PP and verb, the parser should recognize the PP as a filled-gap and prevent wh-attachment to the associated predicate. 24 Japanese 5-year-olds preferred the embedded clause construal (93.5%) in (4) while preferring the main clause construal (77.5%) in (5). This suggests that properties of the first verb drive wh-attachment decisions, regardless of its structural position.

These results demonstrate that children’s wh-attachment decisions are overwhelmingly driven by properties of the first predicate in the sentence, since properties of the verb can block children’s early attachment bias (Exp2) but additional locative PPs cannot (Exp3). This suggests that verb primacy effects in children’s comprehension [2] are unrelated to the temporal priority of verbs in English.

Rapid and accurate sense resolution is vital for both language comprehension and development: most words are polysemous, possessing multiple related senses (e.g., paper), and many are also homophones, possessing multiple unrelated meanings (e.g., bat). Here, we take a developmental approach to the question of how sense resolution is achieved. By examining patterns of success and failure over ontogeny, we can deduce the component representations and mechanisms.

The current study tests whether homophones and polysemes are accessed differently during comprehension. Recent work indicates that 4-year-old children have little difficulty resolving the meanings of polysemes [1], but an older literature suggests that they are unable to resolve homophones [2]. We therefore directly compared 4-year-old children's accuracy resolving homophones to their accuracy resolving both regular and irregular polysemes. In addition, we asked whether children utilize both local [a-c] and global [d-f] contexts in sense resolution. To test what mechanisms children use to resolve senses, we compared their performance to a Bayesian classifier trained on lexical co-occurrence statistics extracted from CHILDES [3]. Previous research suggests that children heavily rely on lexical statistics during parsing decisions, even ignoring plausibility [4].

Method: 32 children (3;10 - 4;2) listened to short vignettes containing an ambiguous target word [a-f]. Then, from a grid of four pictures, they were asked to choose “the picture that goes with the story.” Both the dominant (more frequent) and subordinate (less frequent) senses of the target were depicted, alongside semantic distracters for each sense. Children resolved 8 homophones, 8 irregular polysemes, and 8 regular polysemes (each heard only one sense per word). 16 children heard local context vignettes [a-c] and 16 heard global context [d-f]. To control for vocabulary, we excluded items that participants misidentified in a post-test without competitors.

Analysis & Results: Children's choice of the dominant or subordinate picture was analyzed using mixed effects logistic regressions, with ambiguity type, context type, and sense selected by the context (dominant/subordinate) as predictors. Contra the predictions of [2], children reliably changed the sense they assigned based on context (p<.05). This effect held for both homophones and polysemes, consistent with equivalent mechanisms of sense resolution. In addition, children were able to use multiple kinds of context: accuracy was similar across global and local contexts.

Finally, the comparison with the Bayesian classifier suggested that children use more than lexical statistics during sense resolution. Although neither children nor classifier were error-free, the item-based correlation between their performances was nearly zero (r = -0.03, ns). One possibility is that children have access to plausibility, contrary to work on their syntactic parsing decisions. In-progress work directly tests this, using contexts in which plausibility and statistics are in opposition [g]. In summary, children can draw on multiple contextual cues during sense resolution, and compute the correct sense based on more than lexical statistics. Further, they appear to use equivalent, or identical, mechanisms of lexical access for both homophones and polysemes under context.

[a] Snoopy was outside. He [chased/swung] a bat, which was big. [b] Bugs Bunny was at school. He [said/sent] a letter, which was fun. [c] Oscar was at the beach. He [caught/grilled] a fish, which was exciting. [d] Snoopy was [reading about animals/watching sports]. The bat was big. [e] Bugs Bunny was [at school/the post office]. The letter was fun. [f] Oscar was at [the ocean/a restaurant]. The fish was exciting. [g] Dora's mom wrote a friendly note to her teacher, and then [she signed the letter/she signed it with a letter].

STRUCTURE SENSITIVE AND INSENSITIVE RETRIEVAL OF SUBJECTS IN BRAZILIAN PORTUGUESE

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Competing accounts of structure encoding and retrieval in linguistic working memory make divergent predictions about the structure sensitivity of online dependency formation. Some models posit that the parser can retrieve information from targeted structural positions and predict structure-sensitive retrieval [1], while others rely upon non-structural cues in the context of a content-addressable memory architecture, and predict susceptibility to non-structural interference effects [2-3]. In three experiments with Brazilian Portuguese (BP) speakers we find that identical retrieval cues yield both structure sensitivity and insensitivity, depending on the syntactic dependency involved.

A grammatical constraint on BP null-subject (NS) licensing presents an excellent test of the structural sensitivity of retrieval processes. Unlike Spanish, where referential NSs are freely distributed, in BP they are only possible when licensed by the subject of a higher clause, specifically the closest c-commanding referential subject [4]. Hence, online detection of a NS, based on an agreeing verb with no preceding subject, should trigger retrieval of a subject from a structurally higher clause. The subjects of preceding but non-c-commanding clauses cannot license the NS. This generalization was confirmed in an offline acceptability rating study (Experiment 1, n=42). Meanwhile, in sentences with overt subjects the processing of verb agreement should trigger retrieval of the subject of the same clause, as in English.

Experiment 2 (self-paced reading, n=74) used 24 sets of sentences like (1) to test the structure-sensitivity of NS licensing in BP. Critical sentences contained a NS clause with two preceding subjects: one c-commanding subject ("structurally accessible"), and one non-c-commanding ("inaccessible"). The plural verb in the NS clause either matched the accessible subject ("gram" condition:1a), or neither subject ("ungram":1b), or the inaccessible subject ("interf":1c). Self-paced reading times were fit to a mixed-effects model, simultaneously controlling for participants and items as random effects. As expected, reading times following the critical plural verb were fastest in the grammatical condition and slowest in the ungrammatical condition. Importantly, there were no significant differences between interferer and ungrammatical conditions in these regions. This suggests NS licensing uses a targeted retrieval mechanism immune to non-structural interference effects.

Experiment 3 (speeded acceptability, n=34) also tested BP speakers’ use of plural verb morphology to retrieve subjects, but in the context of a standard agreement interference paradigm, using relative clause constructions like (2) that manipulated the match between a verb and (i) an adjacent subject and (ii) a more distant interfering noun [5-7]. Results showed that BP speakers show exactly the same profile as English speakers, with interference in ungrammatical sentences but not in grammatical sentences.

Together, these results show that the same retrieval cues (plural verb agreement) yield structure sensitive retrieval for one dependency and structure-insensitive retrieval for another. This indicates the need for retrieval mechanisms that target specific non-local structural positions, but presents a challenge for any model reliant on uniform retrieval mechanisms, whether structure-insensitive or structure-guided.

1A. GRAM: Os turistas que o ladrão enganou na rua deserta perceberam que estavam numa área ruim da cidade.
The tourists that the thief fooled in-the street deserted noticed that were-PL in-a area bad of-the city.

2B. UNGRAM: O turista que o ladrão enganou na rua deserta percebeu que estavam num a área ruim da cidade.
The tourist who the thief fooled in-the street deserted noticed that were-PL in-a area bad of the city.

3C. INTERF: O turista que os ladrões enganaram na rua deserta perceberam que estavam numa área ruim da cidade.
The tourist that the thieves fooled in-the street deserted noticed that were-PL in-a area bad of the city.

2A. GRAM: O doutor que o paciente consultou no corredor precisava consultar um especialista.
The doctor-SG that the patient-SG consulted-SG in -the hall needed-SG to consult a specialist.

2B. GRAM, INTER: Os doutores que o paciente consultou no corredor precisavam consultar um especialista.
The doctors-PL that the patient-SG consulted-SG in-the hall needed-PL to consult a specialist.

2C. UNGRAM: O doutor que o paciente consultaram no corredor precisava consultar um especialista.
The doctor-SG that the patient-SG consulted-PL in-the hall needed-SG to consult a specialist.

2D. UNGRAM, INTER: Os doutores que o paciente consultaram no corredor precisavam consultar um especialista.
The doctors-PL that the patient-SG consulted-PL in-the hall needed-PL to consult a specialist.

Individual differences in sentence processing are frequently explained by appealing to differences in working memory capacity (WMC), as measured by tests of complex memory span. This "capacity approach" is consistent with models of working memory in which a single, limited pool of resources is available for both information processing and active maintenance of the partial products of processing. Such models predict that individuals with smaller WMC may be disadvantaged during the comprehension of complex sentences, because they will be less able to efficiently balance task demands. However, research that directly measured retrieval speed suggests that the amount of information that can be actively maintained during sentence processing is very small, perhaps limited to a single item (McElree, 2006). This view leaves little room for individual variation in the capacity of active memory; therefore, variation must occur with respect to the retrieval mechanism itself. This account is further supported by recent evidence that readers are vulnerable to retrieval interference (Van Dyke & McElree, 2006).

In the current study we evaluated the extent to which readers vary in their sensitivity to retrieval interference. Participants read object-cleft sentences that either were or were not accompanied by a memory load. In the load conditions, participants remembered short word lists while reading the sentences. The possibility of retrieval interference was manipulated via the main verb: in the interfering condition the memory list words were plausible direct objects for the sentences' main verbs; in the non-interfering condition they were not. Using this paradigm, Van Dyke & McElree (2006) reported that college students were significantly affected by proactive interference created by the plausible memory words. The current study of a community-based sample of participants (age 18-24) extends those results; participants also completed a battery of 25 individual difference (ID) measures, allowing assessment of factors beyond WMC that may predict individual differences in sentence processing.

The capacity approach predicts no differential effect of interference for low vs. high WMC readers, as the number of memory words to be maintained is constant across conditions. Mixed effects modeling results were inconsistent with this prediction: we found a significant interaction between memory load, verb-type, and memory span on comprehension question accuracy, with lower span readers most affected by interference. In addition, 8 other ID measures also showed this interaction. Further analyses aimed to identify ID measures predictive of unique variance, beginning by residualizing all measures to remove variance shared with a measure of general ability (IQ). Linear regression indicated that receptive vocabulary (and not WMC, reading skill, or productive vocabulary) was the only significant predictor of comprehension. Subsequent mixed modeling analysis revealed that this was the only individual difference measure that interacted with load and verb type to influence comprehension. No additional effects on reading times or recall were observed (as in Gordon et al., 2002). These results are consistent with a "retrieval interference approach", where the operation of the retrieval mechanism is the main explanatory factor. Results are interpreted according to a theory in which the quality of lexical representations determines retrieval success (e.g., Perfetti, 2007).

Example experimental trial:
(1) Memory set: table-truck-stove
(2) Sentence (moving window): It was the boat that the guy who lived by the sea [fixed/sailed] on two sunny days.
(3) Comprehension Question: Did the guy live by the sea?
(4) Memory recall: (participants type in words)

During conversation, interlocutors create representations of common ground, i.e., information that is jointly known, including visually and linguistically co-present information. The role of different memory systems in forming common ground is poorly understood. Findings in amnesia using a collaborative referencing task have demonstrated acquisition of interactively established shared names, suggesting declarative memory may not be necessary to form shared knowledge. Here, we examined whether declarative memory was necessary to represent common ground using only visual co-presence or linguistically introduced information. Patients were five individuals (1 female) with bilateral hippocampal damage due to anoxia or HSE and had severe declarative memory impairments. Patients and healthy matched comparisons viewed a 3-D rendering of 9 cubbyholes, each containing an object. Shared objects were visible to both participant and experimenter. Privileged objects were in partially closed cubbyholes, and were only visible to the participant. We monitored participants' gaze as they interpreted potentially ambiguous instructions to gaze at objects in the display, e.g., “Look at the duck”, in a display containing two ducks. To assess use of visually co-present information, we manipulated whether the second ‘competitor’ duck was in common or privileged ground; the target was always common ground. If participants formed sufficient visual common ground representations, fixations to the target should be higher when the competitor is visually privileged. To assess use of information that is introduced linguistically, both ducks were placed in the participant’s privileged ground. First, the experimenter asked a question, “What’s in your bottom left cubbyhole?”; the participant’s response, “a duck”, brought that object into linguistic common ground. Then, after either a short or long delay, the experimenter instructed the participant to “Look at the duck.” A preference to gaze at the mentioned duck would demonstrate a sufficient linguistic common ground representation; the delay manipulation would indicate whether the representations are maintained over time. Gaze was analyzed using target advantage scores (TarAdv), calculated as the proportion of fixations to the target minus the competitor object (Table 1). In the visual conditions, comparisons and amnesic patients alike were significantly more likely to fixate the target when the competitor was visually privileged (ps<.05), replicating standard findings in healthy participants. When common ground was introduced linguistically, amnesic patients maintained linguistic common ground over a short delay, as revealed by the positive TarAdv (p<.05). At long delays however, amnesic patients were unable to maintain representations of linguistic common ground, showing significantly lower TarAdv scores than comparisons (p<.05, one-tailed). Using a novel combination of on-line psycholinguistic techniques and neuropsychological methods, we demonstrated that amnesic patients can form and rapidly access abstract common ground representations during interactive conversation. These results suggest that hippocampal damage spares the formation of common ground representations that place minimal demands on declarative memory, while impairs representations that place sufficient demands on declarative memory. The findings suggest the establishment of different kinds of common ground may rely on different memory systems.

Table 1. Target Advantage scores between 200ms-3000ms following critical word (“duck”) onset.

<table>
<thead>
<tr>
<th></th>
<th>Visual Condition</th>
<th>Linguistic Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CG Competitor</td>
<td>PG Competitor</td>
</tr>
<tr>
<td>Amnesic (n=5)</td>
<td>-0.02</td>
<td>0.48</td>
</tr>
<tr>
<td>Comparison (n=5)</td>
<td>0.05</td>
<td>0.57</td>
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</tbody>
</table>

SYNTAX IN THE BRAIN
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There is a tacit assumption in neuroscience from the genetic to the systemic level, which holds that the biological foundations of humans are essentially similar to those of nonhuman primates. However, the recent development of linguistics has clarified that human language is radically different from what is known as animal communication. Recently, Hauser, Chomsky, and Fitch have proposed that recursion is the uniquely human trait of the faculty of language (1). Sentences are recursively generated from a limited set of sounds, signs, or letters. In my talk, I will provide the experimental evidence that the fundamental language processing is indeed specialized in the human brain, focusing particularly on the function of the grammar center (2). Specifically, our recent functional magnetic resonance imaging (fMRI) and transcranial magnetic stimulation (TMS) studies have demonstrated that the left inferior frontal gyrus (IFG) is specialized in the syntactic processing and sentence comprehension for both speech and sign languages (3-7). I will further provide most recent evidence of direct causal link between the brain and syntax, such that a lesion in the left IFG is sufficient to cause agrammatic comprehension (8).

Next, I will summarize new findings on cortical plasticity for second language (L2) acquisition. We have recently discovered that the activation of language-related regions increases with proficiency improvements at the early stages of L2 acquisition (9-10), and it becomes lower when a higher proficiency in L2 is attained (11). These results may reflect a more general law of activation changes during language development. Cortical activations increase initially at the onset of acquisition, followed by the maintenance of the activations, and then a fall in activations during consolidation of linguistic competence (2,12). I will further provide most recent evidence of anatomical basis of individual differences in L2, such that the performance of a syntactic task is clearly correlated with leftward lateralization of the grammar center (13). The approach to evaluate learning processes in terms of not only indirect behavioral changes but direct functional brain changes takes a first step toward a new era in the neuroscience of education.

References:
RISING TO THE CHALLENGE: BRAIN IMAGING STUDIES OF SUCCESSFUL SENTENCE COMPREHENSION

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Functional brain imaging studies of speech comprehension highlight a fronto-temporal network that is engaged by a variety of spoken stimuli. However, efforts to fractionate this network into cognitive components (e.g. phonetic, lexical and semantic processing) have been less successful. One reason for this failure may be that the standard assumption of cognitive subtraction breaks down for human language comprehension: removing specific linguistic elements from sentences can evoke additional neural activity compared to intact sentences. This may reflect automatic recruitment of compensatory processes that attempt to comprehend challenging linguistic input.

This presentation will describe insights into the neural basis of speech comprehension that can be gained by directly studying brain mechanisms that achieve robust comprehension in the face of cognitive challenges that are common in natural language. I will illustrate this approach with fMRI studies assessing brain responses associated with sentence comprehension despite (1) perceptual and (2) lexical/semantic challenges. In both cases, observed neural activity is associated with processes that are necessary for comprehension, rather than being optional or meta-linguistic processes that depend on the task or disposition of individual participants.

The first set of studies assesses neural responses to multiple forms of acoustically distorted, yet still intelligible spoken sentences. Davis & Johnsrude (2003) show that activity in the fronto-temporal comprehension network is correlated with speech intelligibility (quantified by word report) and distinguishes between regions that are sensitive, or insensitive to acoustic differences among different distortions. This method therefore highlights regions of the superior temporal gyrus that process the acoustic form of spoken sentences and multiple functional gradients within the lateral temporal lobe: more anterior, posterior and inferior temporal regions are insensitive to acoustic properties of speech and provide plausible candidates for brain regions responsible for abstract, linguistic processing of sentences. Follow-up studies have explored fronto-temporal connectivity of these pathways, traced the time-course of fMRI responses to intelligible speech and explore interactions between sentence content and acoustic distortion in search of interactive compensatory processes.

A second approach assesses neural correlates of a semantic challenge due to spoken words with multiple meanings such as "bark" or "night/knight". fMRI highlights bilateral inferior frontal and left inferior temporal brain regions that respond more strongly to sentences containing these ambiguities (e.g. 1 vs 2, Rodd, Davis & Johnsrude, 2005). Processes involved in activating and selecting among multiple meanings of ambiguous words are necessary for comprehension and hence this method provides a neural marker of speech understanding. We have applied this functional imaging method to look for 'hidden' comprehension in sedated individuals, vegetative patients and in healthy participants engaged in distracting tasks during sentence presentation. In further work we assess the timing of neural responses to ambiguity and disambiguation to dissociate initial meaning activation from subsequent selection and reinterpretation and have used a dual-task method to provide evidence that the inferior frontal contribution to comprehension arises from domain-general selection processes.

(1) The shell was fired towards the tank.

(2) Her secrets were written in her diary.

From Seeing to Saying: Perceiving, Planning, Producing

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When speakers talk about what they see, how do they determine what to say first? A traditional, widely endorsed, intuitively compelling hypothesis is that speakers start talking about what draws attention in a scene (perceptual guidance; Gleitman et al., 2007; Flores d’Arcais, 1975; Osgood & Bock, 1977). Another view is that speakers use information from scenes to generate a rudimentary relational plan that specifies the starting point (structural guidance; Griffin & Bock, 2000; Bock et al. 2004). The goal of the present research was to test these hypotheses with evidence from eye movements during language production.

All the experiments employed a novel cuing paradigm developed by Gleitman et al. (2007) in which attention was drawn to a location where one of two actors would appear. We examined how cue timing and event codability affected the speakers’ gaze patterns, changed the order in which the actors were mentioned, and shifted the temporal relationships between looking and talking.

Experiment 1 found that speakers were more likely to start scene descriptions with the cued actor. This replicates Gleitman et al.’s results in support of perceptual guidance and suggests that participants started speaking before they had projected an utterance framework. Experiments 2 and 3 tested the limits of this strategy. Experiment 2 showed that the cue was effective only when presented before scene onset; when presented just 150ms after scene onset, the likelihood of fixating the cued actor first was at chance. In Experiment 3, the cuing effect was dramatically modulated by the ease of naming events and the participants in events (pre-experimentally determined by norming the stimulus materials). With readily apprehended events, speakers’ eye movements targeted the entities that ensued as sentence subjects regardless of which entities were cued. When events were difficult to interpret, speakers were more willing to begin with, but took longer to plan the cued character, especially when its name was hard to retrieve. Cuing mattered mainly when easily named characters were cued in hard events. The implication is that sentence production processes bend readily to exogenous attention when fast lexical retrieval offers a starting point for recounting a baffling event.

Table 1 summarizes Experiment 3’s cuing effect for easy and difficult events with easy and difficult characters. Shown are the percentages of sentences that began with cued characters minus the percentages of sentences that began with the same characters when uncued (the control condition). Event and character difficulty were based on norms for the consistency of the verbs and nouns used for events and characters, respectively. For example, an event always described as “crashing” would be more codable than an event described variously as “talking,” “speaking,” and “presenting.”

Together, the findings support a broader theory of how speakers talk about what they see. Conceptual and perceptual information both matter, but under different conditions. Speakers rely most on perceptual salience when the sentence subject is easily named but the event is not. Otherwise, structural guidance is the driving force in word ordering. In short, perceptual guidance comes heavily into play when all else fails.

Table 1.                   Easy Character Hard Character
Easy Event 10%  1%
Hard Event 27%  -2%

PROSODIC PHRASING REFLECTS PLANNING PROCESSES IN SENTENCE PRODUCTION

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Semantic relationships among words have been hypothesized to affect the planning processes involved in structuring utterances during fluent production. For example, semantic integration, the degree of conceptual linkage between elements within an utterance, has been hypothesized to influence the timing of planning of elements within a phrase, such that highly semantically integrated elements are planned with more temporal overlap than less integrated elements (Gillespie & Pearlmutter, 2009; Solomon & Pearlmutter, 2004). However, the evidence that integration affects timing during production is indirect. Watson, Breen, and Gibson (2006; WBG) found that syntactically and semantically obligatory arguments were more likely than non-obligatory arguments to be included within the same intonational phrase as their noun or verb heads, and suggested that prosodic phrasing reflects the simultaneous planning of elements that are linguistically closely related.

To examine integration’s effect on prosody and extend WBG’s result, recordings of 16 participants from Solomon and Pearlmutter’s (2004) Experiment 4 were analyzed, in which participants read stimuli like (1) aloud from a computer screen and continued them as full sentences. 24 critical items (half integrated) per subject were obtained; items containing disfluencies were not analyzed. Tokens were first analyzed using the ToBI labeling system (Silverman et al., 1992) to determine if prosodic break strength anywhere between Noun1 and Noun2 varied as a function of integration, but no differences were found; in fact, no strong intonational phrase breaks were present. Nevertheless, some processing-related lengthening associated with less-integrated sequences might still have been present. Thus, word and pause durations were obtained for all tokens. If semantic integration affects the timing of planning of the nouns within these phrases, Noun1 and Noun2 should be more separated in less integrated tokens. Duration of the Prep+Det2 region of these preambles (“with the” in all tokens) was longer in the unintegrated conditions, and this pattern was most prominent in Det2 duration. The effect of semantic integration rating (obtained from Solomon & Pearlmutter, 2004) on Prep and Det2 log-transformed durations was examined with linear mixed effect models including subjects and items as random effects, and a variety of potentially relevant control predictors including speech rate, phonological context, plausibility, frequency, and predictability of upcoming and preceding material. The effect of semantic integration was significant for the Det2 model, such that lower semantic integration predicted increased Det2 duration (p< .01). The integration effect was in the same direction, but marginal, for the Prep model.

This study provides evidence that semantic integration affects timing during language production. This finding is consistent with the error patterns associated with semantic integration: The system is more incremental in planning less integrated phrases, which decreases the chance for interference. This finding is also consistent with WBG’s result that related elements are less likely to be separated prosodically, and other evidence that the prosodic phrasing and timing of an utterance reflects underlying planning processes (e.g., strategic lengthening; Fox Tree & Clark, 1997).

1) The pizza with the yummy topping(s) (integrated)
   The pizza with the tasty beverage(s) (unintegrated)

SENTENCE PRODUCTION AND THE DECLARATIVE AND PROCEDURAL COMPONENTS OF SHORT TERM MEMORY

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We present results from a project to model the short-term memory resources that subserve sentence planning and production. Previous work, based on the ACT-R framework, examined the role of retrievals from a content addressable short-term memory in the course of producing Subject-Verb agreement. Here we discuss new empirical tests of signature predictions of the model, systematic tests of the robustness of the model’s predictions against parameter variation, and modifications that both significantly simplify the model and extend its coverage to new empirical domains.

Empirical results: The retrieval model attributes errors in agreement production to similarity-based interference from non-subject NPs that have subject-like properties (e.g., in their syntactic position and/or specification for case). We present new experimental results which support this hypothesis. For example, in direct questions like (1a), the wh-object occupies the specifier position for the finite verb in its derived position—a canonical position for subjects—whereas in indirect questions like (1b) it does not. Participants produced a higher proportion of agreement errors in number mismatch (singular subject–plural wh-object) than match conditions in direct questions; but equivalent error proportions in corresponding indirect questions.

Model evaluation and simplification: We systematically analyzed the sources of good data fit for the retrieval model to better understand the nature of the explanations it may (or may not) provide. We did this in two ways. First, through large-scale searches of a space of plausible parameter values (there are 5 key quantitative architectural parameters) we confirmed that all of the key qualitative patterns are robust against variations in this space. Second, we explored the role of activation decay in the model’s account, because (a) decay effects depend on assumptions about the relative timing of different combinatorial operations engaged during sentence formulation; and (b) recent independent empirical work continues to call into question decay as an independent source of forgetting in short-term memory. Modeling revealed that good data fit is not dependent on activation decay, and that dropping the decay assumption makes some model predictions more robust against other parametric variations. The resulting model thereby achieves greater explanatory depth and theoretical clarity, because all of the effects result from similarity-based interference.

Modeling Extensions: We model effects of semantic number on the rates of plural number agreement with morphologically singular subjects (example 2) in terms of production rules and their associated utilities. The model posits two encoding dimensions: whether the referent x is an aggregate or a singleton entity, and how the semantic predicate linked to the noun lemma relates to the intended referent (i.e., whether it applies to the referent as a whole, or to the individual members of an aggregate). Production rules employ these feature-value pairs as retrieval cues for lemma selection and include number marking operations as part of phrasal formulation. A key property of the resulting model is that apparent graded semantic number effects (Bock et al., 2006) may emerge from the interaction of an essentially discrete declarative representation system for number with an independently motivated graded representation of procedural utility.

(1) a. Which student(s) was/were the professor talking to —?
b. John asked which student(s) the professor was/were talking to —.
(2) The crowd (at the Olympic events) were animated.

CONTEXT-SENSITIVE INFORMATION DENSITY AFFECTS SYNTACTIC PRODUCTION (EVEN IN THE LAB)

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It has long been hypothesized that communicative efficiency governs the realization of linguistic forms, as most famously evidenced by the negative correlation between word frequency and length (e.g. Zipf29). Such efficiency is also during online word production (BellETAL03): more predictable words are phonetically reduced. Communicative efficiency accounts based on information-density optimization (Jaeger06,LevyJaeger07) predict this relationship and that it should hold at all levels of production—unlike predominant accounts (availability-based production, FerreiraDell00; dependency minimization, Hawkins04). Previous supporting evidence has come from corpora (Jaeger06,10). We present the first evidence from controlled experiments of information-density effects in online syntactic production. We demonstrate speakers’ sensitivity in relativizer that-mention (a) to both local and non-local intra-clausal cues, and (b) to extra-clausal cues. As predicted by communicative efficiency accounts, cues associated with lower relative clause (RC)-onset information density led to lower that-mention rates.

Experiments 1-3 (A below) manipulated RC-onset information density via local (definite-superlative vs. indefinite-base NP onset) and non-local (copular vs. non-copular clause) cues. Previous corpus studies indicate that definite-superlatives NPs and copular clauses are associated with higher RC predictability (WasowETAL07). Experiments 1—2 confirmed this experimentally in forced-choice and sentence completion tasks respectively (ps<0.005). Experiment 3 employed spoken recall to investigate that-mention in the same stimuli. Speakers were less likely to produce ”that” when RC-onset information density—based on negative log RC-probability estimates from Experiments 1&2—was lower (p<0.003). Information density better explained that-mention than untransformed RC predictability.

Experiment 4 (B below) investigated two additional cues previously found to affect both information density and that-mention in corpora: exclusives (the only) and semantically light nouns (person) increase RC probability compared to simple definites (the) and heavy nouns (pilot), respectively (WasowETAL07). In a written recall paradigm, both manipulations had the predicted effects: that-mention rates were lower with exclusives than with simple definites, and lower with light than with heavy nouns (ps<0.04). (Experiment 4&5 exhibit a floor effect: due to very low overall that-mention rates, some effects could only be evaluated on trials for which the stimulus contained "that").

Experiment 5 investigated whether extra-clausal context causes similar information-density effects. In a written recall paradigm, a context sentence (see (C)) set up either high or low expectations of RC modification for the first noun phrase in the target sentence. If speakers condition information density estimates on contextual cues (similar to comprehension), that-mention rates should be lower in high-predictability contexts. That was indeed the case (p<0.003).

These are the first results from controlled experiments lending direct support to rational communicative-efficiency accounts of sentence production. Beyond corroborating previous corpus results, our findings regarding the role of extra-clausal context are novel, and argue that observed effects of information density cannot be attributed solely to grammaticalized high-frequency chunks.

(A) Experiment 1-3 example item in 2 x 2 x 2 conditions. Stimuli presented auditorily, followed by a distractor math task, followed by the auditorily presented recall cue (the target sentence up to the relative clause).

<table>
<thead>
<tr>
<th>Matrix onset (2)</th>
<th>NP onset (2)</th>
<th>that-presence (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The {amendment was/analyst mentioned} a quick/the quickest} resolution (that) the legislator implemented.</td>
<td></td>
<td></td>
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</table>

(B) Experiment 4 example item in 2 (the vs. the only) x 2 (light vs. heavy noun) x 2 (that-presence) conditions.

Light head nouns: The/The only person [(that) he misdiagnosed] had filed a lawsuit.

Heavy head nouns: The/The only pilot [(that) he misdiagnosed] had filed a lawsuit.

(C) Experiment 5 example item in 2 (context) x 2 (that-presence) conditions.

High/Low RC probability context: The cashier scanned {seven hats and three shirts/several types of clothing}. Target sentence: The hat (that) the cashier scanned last was the cheapest.
LOCAL SYNTACTIC COHERENCES VIOLATE GLOBAL STRUCTURAL BINDING DOMAINS IN ONLINE ANAPHORA RESOLUTION

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We present empirical evidence from two visual world studies indicating that local syntactic coherences (e.g., Konieczny et al., 2009) interfere with the resolution of reflexives and pronouns, enabling antecedents that should be globally inaccessible. We used German sentences with object relative clauses center embedded in temporal subclauses (1a). This construction generates a local syntactic coherence (in square brackets) reaching over the relative clause boundary to include the anaphoric expression.

We used a 2 x 2-design, varying the linguistic material by the factors anaphor type (reflexive/pronoun) and local coherence (given/prevented). In the control condition, the presence of the local coherence was prevented by introducing an adverb (experiment 1, (1b)) or by using particle-verbs (experiment 2, (1c)) in the relative clause. Global structure-based accounts (e.g., Binding Theory) assume reflexives and pronouns to have complementary binding domains. In the example, the relative clause subject son should be inaccessible for the reflexive, while the subclause subject father should be inaccessible for the pronoun. We hypothesize that this global assignment can temporarily be overridden or competed with, when coherent substrings locally offer globally inaccessible antecedents.

In experiment 1, the potential referents were presented as visual stimuli: two pictures corresponded to the persons mentioned in the sentence, one picture did not. We assumed that, while listening to the sentence, participants fixate referents mentioned in the sentence, and fixate the referent interpreted as the antecedent of the anaphor. We measured fixations in the critical period (during and after presentation of the anaphoric reference). We found a significant effect of local coherence in the reflexive condition, indicating that the relative clause subject was interpreted as the antecedent of the reflexive. No such effect was found for pronouns. While these data seem to suggest that local coherences only affect the resolution of reflexives, we cannot exclude the possibility that participants would rather rely on the direction of the action and thus fixate both the depictions of agent and patient in the pronoun case.

In experiment 2, we therefore used depicted events corresponding to the globally or the locally coherent interpretation, showing transitive events (pronoun condition) or reflexive events (reflexive condition). We presented four depicted events per stimulus based on the two verb actions (combing, dressing) and the two agents (father, son) mentioned in the sentence. As in experiment 1, we found a significant effect of local coherence in the reflexive condition, showing more fixations on the scene that involves the local antecedent in the reflexive action. In the pronoun condition, the local coherence describes the same situation as the globally consistent relative clause event. We found a reliable boost effect, leading to significantly more fixations on the relative clause event when it was supported by both the global and local coherence.

The results strengthen the assumption of the psychological reality of local coherences by widening its coverage to online anaphora resolution. Different to explanations of binding constraint violations in terms of logophors (e.g., Kaiser et al., 2009), our effects do not seem to depend on semantic/pragmatic aspects, but point to the sequence processing mechanism underlying sentence comprehension.

Examples:

(1a) Während der Vater, den [der Sohn kämmte, sich/ihn im Wohnzimmer] anzog, …
While the father, who [the son combed, himself/him in the living room] dressed, …

(1b) Während der Vater, den der Sohn gründlich kämmte, sich/ihn im Wohnzimmer anzog, …
While the father, who the son thoroughly combed, himself/him in the living room dressed, …

(1c) Während der Vater, den der Sohn anzug, sich/ihn im Wohnzimmer kämmte, …
While the father, who the son dressed [particle v.], himself/him in the living room combed, …

References:
INTEGRATING EYE-MOVEMENT AND NEUROIMAGING METHODS

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As neuroimaging methods become more widely used in sentence processing research, it will be increasingly important to integrate results using these methods with results from behavioral measures. After outlining some concerns about a developing trend for an “encapsulated” neurolinguistic literature, I’ll discuss a controversial issue involving generating and evaluating expectancies, where imaging and behavioral measures might complement each other, resulting in insights that neither measure alone could provide. I’ll also review a recent line of research where my colleagues and I are combining artificial languages, eye-movement measures, and fMRI, to (hopefully) provide new insights into some classic issues about how context influences spoken word recognition.
A common assumption is that, during reading, words are the smallest units that make information available to the processor for the generation of sentence representations. Although evidence from visual word recognition (VWR) shows that sub-lexical units such as suffixes are routinely segmented from their carrier words at an early stage and even in the absence of actual morphological structure [1], it is also generally assumed that morphological segmentation is exclusively dedicated to enable lexical access. However, the question whether segmented suffixes may activate information used in representations of a higher level than the lexical one [2] has rarely been addressed (but see [3]). We tested this idea in a reading comprehension experiment with eye-movement monitoring.

Thirty-six participants read English sentences with balanced heterographic homophones - words with different spellings and meanings, but with a shared phonemic representation that may be morphologically segmented [4]. In one condition (MP; 1), participants saw monomorphemic homophones (word) whose polymorphemic mate (soared) was never shown. If morphological segmentation applies early on the common phonemic representation, initial reading times should be longer on MP homophones than on matched non-homophonous controls (2). No such difference should arise between monomorphemic homophones (creek) with unseen monomorphemic mates (creak) (MM condition; 3) and their controls (4).

More importantly, if segmented suffixes make information available that is used in representations of a higher level than the lexical one, the reading patterns on subsequent text should be different in the MP condition than in its control, and no differences should arise between the MM condition and its control. However, if information only becomes available from the lexical entry as a whole (and not from segmented suffixes), the reading patterns on subsequent text should also be different in the MM condition than in its control, since, like in the MP condition, a meaning representation and other associated information used in higher-level representations would also be activated.

The reading patterns on the homophone/control region suggest that the phonemic representations activated by the MP homophones are morphologically segmented. Participants read these words for significantly longer than their controls, both before exiting them in either direction for the first time and before moving forward in the text. This pattern was reversed for the MM homophones and their controls. This interaction was significant, but planned comparisons revealed that the difference between the MM homophones and their controls was not.

Examination of subsequent regions suggests that the information activated via morphological segmentation is used in higher-level representations. Upon reaching the adverb following the homophones/controls, and before moving past it, participants spent more time on it and on preceding text in the MP condition than in its control, while there were no differences between the MM condition and its control. Before moving past the next word (matrix verb), readers spent longer rereading previous text in the MP condition than in the MM condition. Together with evidence from VWR, these findings suggest that suffixes may be the smallest units contributing information to the mechanisms that build sentence representations.

(1) The stories that mention the magic sword quickly captivated the readers.
(2) The stories that mention the magic swan quickly captivated the readers.
(3) The stories that mention the magic creek quickly captivated the readers.
(4) The stories that mention the magic brook quickly captivated the readers.

The Implicit Prosody Hypothesis (IPH) (Bader, 1998; Fodor, 1998) maintains that prosodic contours influence on-line sentence processing during silent reading. Evidence for the IPH comes from demonstrations that implicit prosodic phrasing can affect attachment decisions (e.g., Augurzky, 2008; Hwang & Schafer, 2009; Hirose, 2003; Quinn, et al., 2000). The current study explores whether implicit metrical patterns affect online sentence processing.

A well-known garden-path sentence appears in (1). Readers encounter difficulty at 'the boats', following the noun/verb homograph 'man,' because multiple evidence sources support an initial parse whereby 'old' is an adjective and 'man' a noun, resulting in high expectation for a following verb. Upon encountering a noun phrase, the reader has to reanalyze 'old man' as a noun and verb.

We exploited this type of garden-path to investigate simultaneous syntactic and metrical reanalysis. We embedded two-syllable noun-verb homographs in sentences like (2), which disambiguated the homograph as a noun (2a) or verb (2b). These homographs had alternating metrical patterns as a noun or verb (e.g. abstract, which is ABstract as a noun and abSTRACT as a verb) or a non-alternating metrical pattern as a noun or verb (e.g. report). Both homograph types were matched across items on length and syntactic category frequency. We also included baseline conditions with nearly unambiguous nouns and verbs (e.g. paper, suggest).

We anticipated a reading time cost at 'suggest' in (2b), since this unambiguous verb requires reanalysis of 'brilliant' from adjective to noun. We also expected cost in Region 3 of (2b) (the best ideas), since this phrase requires reanalysis of 'brilliant abstract/report' as a noun-verb sequence. Critically, if readers compute metrical patterns during silent reading, they should incur an additional cost on Region 3 following a stress-alternating homograph (abstract) due to the need to reanalyze both syntactically and metrically.

Forty-two subjects read 30 sentences like those in (2) silently while eye-movements were recorded with an EyeLink 1000. We observed evidence of syntactic reanalysis in the form of a) longer Region 2 reading times on ‘suggest’ in (2b) (330 ms) than ‘paper’ (297 ms), and b) longer reading times on Region 3 in (2b) than (2a) when the Region 2 word had to be a verb (645 ms for verb disambiguation vs. 545 ms for noun disambiguation). We observed evidence of metrical reanalysis in the form of inflated reading times on Region 2 when ‘abstract’ was subsequently resolved as a verb (341 ms vs. 311 ms). This increase in Region 2 reading time was almost entirely limited to cases in which readers subsequently skipped the first word of Region 3 (64 ms) rather than fixating it (9 ms), indicating that parafoveal preview of the disambiguating word prior to skipping led to metrical reanalysis of the target word during initial fixation.

These results demonstrate that implicit prosody in the form of metrical structure plays a role in controlling eye movements during silent reading.

(1) The old man the boats.
(2) a. Noun: stress alternating/non-stress alternating/unambiguous
   The brilliant [abstract/report/paper] 2 was presented 3 at the prestigious 4 conference 5.
   b. Verb: stress alternating/non-stress alternating/unambiguous
ANTI-LOCAL CONTEXTS INCREASE SUCCESS, NOT THE SPEED, OF DEPENDENCY COMPLETION

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Intra-clausal verb-argument dependencies are sometimes easier to process if the argument head is linearly farther from the verb. This phenomenon, referred to as anti-locality [1,2], is observed experimentally as decreased reading times on the verb. For memory-based theories, this facilitation reflects the participation of an argument encoding whose activation is strengthened from more elaborated processing [1]. For expectation-based theories, the facilitation arises from the growing immediate expectation for the verb [2]. A common difficulty with interpreting RT facilitation, however, is that RT effects may reflect either changes in the speed of underlying processing, differences in the strength/activation of constituent representations, or both [3]. It is thus unknown for which reason anti-locality obtains, and consequently, what mechanisms any theory should incorporate. The goal of the present study is to distinguish the three possibilities. In particular, faster underlying processing seems a plausible explanation: if the expectation for a verb leads to its predictive incorporation into structure, then fewer computations would be required at the verb’s string position. However, our results do not support that prediction and indicate that anti-locality, at least in one construction, is the result of strengthened constituent encodings.

METHOD. The speed-accuracy trade-off (SAT) paradigm provides a means of answering our question, since it deconfounds speed and accuracy [3]. It does so by measuring the full time-course of comprehenders’ sensitivity at discriminating a given contrast. The accuracy-by-latency time series resulting from an SAT experiment are modeled as shifted, saturated exponentials, which are characterized by independent rate and asymptote parameters. We created an appropriate anti-local context by adapting materials from an RT experiment [2]. The target dependency was the subject-verb relation (1). Length was varied by inserting an RC with 0, 1 or 2 VP-internal PPs (1)(i)-(iii). Length was fully crossed with acceptability, which was varied by manipulating the semantic fit of the verb (2). 36 item sets were created, counterbalancing the animacy of the subject head. Additionally, filler items were designed which introduced unacceptability in both sentence and RC-medial positions (e.g., (3)(i-ii)). Requiring participants pay attention to sentence-medial material provides a check against the potential concern that anti-local contexts simply induce shallower processing. Overall, seven participants each saw 216 experimental sentences and 456 filler sentences across 3 1-h sessions of 224 sentences, preceded by 1 ½-hour practice session.

RESULTS. Firstly, rate does reliably not vary across RC length conditions. Secondly, asymptotic accuracy rises monotonically when PPs are interpolated, such that (1)(iii)>(ii)>(ii) [d’: 3.6 > 3.5 > 3.4] (see Analysis). We conclude that our anti-local context improves the likelihood with which integration succeeds, but not speed of integration itself. Such a mechanism is straightforwardly compatible with existing memory-based approaches, and it is also consistent with an expectation-based approach in which growing expectation for a category entails its greater activation. However, one recent study did obtain a true rate advantage for verb processing, when a VP-attaching adverb preceded the verb [4]. Distinct, but overlapping, mechanisms are thus implicated in predictive behavior.

MATERIALS
(1) LENGTH MANIPULATION
(i) On multiple occasions during court sessions, the officer [that the judge questioned] rambled.
(ii) During court sessions, the officer [that the judge questioned on multiple occasions] rambled.
(iii) The officer [that the judge questioned on multiple occasions during court sessions] rambled.
(2) ACCEPTABILITY MANIPULATION: ... the officer ... rambled/#tarnished.
(3) SAMPLE UNACCEPTABLE FILLERS
(i) The award that the scientist won at the ceremony next weekend is very prestigious.
(ii) The memo from the contractor were about a delinquent tax return.

WHEN GRAMMATICAL ERRORS DO NOT MATTER: AN ERP STUDY ON THE EFFECT OF FOREIGN ACCENT ON SYNTACTIC PROCESSING

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Research on language comprehension has often studied ERP-responses to grammatical violations to gain insight into the processes of recovery from misanalysis or repair (e.g., [1], [2]). However, while such violations are rarely produced by native speakers (L1) of a language, they are commonly produced by non-native (L2) speakers. Given listeners’ experience with L1 and L2 speech, violations might be less surprising in L2 than in L1 speech, leading to differences in repair processes. Here we investigate the effect of foreign accent on syntactic processing using gender-agreement errors in Dutch.

Dutch has a two-way distinction in syntactic gender: neuter (het) and common (de). Previous ERP research has shown that gender violations (such as noun phrases preceded by an incorrect article or incorrectly inflected adjective) elicit a clear P600 effect (e.g., [3]). However, no other study has examined the electrophysiological response to such errors produced by an L2 speaker with a foreign accent, even though we know that L2 learners of Dutch frequently produce such gender-agreement errors ([4], [5]).

In this study we compared ERP responses to gender violations (A) in sentences spoken either by an L1 or an L2 (Turkish) speaker of Dutch. Half of the violations consisted of incorrect determiners and half of incorrectly inflected adjectives. In total, 35 percent of all sentences contained a gender violation. Critical nouns were controlled for predictability, gender, and frequency. Dutch L1 speakers (n=34) listened to the native and accented sentences (together 344 sentences), and received 12 comprehension questions to draw their attention to the content. In line with previous research, the gender violations spoken by the L1 speaker resulted in a P600 effect (larger P600 for the syntactic violations compared to correct sentences). Interestingly, when the same listeners heard the same type of violations produced by the L2 speaker, no P600 effect was observed. This suggests that errors in L2 speech are less surprising or faster repaired.

Importantly, a set of control sentences with semantic violations (B) elicited a similar N400 effect for both L1 and L2 speech, suggesting that the difference in P600 could not be attributed to general intelligibility or integration problems in foreign-accented speech. Also, results from a control go/no-go task showed that Dutch listeners (n=20) could easily detect the gender-agreement errors (96% in foreign-accented sentences and 98% in non-accented sentences), but were better in non-accented sentences (p=0.002).

Our findings show that the P600 component is modulated by a non-native accent. Listeners’ previous experience with the correlation between L2 accent and error likelihood might have led to fewer attempted repairs of the L2-accented errors. This seems in line with research suggesting repair processes to be influenced by the probability of error occurrence ([6]).

(A) Gender agreement: Ik wil een reis naar China maken, omdat de/*het cultuur daar zo anders is dan hier.
   "I want to make a trip to China, because the culture there differs from the one over here."

(B) Semantic agreement: Het was vannacht best koud, dus ik had een dikke deken/*avond op mijn bed gelegd.
   "It was very cold last night, so I put a thick blanket/evening on my bed."

RECONSIDERING ERP EVIDENCE FOR EARLY SYNTACTIC ENCAPSULATION

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In Friederici’s (2002) theory of sentence comprehension, there is an early, encapsulated syntactic processing phase (Phase 1, 100-300 msecs) for each word followed by later integrative phases, with distinct ERP components associated with each. The primary index of Phase 1 is the early left anterior negativity (ELAN), which is observed in response to immediately detectable form class violations. The N400 and P600 index hypothesized later, integrative processing in Phases 2 and 3. A keystone result supporting this theory is that an attentional manipulation – proportion of anomalous sentences – had no impact on the ELAN but had a large effect on the P600 (Hahne & Friederici, 1999 [HF99]). Sentences (1) and (2) illustrate their correct and anomalous items, and (3) illustrates a critical filler – a “complete prepositional phrase” (CPP) item that prevents the preposition in (2) from predicting the upcoming anomaly with 100% certainty. Note that “ge” in “gefüttert” indicates past participle.

1) Das Baby wurde gefüttert [The baby was fed]
2) Die Gans wurde im *gefüttert [The goose was in *fed]
3) Die Kuh wurde im Stall gefüttert [The cow was fed in the barn]

HF99 found a ‘normal’ P600 effect (greater positivity for anomalous than correct at the past participle) with anomaly proportion at 0.2, but a reversed effect at 0.8, as though subjects experienced greater difficulty in Phase 3 with correct sentences when they were relatively rare. However, ‘normal’ ELAN effects (greater for anomalous than correct) were observed at both anomaly proportions, consistent with the encapsulated status of the Phase 1 processes the ELAN is hypothesized to index.

We sought to replicate HF99, with four minor differences in design: (1) We used English rather than German; (2) because past participles are not clearly marked at word onset in English as they are in German, we used written rather than spoken presentation, on the logic that grammatical class would be available immediately (a crucial prerequisite for observing the ELAN); (3) we added final phrases after critical words to avoid sentence wrap-up effects (e.g., "the dish was washed in the sink"); (4) we added a 0.5 anomaly proportion condition to increase power.

Anomaly proportion was manipulated between subjects, with groups of 15 subjects in each condition (0.2, 0.5, 0.8). Twenty correct and anomalous sentences of each type were formed using forty critical verbs, with those verbs rotated through conditions with multiple lists. Anomaly proportions were achieved by proportionate addition of correct, anomalous, and CPP fillers for a total of 200 sentences.

Our results differed strikingly from HF99. With 0.2 anomaly proportion, we found weak ELANs, weak N400s, and robust P600s. With 0.5 anomaly proportion, we found strong ELANs and N400s, and weak P600s. With 0.8 anomaly proportion, we found reversed ELANs and P600s (i.e., stronger for correct than anomalous). Although differences from HF99 may be attributed in part to necessary design differences, this does not detract from two novel ELAN findings: it is sensitive to attentional manipulation, and it can be reversed, such that it is triggered by a word that is perfectly grammatical when it occurs in a construction that is rare within the experimental session. Together, these findings pose serious challenges for Friederici’s (2002) early-encapsulation, late-integration model.

FILLER-GAP DEPENDENCY RESOLUTION IN 20- AND 30-MONTH-OLDS: THE ROLE OF MORPHOSYNTAX

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Filler-gap dependencies have held a central position in syntactic theory and models of sentence processing due to their unbounded character. This unboundedness places considerable demands on on-line sentence understanding. Resolution of such dependencies involves the relation of a filler, possibly morphologically marked, to a gap elsewhere in the sentence. While much work has examined the age of acquisition of wh-questions and relativization [1-4], little work has focused on the developmental trajectory of the parser. We show (a) 20-month-olds reveal a fragile sensitivity to morphosyntactic features of the filler but (b) 30-month-olds are robust to changes in the form of the filler.

Recent work [5] has shown that 20-month-olds resolve filler-gap dependencies in wh-questions but not relative clauses. [5] argues that 20-month-olds are developing a grammar-driven parser, which can form a filler-gap relation, but doing so may strain the processor in early stages of development. That analysis makes two predictions: (1) 20-month-olds may show improved performance by amplifying the morphological cue to the filler-gap dependency in relatives; (2) older infants should be less susceptible to misparses caused by less salient marking of the filler, although such marking may still affect temporal dynamics.

In a preferential looking experiment, 72 20-month-olds and 60 30-month-olds heard relative clauses differing in the relative pronoun (that vs. who) and the gap site (subject vs. object). A between-subjects design with 6 items per construction allowed us to obtain a precise measure of the temporal properties of children's understanding. Each trial consisted of three phases. The object-familiarization phase introduced the event participants (e.g., a white dog, a brown dog and a cat). The event-familiarization phase showed a sequence of two events (e.g., the white dog feeds the cat; then, the cat feeds the brown dog). The test phase presented still images of the two dogs on opposite sides of the screen. While these images were displayed infants heard either a subject that-relative (1a), an object that-relative (1b), a subject who-relative (1c) or an object who-relative (1d).

The dependent measure was the proportion of looks to the agentive character (correct in the subject conditions and incorrect in object conditions). For 20-month-olds we found an interaction between dependency (subject vs object) and filler (that vs. who) (F(1,44)=13.8, p<.001). These infants looked longer at the agentive character in subject who-relatives than in object who-relatives (ps<.005), but looked equally at the agentive character in subject and object who-relatives. Moreover, in the who-relatives, looks to the agentive character were above chance in the subject conditions and below chance in the object conditions (all ps<.05). 30-month-olds showed an effect of dependency independent of the type of relative (all ps<.01). Nonetheless, for the 30-month-olds dependency resolution was faster for who-relatives than that-relatives.

These results show that early dependency resolution processes are sensitive to the morphological form of the filler. For 20-month-olds this sensitivity can disrupt dependency resolution altogether, as in the case of the that-relatives, whereas for 30-month-olds it merely alters the timecourse of dependency resolution.

(1)  
   a. Find the dog that fed the cat. that relative clause, subject gap  
   b. Find the dog that the cat fed. that relative clause, object gap  
   c. Find the dog who fed the cat who relative clause, subject gap  
   d. Find the dog who the cat fed who relative clause, object gap
ABSTRACT REPRESENTATION OF PASSIVE STRUCTURES IN YOUNG CHILDREN: EVIDENCE FROM SYNTACTIC PRIMING

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We report two syntactic priming experiments that investigated whether four-year-olds have a single representation underlying the various passive structures, or whether they have distinct representations for short/full and get-/be-passives. Evidence suggests that children initially use different passive forms from the standard ‘full be-passive’ (a cat is being chased by a dog): Some studies have proposed that the different passive forms are structurally distinct and acquired separately, with children acquiring a get-passive form (a cat is getting chased by a dog) earlier than the be-passive [1], and a short passive form (a cat is being chased Ø) before the full passive [2].

Conversely, some priming studies suggest that children have an abstract syntactic representation for the full passive by three or four, though the evidence is mixed [cf. 3 and 4] and most have not explicitly examined the different forms of the passive produced in these experiments. Furthermore, there is evidence that children may repeat the surface form of the passive modelled to them in experiments [e.g. 5]. Thus it is also possible that priming effects observed in children are related to the repetition of lexically-based representations.

Our experiments used a picture-description card-game task [6] in which participants (children and adults) alternated describing pictures of transitive actions with the experimenter. We manipulated the form of the experimenter’s prime descriptions, in a within-participants design, and examined how this affected the form of the participant’s subsequent target description. Experiment 1 used active and short passive primes. We found a reliable priming effect for both groups: Children were 16% (ps< .01) (and adults 10%, ps< .05) more likely to produce a full passive after a short passive prime than after an active prime.

Experiment 2 compared the effect of be-passive, get-passive and active primes on be- and get-passive responses separately. For the children’s be-passive responses, we found a significant priming effect from be-passives only (21%, ps< .05); there was no priming following get-passives relative to following active primes. For the adults’ be-passive responses, both passive primes had a significant effect (be-passives: 22%; get-passives: 11%, ps< .05) Conversely, for the children’s get-passive responses we found a significant priming effect from both passive primes (get-passives: 31%; be-passives: 16%, ps< .05) whereas for the adults’ only the get-passives primed get-passive responses (17%); there was no priming following be-passives relative to following active primes.

Taken together these results suggest that children (and adults) have a common passive representation underlying both be- and get-passives, and short and full passives. We therefore exclude any explanation of syntactic priming effects being wholly dependent upon lexical priming of the auxiliary (getting/being) or the preposition ‘by’ and our results show that speakers can be primed for non-expressed content (Expt 1). However, our results also suggest that repetition of function words can boost priming, particularly of dispreferred forms such as the be-passive for children. Furthermore, they suggest that auxiliary verbs may indeed play an important role in the acquisition of the passive; consistent with previous research, children – but not adults – showed a preference for get-passives when exposed to both passive types.

The current literature suggests that children may be sensitive to different information in language comprehension than adults. For example, even though children have been found to be sensitive to discourse cues in pronoun resolution (Song & Fischer, 2005, 2007), they may be so to a lesser extent than adults (Arnold et al., 2005, 2007). In two visual world eye-tracking experiments in German, we investigated whether four-year-old children and adults build up their pronominal interpretation in the same way during the course of processing. More precisely, we investigated whether factors that have been claimed to influence the discourse prominence of an antecedent, especially, order of mention, grammatical role and dislocation, would have similar effects in children and in adults; in particular, whether these factors would similarly affect the probability of successful retrieval and/or resolution speed in children and adults (Foraker & McElree, 2007; Gundel, 1999). Video clips presented a location and two animals of the same gender. After the introductory sentence "Da sind Der Hase/Der Fuchs and Der Fuchs/Der Hase" [There is a bear/fox and a fox/bear], the target sentence was presented in one of four conditions (topic/non-topic structure and SVO/OVS word order) (see examples below). During the target sentence, the characters participated in actions of familiar transitive verbs (kick, hit, kiss etc.), after which they returned to their original positions at opposite sides of the screen prior to the occurrence of the ambiguous pronoun.

Results showed that both children and adults eventually looked more at subject than at object antecedents, suggesting that the later interpretation of the sentences was similar in both groups. However, there were some differences in the resolution process: Adults showed an earlier subject preference than children. However, they were only moderately influenced by dislocation, so that dislocating the first referent temporarily led to more looks to the second referent. In contrast, children show a later preference for the subject antecedent, and, instead an early preference for the first-mentioned antecedents in both conditions (subject in SVO, object in OVS). The influence of dislocation was similar, but more pronounced than in the adults. The results suggest that children may need more time to process grammatical role information, and may be influenced more by other factors such as order of mention and topicalization. The results add to the literature highlighting differences and similarities in children and adults’ language comprehension; in particular, concerning the weighting of different factors and the ease with which they are integrated online.

(1) DISLOCATION, SVO: Der Hase, der streichelt den Fuchs in der Nähe von dem Fluss, als er...
(The bear (SUBJ), that strokes the fox (OBJ) near the river, when he...'
(2) DISLOCATION, OVS: Den Fuchs, den streichelt der Hase... 'The fox (OBJ), that strokes the bear (SUBJ)...'
(3) NO DISLOCATION, SVO: Der Hase streichelt den Fuchs... 'The bear (SUBJ) strokes the fox (OBJ)...'
(4) NO DISLOCATION, OVS: Den Fuchs streichelt der Hase... 'The fox (OBJ) strokes the bear (SUBJ)...'
GERMAN CHILDREN’S USE OF PROSODIC CUES IN RESOLVING PARTICIPANT ROLES IN TRANSITIVE CONSTRUCTIONS

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In language acquisition, a construction of particular importance is the basic transitive construction, prototypically used to indicate an agent acting on a patient, as in “The Flomer weefs the Miemel”. To interpret such transitive constructions one needs to understand and to distinguish the different roles of participants and thus the grammatical conventions used to mark these in the particular language being learned. In most languages, the transitive construction marks the roles of two participants with multiple, redundant cues. (e.g., word order, case marking or animacy). For German, a language with case marking and the possibility of OVS word order, Dittmar et al. (2008) found that two year olds only understood transitives with novel verbs, where several cues supported each other. Five year olds were able to use word order by itself but not case marking and only 7-year-olds behaved like adults by relying on case marking over word order when these two cues conflicted (e.g. “Den (+accusative) Löwen wieft der (+nominative) Hund” – “The (+accusative) lion is weefing the (+nominative) dog”).

However, most studies examining children’s understanding of transitive constructions focus on the morphosyntactic properties of sentences and ignore an additional cue: prosody. But it has been established that different prosodic realizations guide listeners’ interpretation of ambiguous sentences. Grice, Weber & Crocker (2006) found that adult-listeners use prosodic information in the interpretation of ambiguous SVO and OVS sentences when no clear morphological information is available.

In the current study we investigate whether or not German children aged five use prosody for the assignment of participant roles in order to distinguish their semantic roles, as has been found for adults. Using a video-pointing task, we embedded transitive OVS utterances in a natural context and presented these utterances as either clearly case-marked (e.g. “Den (+accusative) Hund wieft der (+nominative) Hase”) or ambiguous (e.g. “Die (+accusative) Katze wieft die (+nominative) Kuh”). In order to examine the specific role of prosody for children in resolving the semantic function of the participants, the intonational realization of these constructions was either flat or, to support the syntactic marking of the utterance, characterized by a strong, contrastive pitch accent on the first Nominal phrase.

The results show that the prosodic cue has a main effect for children for the assignment of participant roles in transitive OVS-utterances (F(1,15)=5.8, p= 0.029). Children were better in judging the correct agent acting on the correct patient when this was clearly marked by intonation compared to unnatural realizations. Even when no clear case marking was available, children understood participant roles significantly better by using the prosodic cue (p=0.009). These findings show that, when reliable cues contradict each other, 5-year-old children are still able to understand the semantic roles in transitive OVS sentences when appropriate intonation is available. We argue that, to fully understand young children’s skills at interpreting sentences online, the role of intonation must be taken into account.

References:
WORD PRODUCTION IN SPONTANEOUS SPEECH: AVAILABILITY AND COMMUNICATIVE EFFICIENCY

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Production at various levels (e.g., word and syntactic production) seems to be affected by the availability of upcoming material (Clark & Fox-Tree, 2002; Ferreira, 1996). Additionally, production seems to be affected by the information carried by the currently pronounced material, as expected by communicative efficiency accounts (Aylett & Turk, 2004; Jaeger, 2006). However, previous work has not tested whether the two effects are observed independent of each other. We test the partial effects of availability and information density against phonetic reduction in spontaneous speech, which has been attributed to either source.

Data: We extracted 235,000 words (from 9,896 types) from the automatically time-aligned Switchboard corpus, sampling only from fluent contexts and not adjacent to prosodic boundaries.

Study 1 employed mixed linear models with random intercepts for speaker differences and controls for speech rate and phonological context (similarity and identity, as well as phonological complexity effects) were fitted separately for each word against log-transformed durations. Information density was estimated as the current word’s negative log-transformed probability based on (a) the two preceding, I(w|w_i-2, w_i-1), and (b) the two following words, I(w|w_i+1, w_i+2). Availability of the next word was estimated as (a) its log-transformed frequency, -log f(w_i+1), and (b) its log-transformed probability given the two preceding words, -log p(w_i+1|w_i-1, w).

The results provide the first independent support for both accounts. Whenever, an effect of information density or availability reached significance, the effect had the expected direction: speakers pronounce words more slowly (1) if it contains a lot of information and (2) if upcoming material is not available for pronunciation.

Study 2 employed the same type of model but over all word types with more than 200 tokens (161 types, 100,000 tokens), additionally controlling for words’ mean duration. Against highly significant effects of information density of the current word and of the availability of the next word in the expected direction were found (all ps < 0.0001). Model comparison revealed that information density and availability contribute equally to model quality. (Controls had the expected effects; e.g., similarity based interference between word forms lead to longer durations).

Our results provide evidence for independent effects of information density and availability on word pronunciation in spontaneous speech. Follow-up studies are investigating how far ahead speakers seem to plan based on availability-based effects associated with upcoming words beyond the immediately upcoming word.
LEXICAL NEIGHBORS: SPEAKERS’ FRIENDS, LISTENERS’ FOES. A STUDY OF VOWEL QUALITY IN SPONTANEOUS SPEECH

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The sources of pronunciation variation have been intensely debated. “Listener-oriented” accounts of variation attribute variation to speakers’ attempts to maximize intelligibility; “speaker-centric” accounts attribute variation to fluctuations in production difficulty. Words that are easy to understand and produce tend to be phonetically reduced (shortened, with more centralized vowels, etc), whereas “hard” words tend to be lengthened, articulated with more dispersed vowels and higher articulatory target maintenance (Bell et al. 2009). A difficulty in adjudicating between speaker-centric and listener-centric approaches is that most factors facilitating production also facilitate recognition. For example, high frequency, concreteness, and familiarity all promote phonetic reduction – and they all increase speed and accuracy of comprehension and production, other things being equal.

A lexical property that avoids this ambiguity is phonological neighborhood density, i.e. the number of words in the lexicon that are phonologically similar to a given word: High density is associated with short naming latencies and high accuracy of production (Vitevitch, 2002), but also with decreased speed and accuracy of recognition (Luce & Pisoni, 1998). Because of this seemingly paradoxical property, neighborhood density provides a means of investigating the sources of pronunciation variation: Speaker-centricity would predict phonetic reduction of high-density words, whereas listener-centricity would predict higher articulatory target maintenance. We examined the effect of neighborhood density on vowel dispersion in a corpus of spontaneous speech (the Buckeye corpus, Pitt et al., 2007), for all monomorphemic CVC content words containing monophthongs other than schwa (n = 11,832). Vowel dispersion was measured as the Euclidean distance from the center of the speaker’s vowel space, such that more centralized vowels have lower dispersion values. We fitted a mixed-effect regression model of vowel dispersion, taking into account vowel duration, vowel target (e.g. [a] vs. [i]), speaker sex, age, word frequency, phonotactic probability, part-of-speech, phonological context, contextual predictabilities, speech rate, presence of disfluencies, number of previous mentions, and, crucially, phonological neighborhood density (based on the Hoosier Mental Lexicon; Nusbaum et al., 1986).

The model reveals that, other things being equal, vowels are slightly more centralized for words from dense neighborhoods (t=-2.21). Model comparison and cross-validation confirm the reliability of this finding. This result seems to contradict previous studies (Wright 1997; Munson & Solomon, 2004), which reported greater dispersion for high-density words, based on single-word reading. However, in those studies, neighborhood density positively covaried with neighbor frequency. When we enter neighbor frequency as a separate predictor into our model, we find that words with high-frequency neighbors are produced with more dispersed vowels (t=4.97), consistent with earlier observations. The previous findings may thus be attributable to neighbor frequency, not density. Speakers pronounce high-density words with more centralized vowels, and they pronounce words with high-frequency neighbors with more dispersed vowels. We discuss our findings in the context of a model of lexical access (Dell, 1986; Dell & Gordon, 2002), which predicts faster and more accurate retrieval of high-density words.
‘FREQUENT FRAMES’ IN GERMAN CHILD-DIRECTED SPEECH – A LIMITED CUE TO
GRAMMATICAL CATEGORIES

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Mintz (2003) found that frequently occurring frames in English child-directed speech (CDS) formed by linking the preceding (A) and succeeding (B) word (e.g. A_x_B) predicted with a high degree of accuracy (91–98%) the syntactic category of the intervening word (x). Chemla, Mintz, Bernal & Christophe (2009) extended this result to French CDS. In both languages, frames mainly categorize verbs and nouns and predominantly rely on function words (e.g. determiners, pronouns) as framing elements. This study presents a similar, frequent frame analysis for German, a language with a less restricted word order and a morphologically more complex determiner system compared to English or French. The number of determiners increases because these are marked for case, number, and gender. Furthermore, in colloquial German, determiners are often used pronominally. We therefore hypothesised that frequent frames in German might be less accurate in categorizing words than for English and French.

Our analysis is based on CDS to one German-speaking child. We analyzed 58 one-hour recordings of child-adult interaction made between the ages of 2;0 and 2;6. All words in the corpus were automatically tagged with a German version of the CHILDES MOR-program (cf. MacWhinney, 2000), developed by Behrens (2000). Following Mintz (2003), the set of frames evaluated were the 45 most frequent frames. Categorization success was controlled by creating chance categories against which the actual results were compared.

The results show that, as in English and French, German frames rely heavily on function words as framing elements. Mean accuracy scores for types and tokens were 59% and 78%, respectively (p<.001). Scores were significantly different from chance categorization (p<.001). Three conclusions follow: first, the frames do gather some relatively reliable evidence of categories but secondly, there is considerable variability within the frames as indicated by the rather low accuracy scores. Third, there are frames containing types of various syntactic categories whereas token frequencies are skewed to favour one syntactic category as mean accuracy scores for types and tokens differ significantly. Following this up we investigated how evenly types are distributed within each frame by calculating normalized Shannon-Weaver values as a measure of diversity (Zar, 1999).

Three kinds of frames could be differentiated. First, there are highly accurate frames collecting a variety of different words from the same category. These frames might help to learn the category of the intervening word, particularly of verbs as most of these frames collected verbs. Second, there are highly accurate but lexically specific frames because one single word takes the lion’s share of all gathered tokens. Therefore, these frames are likely to become associated with only one particular lexical item making them less accessible for use with new items (Bybee, 2007). Third, there are rather noisy and misleading frames collecting a variety of different words that belong to different categories. The lack of specificity can be explained, above all, by the above-mentioned characteristics of German.

Thus, while frames may be a guide to learning, particularly of verbs, the current study on German highlights the importance of identifying other factors.

WHAT LEXICAL AND PERCEPTUAL PRIMES TELL US ABOUT CROSS-LINGUISTIC SENTENCE PRODUCTION

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Previous work on English found that production of actives/passives is sensitive to linguistic (lexical) and non-linguistic (perceptual) primes. However, recent work on Korean ([6]) found no significant effects of lexical or perceptual primes on active/passive production. Then, do typological differences between English and Korean have consequences for sentence production? This is the first question we investigate. The second question concerns the relation between eye-movements and production. [5] argue that initial eye-movements are not related to structural choice, whereas [4] conclude they are. To see if these claims can be reconciled, we looked at lexical and perceptual priming cross-linguistically with visual-world eye-tracking experiments on Korean and English.

EXPERIMENTS-80 Participants described scenes designed to elicit actives or passives. In Exp.1 (Lexical primes, 20 English speakers, 20 Korean speakers), the agent/patient was primed with a semantically-related word. In Exp.2 (Perceptual primes, 20 English speakers, 20 Korean speakers), the agent/patient was primed with an attention-capturing flash.

PRODUCTION RESULTS-KOREAN: Participants exhibited a strong preference for the active voice with canonical word order. Priming patients did not increase use of passives or patient-initial sentences in Exp.1 (lexical) or Exp. 2 (perceptual). Scrambling was rare. These findings are consistent with [6]. ENGLISH: In Exp.1 (lexical), priming patients significantly increased use of passives (e.g., a hen is being chased by a fox) (Agent-prime: 4%, Patient-prime: 8%) and patient-first sentences (e.g., a hen is running away from a fox) (Agent-prime: 5%, Patient-prime: 11%) (p<.05). However, no such effect was found in Exp.2 (perceptual). The finding that only lexical primes influenced choice of structure and referent suggests that lexical primes exert more influence on production. This fits with the levels-of-processing theory ([3]), which suggests that information processed at a deeper semantic level remains more accessible than information processed at a shallow perceptual level.

EYE-MOVEMENT RESULTS--Eye-movement data in Korean and English were very similar. Looks to primed characters: In both languages, perceptual primes triggered more looks to the primed character right after picture-onset (0-400ms) (consistent with [4]), whereas with lexical primes, the effects were slightly delayed (400-800ms). Looks to first-mentioned referent: In both languages regardless of prime type, participants looked more at the character that they would mention first (N1) during the first 200ms after picture-onset.

The greater looks to N1 than N2 during 200ms after picture-onset suggests a close relation between eye-movements and production, as in [4]. However, additional analyses show that this finding could be reconciled with [5]'s claims. We found that in both languages (i) N1-looks were mostly looks to agents, and that (ii) on trials where participants produced passives, looks to patient were not greater than looks to agents during 0-200ms after picture-onset. Thus, the close relationship between eye-movements and production in [4] may be related to substantial looks to agents and production of actives. The initial preference for agents fits with people's tendency to look at more informative things ([1]). Because agents provide more information about causality and other aspects, people may initially look at agents first.

PSYCHOLINGUISTICS IN THE FIELD ACCESSIBILITY BASED PRODUCTION IN YUKATEK MAYA

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While most psycholinguistic work is based on the assumption that the language production system is universal, few of the world’s languages have been investigated to date (for exceptions, see e.g. Branigan et al, 2008; Ferreira & Yoshita, 2003). Some types of languages have not been investigated at all. We investigate how accessibility affects language production in Yukatek Maya (an indigenous language of Mexico), which differs drastically in terms of structure from previously studied languages. Our work follows Christianson & Ferreira’s (2005) ground-breaking work on Odawa with the goal to contribute to the emerging discipline of field-based psycholinguistics.

Two aspects of Yukatek grammar make it attractive for comparing availability accounts (direct accessibility accounts, Levelt & Maassen, 1981; Ferreira & Dell, 2000) and alignment accounts (indirect accessibility accounts, Aissen, 2003; Bock & Warren, 1985; Ferreira, 1994): 1) frequent left-dislocation and 2) passive voice morphology which neither presupposes nor precludes a word order change. Consequently, both agent-verb-patient (AVP) and patient-verb-agent (PVA) constituent orders are common in Yukatek.

We conducted a video description experiment (23 participants, 16 items, 20 fillers). Target videos manipulated agent and patient animacy in transitive events, such as hitting. Analyses employ multilevel logit models with the maximal random effect structure for participants and items justified by model comparison. We annotated constituent order, voice, as well as the animacy and definiteness of the agent and patient. The examples in 1) and 2) show active and passive voice responses to stimuli with human and inanimate agents and patients. Overall, agent-before-patient constituent order was strongly preferred, as was active voice (Table 1).

Word order: As predicted by direct accounts, human agents and patients were significantly more likely to be mentioned earlier (ps<0.0001; interaction: n.s., N=597). Although human agents and patients were more likely to be definite phrases (ps<0.0002) and definite phrases showed some tendency to be ordered earlier (agent: p<0.0001; patient: n.s.; interaction: p<0.0001), the animacy effect held independently (ps<0.0002; interaction: n.s.). The agent animacy effect was partly mediated by an effect on transitivity (whether participants described an event as e.g. an apple hitting a man or an apple falling on a man) in that inanimate agents were less often described transitively (p<0.0001; no patient effects). The agent and patient animacy effect remained significant even for transitive sentences only (ps<0.004; no interaction, N=502).

Voice: Initial evidence was also compatible with a revised alignment account. Human agents correlated with active use (p<0.0001) and human patients with passive use, though more weakly (p<0.03, N=604).

Though speakers of Yukatek tended to mention animate referents first, in line with the cross-linguistic findings on direct accessibility (Ferreira & Yoshita, 2003; Branigan & Feleki; 1999, Prat-Sala & Branigan, 2000), they also showed a tendency to use passive voice in addition to mentioning human patients before inanimate agents. We offer discussion of the complex relationship between constituent order and voice in Yukatek. Along more general lines, our results provide support for the universality of conceptual accessibility in language production and the feasibility of field-based psycholinguistic studies.

Table 1 – Voice and Word Order of A(gent), P(atient), V(erb) of 531 transitives (excluding 161 non-transitives and 32 undetermined)

<table>
<thead>
<tr>
<th>Word order</th>
<th>Total</th>
<th>Active</th>
<th>Passive</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVP</td>
<td>440</td>
<td>427</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>PVA</td>
<td>63</td>
<td>2</td>
<td>61</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>28</td>
<td>20</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

Example stimuli and responses (Second line morpheme-by-morpheme gloss, third line free translation):

Human Agent, Inanimate Patient, Active AVP
1) Le=máak=o’ t-uh=lah-ah le=mesa=’o’
   DET=person=D2 PROV-ADV-CMP.B3 DET=table=D
   The person is slapping the table.

Inanimate Agent, Human Patient, Passive PVA
2) Le=máak=o’ tún híirix-t-’al tuméen u=kúamyon
   DET=person=D2 PROG.A3 slide-APP-PASS.INC CAUSE A3=truck
   The person is being pulled along by a truck.

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WORKING MEMORY SPAN MODULATES EFFECTS OF PITCH ACCENTING ON DISCOURSE MEMORY

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The present study investigated the relationship between individual differences in working memory (WM) span and the effect of prosodic pitch accents on discourse memory. Participants listened to recorded stories in which the pitch accents were manipulated between contrastive pitch accents (or L+H* in the ToBI system) and presentational accents (H* in ToBI). Referents receiving contrastive accents were better remembered, and listeners who had a high WM span showed a greater benefit than low span listeners.

Prosody can influence language processing through pitch accents placed on particular words (Cutler, Dahan, & van Donselaar, 1997, for review), but little work has investigated individual differences in use of this information. Fraundorf, Watson, and Benjamin (2009) found that referents that receive contrastive accents are better remembered than those receiving presentational accents. One possibility is that this benefit is greater for high-span listeners, who may have more resources to process prosodic information. Alternately, because pitch accents may direct attention to important referents, they may be particularly beneficial for low-span listeners in helping them encode the most important information even if they do not have sufficient resources for full encoding.

Participants (N=24) first completed four WM tasks, including modified loaded reading and loaded listening span tests (from Stine & Hindman, 1994), and alphabet span and subtract 2 span tests (Waters & Caplan, 2003). Because composite measures across multiple tests are often more reliable (Waters & Caplan, 2003), the measured spans were averaged across the four tests.

Participants subsequently listened to recorded stories that each contained two contrast sets. For instance, context passage (1) suggests one contrast between the British and French, and one between Malaysia and Indonesia. The continuation in (2) refers to one referent from each set. We independently manipulated whether each referent in the continuation received a contrastive or presentational accent. (Capitalization indicates contrastive accenting.) Words receiving contrastive accents had greater pitch excursion, intensity, and duration than words receiving presentational accents. After listening to 48 stories, participants completed a two-alternative forced choice recognition test for the referents in each continuation.

Log odds of correct recognition was modeled using a hierarchical linear model with crossed random effects for subjects and items. Referents were remembered better when receiving contrastive accents (M=83% correct) versus presentational accents (M=79%), Wald z=2.57, p<.05. Moreover, accent type interacted with WM span, Wald z=2.21, p<.05. For every 1 unit increase in WM span, the odds ratio between contrastive and presentational accents was 1.49 times greater. The main effect of WM span was not reliable, Wald z=1.14, p=.25. There was no main effect of utterance position (first or second referent in the continuation), nor did this variable interact with any others (all ps > .20)

These results indicate that individual differences can modulate the effects of pitch accenting on memory for a discourse. Specifically, high-span listeners showed a greater benefit from contrastive accents than low-span listeners. These results are consistent with an account in which high-span listeners make greater use of prosodic information.

(1) Both the British and the French biologists had been searching Malaysia and Indonesia for the endangered monkeys.
(2) Finally, the (British/BRITISH) spotted one of the monkeys in (Malaysia/MALAYSIA).
THE ROLE OF SYNTACTIC PARAMETERS IN SECOND LANGUAGE PROCESSING: EVIDENCE FROM EVENT-RELATED POTENTIALS

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Introduction: ERP studies on native versus non-native language processing have argued that the observed differences result either from the speakers’ Age of Acquisition (AoA) [1][2] or from the level of language proficiency attained [3] [4], but the impact of these factors is still unclear. Some recent results suggest that the relative impact of AoA and proficiency on non-native language processing correlates with language distance. Here we report the results of the study in which three syntactic parameters were tested. Two had diverging values (1ab) the head-parameter (final in Basque initial in Spanish), (2ab) argument alignment (ergative in Basque/accusative in Spanish) and one converged (3ab) verb agreement (both languages have it).

In the ungrammatical (1b) the head of the postpositional phrase (arabera) precedes the complement instead of following it, in (2b) the subject (ni) lacks ergative case mark and in (3b) the verb (duzu) agrees with the 3person object instead of the first person (ni).

Methods & Materials: 17 native speakers of Basque and 17 highly proficient non-native Spanish-Basque (AoA 3yrs) bilinguals participated in the study. Event-related potentials (59 electrodes, impedance kept below 5 kOhm, bandpass 0.001-50Hz, and digitalization rate 500Hz) were registered while the participants were reading the sentences (word-by-word) and performing the grammaticality judgment task.

Results: The ungrammaticality led to a different ERP pattern among both groups in head parameter and ergative conditions, whereas verb agreement violations elicited similar ERP signatures for natives and non-natives. In the head parameter condition, both groups displayed a similar P600 component (600-800 ms), but differed with respect to the early negativities (300-500 ms): left lateralized in natives and long lasting (300-600 ms) and frontally distributed in non-natives. In ergative violations the non-natives did not show a P600, found among natives. Finally, verb agreement violations led to a comparable N400-P600 pattern in all participants.

Conclusions: Our results suggest that native and nonnative processing differs for the diverging parameters, but not for the convergent one. These findings suggest that syntactic processing might be sensitive to AoA when diverging core syntactic parameters are involved, but not otherwise.

Examples:

(1) (a) (...) [PP [guraso-en] arabera]] (...) 
(b) (...) [PP *arabera [guraso-en]] (...) 
(... ) according parents-gen (=according to (our) parents)

(2) (a) (...) erosi dut ni-k (...) 
(b) (...) erosi dut "ni (...) 
(...) bought have I-Subj/*Subj (=I bought)

(3) (a) zu-k ni (...) eramaten na-u-zu (...) 
(b) zu-k ni (...) eramaten *d-u-zu (...) 
you-Subj me(...) take me/*3person-have-you (=you take me)

References:
FOCUS PARTICLES AND SPOKEN LANGUAGE PROCESSING IN DUTCH: EVIDENCE FROM ERPS

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Sentences that occur outside of discourse context typically show a broad focus structure and are pronounced with a neutral intonation. Syntactically, the rightmost element in an out-of-the-blue sentence is assumed to represent the default focus and is perceived as prosodically most prominent. Recent ERP studies suggest that the comprehension of isolated sentences is qualitatively different from sentences in context. Accented elements in isolated sentences do not elicit frontal negativities or the Closure Positive Shift (CPS), which have been related to the processing of pitch accents on focus elements in context [1]. Furthermore, for isolated sentences, listeners accept neutral intonation but reject a narrow focus accentuation as inappropriate because a prominent contrastive pitch accent cannot be interpreted without a context [1]. However, narrow focus intonation may become acceptable for isolated sentences if focus particles induce expectation for focus and its prosodic marking [2].

In the current ERP experiment, we tested whether the presence of a focus particle (i.e., only) in isolated sentences facilitates the processing of contrastive pitch accents on elements in medial position. Thirty Dutch participants listened to sentences with a focus particle (2a, 2b) or without a focus particle (1a, 1b) and performed a comprehension task after some of the trials. We predicted that in the absence of context, contrastive pitch accents on medial elements should be unexpected and therefore incongruous. However, contrastive accents on medial elements might become congruous if preceded by a focus particle. Note, however, that the prosodic realization of focus particles differed between the conditions: ‘Only’ had a rising intonation if it preceded an accented noun phrase (2a) and a flat intonation if it preceded an unaccented noun phrase (2b).

ERPs were time-locked to stimulus onset relative to a 100 ms post-stimulus-onset baseline. ANOVAs performed on nine ROIs indicated an interaction between the presence of a focus particle and accentuation for medial elements. In sentences without a focus particle (1a,b), accented elements triggered positive ERP fluctuations between 200-400 ms as compared to unaccented elements. This positivity may reflect processing difficulty due to the infelicitous accent, but it can also, in line with [2], be ascribed to the mere processing of a pitch accent. In sentences with a focus particle (2a,b), however, no such effect of accentuation was present. Instead, accented elements elicited an anterior negativity between 800-1100 ms as compared to unaccented elements. This late negativity may be linked to reference set computation (“what could they have given instead of a bonus?”), but it can also be related to processing difficulty at the final word of the sentence.

Our results suggest that listeners respond immediately to acoustic changes in the speech signal and process accented elements differently from unaccented ones. The presence of a focus particle in isolated sentences seems to affect the processing of accentuation.

1a no particle, accent on object They gave a BONUS to the player.
1b no particle, no accent on object They gave a bonus to the PLAYER.
2a focus particle, accent on object They gave only a BONUS to the player.
2b focus particle, no accent on object They gave only a bonus to the PLAYER.

SEMANTIC SCOPE EFFECTS OF GENERICITY ON PRONOMINAL ANAPHORA

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A growing body of evidence shows that words are very rapidly integrated into the discourse-level representation and that the integration process is reflected by event-related potential (ERP) components (Van Berkum, 2008). Specifically, previous studies on pronoun resolution reported an Nref effect (a long-lasting frontal negativity beginning around 300ms post-onset) for referentially ambiguous pronouns (Nieuwland & Van Berkum, 2008) and for pronouns whose potential antecedents are inaccessible at the level of discourse structure (Dwivedi et al., 2006). In this study, we investigate the effect of semantic scope on pronoun resolution in the case of generic sentences.

Twenty-three native Italian participants were presented with sixty sentences in two conditions, as illustrated in (1). In the first clause of each sentence, a definite DP (la bicicletta da corsa) was introduced and later referred to by means of a clitic pronoun (la). Crucially, in (1a), the definite DP refers to an entity in the actual world, a racing bike; in (1b), by contrast, the first clause has a generic reading. Generic sentences are hypothesized to contain an often implicit semantic operator GEN that induces a tripartite semantic structure similar to that of modals and adverbials of quantification (Carlson & Pelletier, 1995). A noun phrase in the scope of a GEN operator cannot act as antecedent for a subsequent pronoun when the latter is meant to pick up an individual/specific entity. In (1), the verb of the second clause (sollevò) requires a specific reading of the referent of the pronoun, thereby preventing coreference resolution in (1b) but not in (1a).

The results revealed an unexpected effect before the verb, when reading the pronoun. The ERPs showed a rather frontal negativity within the [400-700] ms time-window after the onset of the pronoun for (1b) relative to (1a), significant between 500 and 550ms. Since in many of the items the pronoun was preceded by a temporal adverb (e.g., yesterday) inducing an episodic interpretation of the whole clause, our data suggest that a pronoun whose potential antecedent is in the scope of a GEN operator invokes extra processing steps during online integration. This extra processing, which could be the result of reinterpreting the referent of the pronoun as an instance of the type expressed by the potential antecedent, becomes manifest as a negativity sharing features of the Nref (topography) but with a later onset and a faster return to baseline. These results are relevant to the current debate aimed to correlate different kinds of referential processing difficulties to specific neurophysiological responses (e.g., Nieuwland & Van Berkum, 2008).

(1) a. La bicicletta da corsa era particolarmente leggera ma ieri Giovanni la sollevò con fatica.
   The bike racing was especially light but yesterday John it lifted-up with effort.
   (The racing bike was especially light but yesterday John lifted it up with effort.)

b. La bicicletta da corsa è generalmente leggera ma ieri Giovanni la sollevò con fatica.
   The bike racing is generally light but yesterday John it lifted-up with effort.
   (The racing bike is generally light but yesterday John lifted it up with effort.)

REVERSING CAUSAL COHERENCE THROUGH LINGUISTIC CUES: EVIDENCE FROM EVENT RELATED POTENTIALS

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During language comprehension, our brains rapidly distinguish information that is coherent with our real world knowledge and information that is not. Words that are coherent with real world knowledge evoke a smaller N400 event-related potential (ERP) than words that are incoherent. In many situations, linguistic coherence is determined by a match between semantic associations amongst words in the current discourse and stored associations in our long term memories about entities, properties and events in the real world.

However, there exist linguistic operators that can reverse previously established coherence relations. For instance, the scalar item “even” reverses scalar inferences, such that the least likely event actually becomes true. In (1), based on our world knowledge, (1a) is coherent with its preceding context, and (1c) is not. The addition of the scalar term “even so” in (1b) and (1d) reverses the coherence relation, such that now under a different context, (1b) is not coherent, whereas (1d) is coherent.

1a. The schools were closed that day.
1b. Even so, The schools were closed that day.

1c. The schools were closed that day.
1d. Even so, the schools were closed that day.

We used ERPs to determine how rapidly the linguistic operator, “even so”, reverses our online evaluations of causal coherence during word-by-word discourse processing. 180 sets of three-sentence scenarios like (1) were constructed, each with four conditions. A cloze task (n=40) on these sentences showed that these contexts were of medium-constraint. The coherent conditions (a&d) had average cloze probabilities of 0.42 and 0.31, and the incoherent ones (b&c) had cloze probabilities of 0.03 and 0.04 respectively. Semantic co-occurrence between content words was matched across the four conditions.

In Experiment 1, participants (n=28) explicitly rated causal coherence on a 1-5 scale. Incoherent (1b) (vs. coherent (1a)) critical words (“closed” in (1)) evoked an N400 followed by a P600 effect. The addition of “even so” led to both a larger N400 and P600 effect in (1c) vs. (1d). In Experiment 2, participants (n=20) read the same sentences but simply answered comprehension questions on 25% of trials. Incoherent (1b) (versus coherent 1a) evoked only a P600 effect at the critical words, without a N400. The addition of “even so” (1c&1d) led to both an N400 and a P600 effect.

We conclude that, in medium-constraining contexts, people rapidly employ the reversal function of “even so” to establish coherence relations across sentence boundaries. This can override the lexical semantic associations between individual words in the context. This reversal of coherence influences lexico-semantic processing of upcoming words (N400) and at the same time triggers a reanalysis in relation to the preceding context (P600). This is the case both when readers are required to make explicit coherence judgments and during normal online comprehension.
THE EYES ARE FASTER THAN THE BRAIN

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By all accounts lexical processing during reading occurs very quickly, but conclusions differ on how quickly it occurs and what steps it involves. One prominent account of the speed of lexical processing is based on the EZ Reader Model (Reichle, et al. 1998; Pollatsek, et al. 2006) in which word recognition plays a primary role in the timing of saccades through a text. On this view recognizing a word and retrieving its meaning are completed in about 200 to 300 ms. A second prominent account of the speed of word recognition is based on the neurophysiologic information obtained in studies of event-related potentials (ERPs), where words have been found to elicit the N400 (Kutas, et al. 2006; Barber, et al. 2007). This negative deflection is typically observed 300-500 ms after the eliciting word, suggesting that lexical processing typically takes place around 400 ms after visual processing of the word begins.

We present parallel eye-tracking and ERP studies that measured the time-course of repetition priming between words in a sentence. For eye-tracking, the time-course of priming was calculated as the difference between the cumulative distribution function of single-fixation durations for a word when it was primed (repeated) as compared to when it was unprimed (new). Evidence of priming appeared around 150 ms after the word was fixated, peaked roughly 50 ms later, and was completed within another 125 ms. For ERPs, the time-course of priming was calculated as the difference wave between ERPs for a word when it was primed as compared to when it was unprimed. Evidence of priming appeared around 275 ms after the word was presented, peaked roughly 125 ms later, and was completed within another 150 ms. Thus, estimates of the time course of repetition priming from eye-movement and ERP measures scarcely overlapped.

One explanation for the disparity in these estimates is that first-pass eye-movement measures do not reflect complete processing of a word in a sentence as contended by the EZ Reader model. Instead, those measures might reflect incomplete processing of a word based on coarse encoding of visual information. We present data from an additional eye-tracking experiment on repetition priming that used the boundary technique to manipulate information about the target word that was available in parafoveal preview; words were presented either in full preview or with the second and third letters transposed. The serial-attention switching mechanism of the EZ Reader model is based on the idea that skipping a word (other than in cases of motor error) occurs because the word is recognized completely during parafoveal preview. Thus, the model predicts that repetition should only increase skipping with full preview but not with transposed-letter preview (where the previewed string is a non-word). The results show that skipping rates are higher for repeated words than new words with full preview but not with transposed-letter preview [F1(1,39)=6.72, p<.02; F2 (1,39)=5.76, p<.025 for the interaction]. These data support the idea that first-pass eye-movement measures reflect complete lexical processing and suggest that neural measures other than N400 must be considered in efforts to explain why the eyes are faster than the brain (Rayner, et al. 2009; Dikker, et al. 2009).

ACOUSTIC AND SYNTACTIC INFLUENCES ON THE NEURAL PROCESSING OF PROSODIC BOUNDARIES

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Understanding the processing of speech prosody is key to our understanding of sentence processing (e.g., Schafer 1997, Friederici 2002, Watson & Gibson 2004, Frazier et al. 2006). Event-related brain potentials (ERPs) hold particular promise in exploring prosodic processing, especially with the discovery of a brain response argued to reflect the processing of prosodic boundaries themselves, the Closure Positive Shift (CPS; Steinhauer et al. 1999). In order to further illuminate the CPS and related effects, we conducted an ERP experiment in English, using a different set of syntactic structures than those found in previous CPS studies in German, Dutch, and Japanese. The results suggest that there may be two distinct ERP responses to a prosodic boundary, which differ in their sensitivity to the acoustic properties and syntactic position of the boundary.

The experimental stimuli were spoken English sentences containing temporary structural ambiguities that ultimately disambiguate toward either a preferred Direct Object (DO) or dispreferred Subordinate Clause (SC) structure (e.g., The basketball player accepted the contract {DO because it paid well. /SC requires him to play every game. }). Each experimental sentence had a single sentence-internal prosodic boundary (L-H% in ToBI notation) whose location was more appropriate for either the SC structure (just before the phrase "the contract") or the DO structure (just after the phrase "the contract"). The design was fully crossed, resulting in two conditions where prosody matched syntactic structure and two where prosody and syntax mismatched. Cross-splicing ensured precise control on prosodic conditions, lexical frequency was balanced across disambiguating words, and structural preferences were established with norming studies. EEG was recorded from 28 scalp electrodes for 38 subjects. Each subject heard 120 experimental items and 120 distractors in one of four counter-balanced lists, and answered short yes-no comprehension questions after each item.

ERPs time-locked to the disambiguating words and to the prosodic boundaries were analyzed independently using linear mixed-model analysis, but we focus here on the boundaries. In accordance with previous studies, we observed a robust CPS, but with two novel findings. First, we additionally observed a later, more frontally-distributed positivity (analysis window 800-1000ms). Second, this late frontal positivity and the "canonical" CPS appear to be affected differentially by the acoustic properties and syntactic position of the boundary. Specifically, the duration of the boundary pause affected the strength of both components (though with somewhat different scalp distribution), but the syntactic position affected only the late frontal positivity.

These findings have several important implications. While our results support findings from recent literature that the neural processing of prosody is affected by syntactic expectations (Kerhofs et al. 2007), we show that syntactic position appears to only affect a later component which may overlap with but appears distinct to the more "traditional" CPS. This study is also among the first to demonstrate a clear effect of a gradient acoustic property on the CPS even within the phonological category of a major prosodic boundary. Taken together, this study represents a clear step forward in our understanding of the neural processing of speech prosody.
**THE LIMITS OF INDEPENDENT SEMANTIC COMPOSITION: ERP EVIDENCE FROM CHINESE**

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Recent ERP studies have challenged the widespread view that incremental sentence interpretation relies on the syntactic structure of sentences [1,4,5,6]. Many have observed a P600 in response to thematic role reversal of verb arguments in syntactically well-formed sentences (e.g., (a), (b)) [1-4,7], and have argued for an independent semantic processing stream that can construct interpretations that are incompatible with the surface form of the sentence. Here we highlight a critical distinction between the environments in which “thematic P600s” have been observed, and hypothesize that non-surface meaning composition is gated by the similarity between the arguments’ semantic features. Particularly, role reversal in sentences with animacy-mismatching arguments is confounded by an animacy violation (e.g., (a)), which has been demonstrated independently to elicit P600 responses [8,9]. We present new evidence that the P600 elicited in such contexts reflects the detection of animacy violation rather than the computation of non-surface meanings.

(a) The meal was devouring… [1]
(b) The fox that at the poacher hunted… (translated from Dutch) [3]

Using the verb-final BA-construction in Chinese, the current study (n=19) examined the evidence for non-surface semantic composition in sentences with arguments that either match or mismatch in animacy. Importantly, this construction has a SOV word order that unambiguously signals the syntactic roles of the arguments.

Experiment 1 tested whether role reversal in sentences with animacy-mismatching arguments affects ERPs beyond the effect of animacy violation using a 2 (animacy congruity) x 2 (combinability) design. A verb-argument triplet was “animacy congruous” if both arguments fulfilled the verb’s animacy requirements, and “combinable” if the arguments and the verb could describe a plausible scenario. Within each item set, all conditions began with an identical animate subject–inanimate object pair and differed only at the phrase-final verb. The same verbs were used in different conditions across item sets to avoid lexical confounds. ERP results showed an N400 reflecting a main effect of combinability, and a P600 reflecting a main effect of animacy violation. This is consistent with previous findings that combinability does not modulate the P600 effect [3,5,8]. The P600s elicited in both animacy-violated conditions were identical and, crucially, not modulated by the presence of a plausible reversal interpretation. This suggests that role-reversal interpretations are not computed when the arguments mismatch in animacy.

Experiment 2 examined the effect of role reversal in sentences with animacy-matching arguments. The two conditions differed only in the order of the arguments. As in previous studies [2,4,7], the role-reversed sentences elicited a P600 relative to the canonical controls. This is consistent with the hypothesis that non-surface meaning composition is facilitated by the match between the arguments’ animacy.

Taken together, these findings suggest a new generalization about the computation of non-surface meanings and its architectural implications. Whereas role-reversal interpretations are facilitated in cases where arguments match in animacy, they are absent in cases where the arguments mismatch in animacy. This suggests that semantic composition is not independent of structure, but instead is tightly gated by the similarity between the arguments’ semantic features.

ACCOMMODATING TALKER VARIABILITY IN ONLINE SPEECH PROCESSING

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Two theories attempt to explain how we adapt to talker-specific differences, such as accent, when processing speech; however, questions about the theories and how to differentiate them remain. Two experiments were done in order to identify characteristics of the adaptation process with the aim of constraining and improving these theories.

One question that was addressed is what types of information can be used to guide this process. According to the normalization theory of adaptation, only acoustic information is used in the creation of transformational algorithms, although extralinguistic information may be incorporated at another stage [1]. In the episodic theory, extralinguistic information is stored along with acoustic information and is integral to interpreting speech input [2].

The second question is whether a long-term memory component exists in the process of adaptation. In the normalization theory, a new algorithm is created whenever there is a speaker switch [1]. Information about talker characteristics may be stored to aid in talker identification, but the algorithms themselves are not. In the episodic theory, both acoustic and extralinguistic information are stored together [2].

In Experiment 1, 38 participants completed an eye tracking task in which they listened to a male talker with a dialect of U.S. English in which the /æ/ vowel is raised to /ɛ/ only before /ɡ/ (e.g., bag is pronounced /beɪɡ/), and a female talker with a familiar (non-raised) dialect. After a period of exposure to the talkers, participants viewed a grid containing four words: an -ag word, an -ack word or –ake word with the same initial phoneme (e.g., bag and back/bake), and two unrelated fillers. On each trial, participants heard one of the talkers (selected at random) say the preamble “Click on,” followed by the target word.

Results indicated that on –ack trials, participants fixated more on the target when hearing the accented talker (for whom the competitor –ag word was pronounced with a different vowel) than when hearing the unaccented talker (who pronounced both words with the same vowel). The reverse pattern of results was found on –ake target trials, in which the target and competitor word vowels were more similar for the accented talker than for the unaccented talker.

In Experiment 2, 56 participants completed a task that was identical to Experiment 1, except that a picture of the talker was presented before the target word instead of a preamble. The results replicated those of Experiment 1, indicating that participants were able to use non-linguistic information as a cue to talker identity and prepare to process that talker’s speech.

These results suggest that talker adaptation is a process that can happen quickly and that listeners are able to access information stored during previous experiences with the talker in long term memory based solely on non-linguistic cues.

COMMON GROUND REPRESENTATIONS ARE MORE THAN ALL-OR-NOTHING: GRADIENT EFFECTS OF COMMON GROUND IN ON-LINE LANGUAGE UNDERSTANDING

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Theories of common ground (CG) typically assume that CG representations contain more detailed information than simply whether an entity is or is not CG1,2. However, experimental investigations of whether CG guides language processing have typically treated CG as an all-or-nothing phenomenon, and have yielded equivocal results3,4. Thus, the hypothesis that on-line processing is sensitive to more detailed information, such as how CG was established, has not been tested. If so, variations in the strength of CG representations due to differences in how CG was encoded, could help explain the equivocal findings.

The present experiment tested the hypothesis that addressees are sensitive to how a potential discourse referent became CG, and that this sensitivity can result in gradient CG effects. Eye-tracked participants (n=48) and an experimenter (E) sat at separate computers. On each trial, the participant’s screen (see example below) contained 4 animals; two E also saw (visually-shared), and two only the participant saw (visually-privileged). On critical trials, the participant described her privileged animals, making them linguistically co-present. In a control condition, the animals were not mentioned. The critical instruction contained an expression (pig…) that was temporarily ambiguous between two animals in the scene (one shared, one privileged). If participants are sensitive to CG, when the visually-privileged pig is in linguistic CG, addressees should be more likely to consider it the referent. To test the hypothesis that CG representations are gradient, we manipulated two factors hypothesized to modulate the strength of the belief that the linguistically-mentioned animals are CG: (A) Initiation: Either E or the computer instructed the participant to reveal her secret animals. We hypothesized participants would more strongly believe linguistically-mentioned animals to be CG if E had inquired about them. (B) Feedback: We manipulated the feedback E gave after the participant mentioned her secret animals (repeat/OK/none). We hypothesized that CG would be stronger when E provided clear evidence of understanding (repeat or OK). Finally, participants completed a Stroop task to assess inhibition control (IC).

Following “pig”, participants were more likely to fixate the visually-privileged animal (pig wearing bowtie) when it was linguistically mentioned, vs. control. Focusing on mentioned trials, there were significant interactions between Time, Initiation, Feedback, and IC: There was a clear preference to fixate the mentioned animal when E asked the participant to reveal her secret animals, regardless of Feedback or IC. However, when the participant was prompted by the computer, there were fewer mentioned animal fixations, and the pattern of results was modulated by Feedback and IC.

The results demonstrate interlocutors encode more detailed information than simply whether information is or is not CG. On-line processing is sensitive to how information became part of CG. These results are consistent with the claim that interlocutors encode detailed, diary-like information about how information enters CG1, as well as claims that automatic associations form the basis of much of CG, and have graded effects on language2. Finally, IC modulated use of CG, though the relationship was more complicated than was previously found for interpretation of questions4, possibly because imperatives make fewer assumptions about the addressee’s knowledge state.

Example screen (participant’s view): 4 shapes (star, heart, diamond, triangle). 4 stationary animals: a pig wearing a hat (CG), a pig wearing a bowtie (PG), a horse wearing a purse (CG), and a horse wearing a flower (PG).

Example linguistic stimuli: These occurred in 1-4 order.
(1) Experimenter: “What are your secret animals?” (experimenter-initiated condition)
or Computer text prompt: “Tell the experimenter what your secret animals are”.
(2) Participant: “a pig wearing a bow tie and a horse wearing a flower.”
(3) Experimenter: “OK” (OK condition), or “a pig wearing a bowtie and a horse wearing a flower” (repeat condition), or [nothing] (no feedback condition)
(4) Experimenter: “So first, put the star below the pig that’s wearing the hat/bowtie.” (critical sentence)

ANTICIPATING MOVED OBJECTS: EVENT-PLAUSIBILITY MATTERS, BUT NOT ALWAYS...

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Altmann and Kamide (2009) showed participants scenes depicting e.g. a woman, a table, and on the floor, a wine bottle and glass. Subsequently (with the scene removed), participants heard “she will pick up the bottle, and pour the wine carefully into the glass” preceded by a context in which the glass was heard to move to the table (Ex. 1) or stay put on the floor (Ex. 2). They found that during “the glass”, participants looked towards where the glass had been in the situation described by the language – back to where the table had been after (1) but back to the floor after (2). This same pattern was found in anticipatory eye movements during “the wine carefully into”. Altmann and Kamide speculated that the event-based representations driving eye movements in the “moved” condition are experientially based, and that object-representations whose states are determined by implausible events would be less accessible than object-representations whose states are more plausible. If right, this would predict fewer looks, during the sentence-final “the glass”, back to the lamp in (3) than back to the table in (1). Here, we describe a range of studies showing a quite different data pattern to that predicted by Altmann and Kamide: Plausibility only manifests in anticipatory looks, and only in cases where the scene has been removed prior to the language:

The first two studies we report contrasted plausible locations to which the glass was moved (the table) with implausible locations (the lamp). The studies were identical except that Study 1 removed the scenes before auditory playback whereas Study 2 kept the scenes onscreen during the unfolding language. In both studies, there were as many looks to the plausible location (in 1) as to the implausible location (in 3) during the final “the glass”, contra Altmann and Kamide. However, although there were also anticipatory looks towards the implausible location in Study 2 (i.e. during “the wine carefully into”), there were no such looks in Study 1. Why is it, then, that when the scene is concurrent with the language, there is no evidence of a ‘cost’ associated with the implausible event, whereas when the scene is absent, there is such evidence, but *only* when anticipating, but not hearing direct reference to, the glass?

We report additional studies which test the following hypotheses: (1) plausibility does not influence the retrieval of information about an entity (such as its location), but does influence the likelihood of that entity being anticipated; (2) in the context of a concurrent scene, it is assumed that the participants in the event will be drawn from that scene, but in the absence of a concurrent context, there is no such assumption, with real world experiential knowledge now constraining anticipatory hypotheses; (3) entities introduced by the language, but not the scene, *will* be assumed to take part in subsequent events (e.g. 4 below, for which we now predict anticipatory looks towards the lamp even in the blank screen case, unlike 3).

1. The woman will move the glass onto the table. Then, she will pick up the bottle and pour the wine carefully into the glass. [scene contains: woman, table, bookcase, lamp, wine bottle and wine glass on floor]
2. The woman is too lazy to move the glass onto the table. Instead, she will pick up the bottle and pour the wine carefully into the glass. [scene as above]
3. The woman will move the glass onto the lamp. Then, she will pick up the bottle, and pour the wine carefully into the glass. [scene as above]
4. The woman will move a glass onto the lamp. Then, she will pick up the bottle, and pour the wine carefully into the glass. [scene as above but *without* the wine glass].

PLAUSIBILITY EFFECTS WHEN READING ONE- AND TWO-CHARACTER WORDS IN CHINESE: EVIDENCE FROM EYE MOVEMENTS

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In written Chinese, spaces do not mark word boundaries, and the same character may function either as an independent word or as part of a multi-character word with a distinct meaning. The present experiment explored the consequences of this variability for the timing of plausibility effects on eye movements in reading.

Readers’ (N = 36) eye movements were monitored as they read sentences containing a critical character that was either a one-character word or the initial character of a two-character word. By manipulating the two-character verb prior to the target word, the one character target word (or the first character of the two-character target word) was either plausible or implausible at the point at which it appeared, whereas the two-character word was always plausible. Therefore, there were four conditions: (1) a plausible two-character target word with its first character plausible at the point it appeared, (2) a plausible two-character target word with its first character implausible (as an independent word) at the point it appeared, (3) a plausible one-character target word, and (4) an implausible one-character target word (see Staub, Rayner, Pollatsek, Hyönä, & Majewski, 2007, for a similar manipulation involving noun–noun compounds in English).

First-pass reading times were significantly inflated on a region including the implausible one-character word and the preceding character. Also, the implausible one-character target word was significantly less likely to be skipped in first-pass reading than the plausible one-character target word. However, the plausibility manipulation on the initial character of a two-character target word did not yield significant effects on reading of this word or its component characters, on any eye movement measure.

These results suggest that processes of semantic integration in reading Chinese are performed on a word-by-word basis, instead of a character-by-character basis. Moreover, they suggest that word segmentation must take place very early in the course of processing. The results are in apparent contrast with the results obtained by Staub et al. (2007), who found significant disruption in the eye movement record when the first word of a plausible English noun–noun compound was implausible as a head noun. It appears that the absence of interword spaces in written Chinese may give rise to distinct reading strategies.

1. 陆老板生气地要踢打门卫时被人劝住了。 (plausible-plausible)
   [Mr. Lu wanted to kick the gatekeeper when he was mad with rage, but he was stopped by people.]
2. 陆老板生气地要解雇门卫时被人劝住了。 (plausible-implausible)
   [Mr. Lu wanted to dismiss the gatekeeper when he was mad with rage, but he was stopped by people.]
3. 陆老板生气地要踢打门卫时被人劝住了。 (plausible)
   [Mr. Lu wanted to kick the door when he was mad with rage, but he was stopped by people.]
4. 陆老板生气地要解雇门卫时被人劝住了。 (implausible)
   [Mr. Lu wanted to dismiss the door when he was mad with rage, but he was stopped by people.]

Sentences Processing Mechanisms Influence Cross-situational Word Learning

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Foreign-language (FL) learners can potentially exploit two contextual constraints to learn novel words in natural contexts of language use (i.e., outside the classroom): Firstly, words are embedded in sentential contexts and, secondly, there is a rich but ambiguous visual context containing possible world referents. Research shows that adults manage to learn world-word mappings under referential uncertainty by performing statistics of co-occurring words and referents (cross-situational word learning, CSWL, Yu & Smith, 2007). However, words in these studies are usually presented linguistically unconnected. We investigate whether sentence-processing mechanisms additionally constrain the linking of words and referents. In particular, we examine the effect of verb-derived, plausibility-based expectations (Altmann & Kamide, 1999) on noun learning.

We conducted three adult-language-learning experiments using a pseudo-natural language. The learning procedure was stepwise: participants learned verbs, then they were confronted with a combined sentence-comprehension and noun-learning task. Sentences consisted of the previously learned verbs and novel nouns as the sentence’s subjects and objects. Co-present scenes were depicted, showing both the characters and objects onto which the nouns had to be mapped (targets), as well as distractors.

In Experiment 1 (N=24), we investigated whether participants would, firstly, successfully learn nouns and, secondly, exploit verb constraints to find the scene target. All verbs had semantic restrictions (e.g., bermamema, ‘eat’) and all sentences had subject-verb-object structure (SVO) (Example 1). For Experiment 2 (N=40), word order was added as a between-subject manipulation (SVO/OVS). In both experiments (and both conditions of Exp2), participants succeeded in learning nouns significantly above chance, showing that they conducted CSWL (baseline 25%; Exp1: 55%, t(23) = 9.28, p < .001; Exp2, SVO: 70%, t(37) = 8.25, p < .001; OVS: 51%, t(37)= 3.84, p < .001). Interestingly, predictive eye-movements to referents starting in verb region in SVO reveal a rapid integration of verb information together with visual information and world knowledge (significantly more inspections on target than distractor in verb region, Exp1: Chi-Square(1) = 6.09, p = .01).

Experiment 3 (N=32) further examined how semantic verb restrictions interact with CSWL. Pictures always showed four objects. Degree of referential uncertainty was manipulated with three levels. In Condition 1, there was no referential uncertainty: Verbs were restrictive and only one scene object matched the verb’s selectional restrictions (bermamema, selected the depicted tomato). In Condition 2, verbs were restrictive but two scene objects were possible candidates (tomato and toast): CSWL had to be performed but referential uncertainty was low. In Condition 3, verbs were non-restrictive: Referential uncertainty was high and only CSWL could enable learning nouns. Results reveal that verb restrictions boost noun learning: Learning rates and confidence ratings were highest for Condition 1 and lowest for Condition 3 (ratings: main effect, Chi-Square(3) = 35.99, p < .001 and significant differences between all levels).

These findings suggest that adults invoke anticipatory comprehension mechanisms during situated foreign-language learning, and that anticipatory identification of plausible world referents substantially reduce the complexity of pure CSWL.

References
VERB TYPE DETERMINES WHEN THE SUBJECT IS REACTIVATED: EVIDENCE FROM EYE MOVEMENTS

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Intransitive verbs are classified on the basis of the thematic role of their argument (Levin and Rappaport Hovav, 1995). The argument of unergative verbs (jump) is the agent of the event and syntactically taken to be a subject. The argument of unaccusative verbs (disappear) is the theme of the event and hypothesized to be a syntactic object. Evidence exists that the two verb types are processed differently (Bever and Sanz, 1997; Friedmannn et al., 2008; Charnavel et al., 2009). Results from various experiments show that unaccusative verbs trigger reactivation of the argument late after verb offset. For unergative verbs previous studies give different answers to whether they trigger reactivation. The present experiment was designed to shed more light on the reactivation pattern by using a more sensitive measure.

The existing studies take all theme arguments to be syntactic objects. However, Reinhart (2000 and subsequent work) argues that a specific set of verbs exists for which the argument is assigned the theme-role, but is syntactically a subject (such as 'glow'). In our experiment, we wanted to determine whether these verbs pattern in processing with unaccusatives, on the basis of thematic structure, or with unergatives, on the basis of syntactic structure.

To gain insight into these issues we used the visual world paradigm. A benefit is that you measure processing during the complete sentence, instead of at particular probe sites. The method is based on Huettig and Altmann (2004) who found that people will spontaneously fixate on a visual object (target) semantically related to a spoken word. The present experiment hypothesizes that people will not only look to the target upon hearing a related word, but also when this word is reactivated upon hearing the verb. Forty Dutch native speakers were orally presented with sentences (f.e. 1a) with either one of the three verb-types (of equal frequency). While listening, a visual display with four objects was shown, one (saw) being related to the verb's argument (wood). The control condition (1b) consisted of the same visual display combined with an identical spoken sentence in which the argument of the verb was replaced with an argument not related to any of the visual objects in the display ('clock' instead of 'wood') and served as the baseline. Eye movements were measured by a Tobii 1750 sampling at 50 Hz.

Results show that, when aligned for verb offset, for all verb types looks to the target relative to baseline increase as a result of presenting the verb. In accordance with previous studies, we found a late rise in looks to the target for unaccusatives, only starting from about 400 ms after verb offset. In unergatives we found an early rise in looks to the target starting right after verb onset. Importantly, glow-type verbs pattern with unergatives and as such show an early rise in looks due to presentation of the verb.

Our interpretation of the finding is that presenting the verb leads to integration of the subject and verb and as such opens semantic information related to this combined representation yielding eye movements towards representations that conceptually overlap. Crucially, syntactic subjects are integrated fast; whereas syntactic objects have to wait longer to be integrated irrespective of thematic role.

Example (1a) Test Sentence: Koekiemonster zei dat het hout (subject NP) van de dikke meneer met het kale hoofd hard viel (V) toen het zware onweer met een flits was begonnen
‘Cookiemonster said that the wood (subject NP) of the fat gentleman with the bald head fell (V) hard when the heavy thunderstorm had begun with lightening’

Example (1b) Control Sentence: Koekiemonster zei dat de klok (subject NP) van de dikke meneer met het kale hoofd hard viel (V) toen het zware onweer met een flits was begonnen
‘Cookiemonster said that the clock (subject NP) of the fat gentleman with the bald head fell (V) hard when the heavy thunderstorm had begun with lightening’

Visual display (1): saw (target), peacock, shell, stroller (all distracters)
**FIXATION DURATIONS IN FIRST-PASS READING REFLECT UNCERTAINTY ABOUT WORD IDENTITY**

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In reading, it's often assumed that words are recognized sufficiently quickly, accurately, and unambiguously that downstream processes may proceed with perfect information about word identity. But is this reasonable? Fixations during reading average ~200 ms, comparable to average saccade planning time (Matin, Shao, & Boff, 1993); planning for the next saccade must therefore begin very early in the fixation, presumably well before the fixation's associated processing has finished. Arguably, therefore, only noisy information about the fixated word's identity — and derived properties like frequency or surprisal — should be available to affect that saccade's timing, and thus the current fixation's duration.

For instance, suppose that one is looking at the word cat, which has a visual neighbor bat. A conventional model might predict that the reading time on cat is dependent on the surprisal of cat (Hale, 2001; Levy, 2008). We predict instead that reading time will depend on a mixture of the surprisal of cat with that of bat (among others), with each contributing according to its likelihood given available, noisy information about word identity. We used a simple Bayesian model of visual word recognition to test this hypothesis on reading data.

Visual word recognition model: Our model uses Bayes' rule to combine a bottom-up model of letter confusability derived from norming (Engel, Dougherty, & Jones, 1973; Geyer, 1977) with a top-down prior derived from context. It has one free parameter setting the overall level of visual noise.

Reading-time study: We extracted first and second fixation durations from the Dundee corpus (Kennedy, Hill, & Pynte, 2003), and estimated word probability using a BNC trigram model. These probabilities were used in two conceptually distinct ways: first, for the top-down prior in our visual model; and second, for the surprisal values averaged together to produce the “average neighborhood surprisal” (ANS). (In principle this second step could use any other property believed to affect reading time.) Finally, first and second fixation times were multiply regressed on raw surprisal (RS) and ANS with word length and frequency as controls, with regression coefficients and noise parameter fit simultaneously.

The best fitting model has a moderate level of noise, corresponding to a mean naming accuracy for individual letters of 66%. Though ANS and RS are highly correlated (R2 = 0.96), the regression model unambiguously finds ANS significant, and RS not significant, as predicted.

The same analysis on second fixations produces analogous results, except that the estimated noise parameter for second fixations is half that for first fixations. Our model makes this result highly interpretable — two fixations provide twice the visual information that one does.

Finally, our assumption that people are able to bring full contextual information to bear when marginalizing over all possible words is a strong one, which we checked by comparing our full model to one using simple word frequency for its prior. The full model was superior.

We conclude that the linguistic processing system is able maintain and efficiently marginalize over noisy representations of linguistic input.


ACCESSING NON-PROMINENT ANTECEDENTS: THE ROLE OF NEGATION AND REPAIR
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Anaphor resolution is usually assumed to prefer prominent, salient, or available antecedents with prominence being affected by factors such as topicality, grammatical function, animacy, etc. Non-prominent antecedents may, however, also vary with respect to their accessibility. Whereas non-topics, inanimates etc. may just be less accessible than their more prominent counterparts, negated entities have been argued to be inaccessible by being encapsulated or suppressed from the current mental model.

In a self-paced reading experiment as well as in a visual world experiment, we will show that, in both, reading and spoken language comprehension, the accessibility of negated antecedents depends on the way the entity is negated. We compared negated and non-negated entities in sentences like

- (1a,b), where the negated entity is more local to the anaphoric pronoun “elle” and in a default focus position (with typical nuclear contour).
- (2a,b), where the negated entity is less local than the non-negated one and in a non-focus position.
- (3a,b), where the negation is replaced by a repair, with the negated entity following similar constraints as in (2a,b).

The surface position of the negated entity (and/or its role in the information structure of the sentence) may influence its accessibility with more local and/or focused entities being more accessible than more distant and/or non-focused ones. Information structure and/or surface order may thus play a role for non-prominent antecedent as it does for prominent ones. Repairs may have a different discourse function, since they imply that the repaired constituent has not even been intended to be mentioned by the speaker. They should thus never have been part of the current mental model (see however Lau & Ferreira, 2005).

In a visual world experiment, we presented participants with sentences like (1a,b) to (3a,b) and with pictures of the negated entity, the non-negated entity, a semantically related but unmentioned entity and a non-related entity. Fixation patterns time-locked to the pronoun showed a preference for the non-negated/non-repaired entity in all constructions. The non-negated entity was, however, looked at reliably more often than the semantically related but unmentioned entity in condition (1a,b) when it was more local and focused. It was still fixated more often in condition (2a,b), when it was more distant and unfocused (all ps < .05). Repaired entities were however not fixated more often than semantically related but unmentioned entities.

In a parallel self-paced reading experiment, the negated and the nonnegated antecedent differed in gender (une pizza, pas un gateau/a pizza [fem], not a cake [masc]), so that the anaphoric pronoun was only compatible with either the negated/repaired or with non-negated/non-repaired antecedent. Pronouns compatible with the non-negated antecedent with respect to gender marking were generally read faster than those compatible with their negated counterparts (ps < .01). The difference between pronouns referring to negated and non-negated antecedents was, however, larger for non-local/non-focused negated antecedents than for local/focused ones. Repaired antecedents were hardest to access (ps < .05). Locality, information structure and the pragmatic constraints of repairs are thus playing a considerable role for the accessibility of non-prominent antecedents in anaphor resolution as much as for prominent antecedents.

(1) J’ai fait une pizza, pas une tarte ce matin. Ce soir comme d’habitude elle sera certainement a. très appréciée par ton frère / b. apportée par ton frère. / I made a pizza, not a pie this morning. This evening, as usual, it will certainly be a. highly appreciated by your brother / b. brought by your brother.

(2) Je n’ai pas fait une pizza mais une tarte ce matin. Ce soir comme d’habitude elle sera certainement a. apportée par ton frère / b. très appréciée par ton frère. / I did not make a pizza but a pie this morning. This evening, as usual, it will certainly be a. highly appreciated by your brother / b. brought by your brother.

(3) J’ai fait une pizza, euh non, une tarte ce matin. Ce soir comme d’habitude elle sera certainement a. apportée par ton frère / b. très appréciée par ton frère. / I made a pizza, uh no, a pie this morning. This evening, as usual, it will certainly be a. highly appreciated by your brother / b. brought by your brother.
PROCESSING SUBJECT AND OBJECT RELATIVE CLAUSES IN DEAFL-ENGLISH BILINGUALS

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Many deaf individuals are bilingual in that they use a sign language and a written language, with the written language effectively becoming, in most cases, their L2. In this study we aim to begin to tease apart which aspects of their reading patterns are predictable within the context of other L2-processing studies and which ones might derive from their particular experience as deaf individuals. To this end, we used eye-tracking to explore to what extent deaf ASL-English bilinguals incorporate structural and semantic cues during the processing of English subject and object relative clauses (RCs) with animate and inanimate relativized NPs.

Studies show that English-L1 readers find object RCs harder to process than subject RCs (e.g., Traxler, Williams, Blozis, & Morris, 2005). However, the so-called object relative penalty disappears when available semantic cues help readers interpret the sentence NPs in their appropriate thematic positions. Thus, if the antecedent to the relative pronoun is inanimate (a good candidate for an object), readers find it easier to interpret object RCs. This indicates that L1-English readers incorporate both structural and semantic cues in sentence processing. One question we address is whether deaf readers incorporate both structural and semantic cues in a similar fashion. As L2-readers, they might be more attentive to semantic than to structural cues when processing RCs in their L2 (Frenck-Mestre & Pynte, 1997; Clahsen & Felser, 2006). On the other hand, their reliance on syntactic cues might vary with proficiency level (Dussias, 2003; Hopp, 2006a, 2006b).

Twenty-eight college-educated, deaf ASL-English bilinguals read 44 RC sentences in four conditions (from Traxler et al., 2005):

(Animate subject RC): The hiker that fled the avalanche appeared on the news
(Animate object RC): The hiker that the avalanche buried appeared on the news
(Inanimate subject RC): The avalanche that buried the hiker appeared on the news
(Inanimate object RC): The avalanche that the hiker fled appeared on the news

English proficiency measures were also collected. Eye fixations were analyzed in the RC region (underlined above) and the main verb region (in italics above).

Our results indicate that the most English proficient deaf readers behave like English-L1 readers in showing a RC subject-object contrast modulated by animacy in the inanimate-object condition. The less proficient participants do not show the expected subject/object contrast. Instead they find processing difficulty in those conditions in which animacy cues conflict with their expectations for a thematic position (i.e., inanimate subject and animate object conditions). This suggests that, in contrast to the more proficient participants, their parsing is lead by semantic rather than by structural cues.

These results highlight the need to contextualize the reading patterns of deaf individuals within studies on bilingual sentence processing. Traditionally, the reading patterns of deaf individuals have been compared to those of hearing L1-readers. Any differences in parsing were attributed to reading deficits due to deafness. Our results suggest that the reading patterns of the less proficient readers are predictable based on what we know from other L2 studies.
GRAMMATICAL GENDER IN L2 SPANISH: A PRODUCTION OR A REAL-TIME PROCESSING PROBLEM?

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Grammatical gender is one of the most elusive linguistic properties for second language (L2) learners to master. Persistent difficulty with gender assignment and agreement in production is documented extensively in various L2 populations, including learners with advanced proficiency. Findings differ, however, in studies of L2 learners’ sensitivity to gender cues in comprehension. Some have found ceiling performance on offline tasks, and concluded that L2 learners’ linguistic representation of gender is intact (White et al. 2004; Montrul et al. 2008). On these accounts, errors in production are considered a production-specific performance problem (Prévost & White 2000). Yet recent studies demonstrate differences between native and nonnative speakers’ sensitivity to gender cues in online receptive tasks (Dowens et al. 2009; Lew-Williams & Fernald 2009; Sabourin & Stowe 2008), indicating that L2 learners’ difficulty with grammatical gender is not restricted to production. These findings suggest that L2 learners may have difficulty retrieving gender information when processing language in real time.

No previous studies, however, have investigated grammatical gender in on- and offline comprehension as well as production in the same group of learners, a comparison crucial to teasing apart these previous interpretations. Here we tested 19 highly proficient, late L2 learners of Spanish (L1=English; first exposure at >10yrs; within native-speaker range on oral and written proficiency measures) on the following tasks targeting grammatical gender:

(i) elicited production
(ii) offline sentence-picture matching (adapted from Montrul et al. 2008)
(iii) two experiments employing an eye-tracking procedure;

In Expt. 1, participants saw pairs of objects with names of either the same (la pelota – la galleta) or different gender (la pelota – el zapato). Previous research shows that 3-year-old and adult native speakers, but not intermediate-level L2 learners of Spanish, are faster to orient to the referent on different-gender trials, where the determiner is informative about the gender of the following noun (Lew-Williams & Fernald 2007, 2009). In Expt. 2, participants were first exposed to four novel nouns paired with determiners (2 masculine, 2 feminine), and then tested on the same paradigm as in Expt.2, but using these novel, instead of familiar, nouns.

Preliminary results (n=15) show

- below-ceiling performance in production (mean accuracy = 79%, sd=15.2);
- ceiling performance in offline comprehension (mean accuracy = 95%, sd=8.2);
- no difference in speed of processing on same- versus different-gender trials with familiar nouns (717ms vs. 735ms, t(14) = .574, p=.575), and only a marginally significant difference in reaction time with novel nouns (811ms vs. 742ms, t(14) = -1.91, p=.08).

Thus, highly proficient L2 Spanish speakers showed native-like skills in offline but not online comprehension, indicating that L2 learners’ difficulty with grammatical gender is not a production-specific phenomenon, but affects the rapid retrieval and integration of gender information in the real-time use of language, in both productive and receptive modes. We argue that the differences in Expt. 1 between our high-proficiency L2 learners and Lew-Williams and Fernald’s 3-yr-old native speakers may result from differences in how L1 and L2 learners parse article-noun sequences in the input, and consequently represent and access grammatical gender in the lexicon.
CONVERGING EVIDENCE FROM PRODUCTION AND COMPREHENSION OF DATIVE CONSTRUCTIONS IN ENGLISH

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Syntactic alternation between the prepositional dative construction (example 1) and double object construction (example 2) has been explored in a number of corpus-based studies that link the likelihood of either alternative to multiple syntactic, semantic, pragmatic and phonological properties of the alternating objects, sentence as a whole and the discourse context (e.g., Bresnan et al., 2007). Also, Tily et al. (2009) found that the likelihood of the prepositional dative construction correlates negatively with the acoustic duration of the preposition "to", indicating the facilitatory role of the syntactic probability on production costs. We further this line of research by considering the role of syntactic probabilities on the ease of planning for production and the ease of visual comprehension of dative alternation.

In Experiment 1 we considered 2360 dative constructions extracted from the Switchboard corpus of spontaneous speech. The dependent variable was the acoustic duration of the dative verb ("gave") and the critical predictor was the likelihood of the syntactic construction that follows that verb, estimated for this utterance using the corpus-derived model of Bresnan et al. (2004). A linear mixed model with multiple additional control variables and random effects revealed a strong negative correlation between the verb's acoustic duration and the likelihood of the upcoming construction (p < 0.0001). The verb followed by the least likely alternative was about 60 ms longer in acoustic duration than the one followed by the alternative that was most likely given the properties of objects and the sentence. This finding indicates that probabilities of syntactic choices play a role even before these choices are realized, that is, at the planning stage. Speakers demonstrably adjust their production strategies to syntactic probabilities of upcoming material.

Experiment 2 is a pilot study in visual comprehension of dative constructions: we extracted 60 such constructions from the Dundee eye-movement corpus. The fixation times on the verb were considered as the dependent variable, while the lexical bias of that verb towards the realized dative construction was the critical predictor. Statistical models showed that a greater verb's bias came with shorter gaze durations (p < 0.01), such that the verb followed by the least biased alternative was fixated on some 30 ms longer than the one followed by the most biased alternative. The fact that the syntactic constituents can affect the comprehension cost before they are fixated can be explained by the parafoveal preview of the object following the verb: our models reveal a significant effect of the frequency of the word following the verb on the verb's reading times.

To sum up, converging production and comprehension data corroborate the idea that speakers and comprehenders alike share and use probabilistic knowledge of language structure in planning and understanding dative constructions. Moreover, this knowledge is relied on early in the process of production planning and the timeline of visual comprehension. We discuss these findings in light of a unified probabilistic account of production and comprehension of discontinuous syntactic dependencies.

THE INFLUENCE OF HIGH LEVEL COGNITION ON EYE MOVEMENT CONTROL IN READING: DOES SYNTACTIC PREDICTABILITY AFFECT PARAFOVEAL PROCESSING?

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Although it is by now well established that humans engage in syntactic prediction during language processing (Lau, Stroud, Plesch, & Phillips, 2006; Staub & Clifton, 2006), there has been little research to date on the influence that this type of prediction may have on saccade planning in reading. Indeed, standard models of eye movement control in reading (e.g., SWIFT [Engbert, Nuthmann, Richter & Kliegl, 2000]; E-Z Reader [Reichle, Rayner & Pollatsek, 2003]) do not include high-level predictive influences. In the present paper we present two experiments designed to investigate the influences of predictive constraints on eye movement planning in two different syntactic predictive contexts, focusing on parafoveal processing. Our hypothesis in both experiments is that parafoveal information may be of more use, and therefore more likely skipped, if it is consistent with a syntactic prediction.

Experiment 1 used English cleft constructions that formed a dependency such that the reciprocal ‘to each other’ affects the parafoveal processing of upcoming plural nouns in sentences like 1a–1b. In 1a and 1b after reading the reciprocal it is likely that the readers set an expectation for an upcoming plural noun (which licenses ‘to each other’) in the first possible subject position. The Match condition (1a) was contrasted with Mismatch condition (1b) in which the plural subject was delayed and with two control conditions (plural: 1c, singular: 1d). Thirty-two participants read 28 materials. Fixation probability on “the girl(s)” was significantly lower in the match condition (87%) than in the mismatch or control-plural conditions (96%, 94%), despite the fact that the noun phrase is generally longer in (1a) than (1b).

In Experiment 2, the prediction of syntactic number was constrained by the determiners "these" or "this" (2a, 2b), with control conditions using "the" (2c, 2d), in a 140-item, 40-participant design where the next number-marked constituent always agreed with the determiner which predicted it. Fixation probability on the predicted word "bag(s)" did not differ by predictive conditions; however, analyzing a region including the subsequent word [bag(s) + that], fixations on the critical region "bags that" were significantly lower when a plural noun was preceded by "these" (2a) than "the" (2c) although there were no effects for singular nouns. Because the length of the critical region varied greatly (from approximately 8–18 characters), we additionally analyzed the results with an additional factor of region length: Although this greatly influenced fixation probability, it did not interact with the predictive skipping caused by "these". In addition to predictive factors, also there was an interaction between surface frequency and word skipping at the noun region (bag/bags), suggesting that lexical factors may also influence saccade planning.

Taken together, the results of these two experiments suggest that in predictive context morphological information in the parafovea is processed to some degree, even when the relevant information is relatively distant from the fixation. When this information matches a syntactic prediction, readers are more likely to skip the word, at least in cases where a plural is predicted. Our results suggest a top-down influence from syntactic processes on eye-movement planning, suggesting that models of reading may have to include higher-level cognitive influences (Anderson, Matessa & Lebiere, 1997).

Examples
1a. MATCH: It was to each other that the boys from school said that the children……. /1b. MISMATCH: It was to each other that the boy from school said that the children……. /1c. Control-plural: It was to John and Mary that the boys said that the children……./1d. Control-Singular: It was to John and Mary that the boy said that the children……
2a. Yesterday Mary bought these fabulous bags that are made of recycled rice sacks. /2b. Yesterday Mary bought this fabulous bag that is made of recycled rice sacks. /2c. Yesterday Mary bought the fabulous bags that are made of recycled rice sacks. /2d. Yesterday Mary bought the fabulous bag that is made of recycled rice sack.
A BROAD-COVERAGE MODEL OF SEMANTIC INTERFERENCE EFFECTS IN PICTURE NAMING

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Semantic context effects are a valuable tool in investigating mechanisms of language production. The well-known picture-word interference (PWI) paradigm (Lupker, 1979 Memory and Cognition, ibiz.) has been used to find that subjects are slower to name pictures which are taxonomically related to distractor words compared to unrelated or associatively related distractors. The null effect for associatively related words has been used to argue that competition due to semantic similarity does not drive lexical selection (Mahon et al., 2007 JEP: Learning Memory & Cognition). A newer experimental paradigm, known as semantic blocking (SB; cf. Damian et al., 2001 Cognition) has subjects name pictures which are grouped in blocks. In contrast to PWI, Abdel Rahman & Melinger (2007 Language and Cognitive Processes) found interference effects in blocks which were associatively related in addition to blocks which were taxonomically related.

In this work, we present a computational model which can simulate both the PWI and SB results, giving a pattern of results consistent with both experimental paradigms. The model follows Howard et al. (2006 Cognition) in that it relies upon (i) shared activation, (ii) competitive selection and (iii) priming.

A key contribution of the model is the manner in which shared activation is computed. It is common to assume that the degree of sharing is determined by weights which represent the degree of similarity between pairs of concepts. In previous work (cf. Oppenheim et al., 2009 Cognition), these weights have been learned using low-coverage datasets covering hundreds of words. The present model, however, sets the weights based on measures derived from computational linguistics research which cover hundreds of thousands of words. In particular, the model utilises the Lin’s WordNet-based metric of taxonomic similarity (Lin, 1998 Proceedings Of International Conference on Machine Learning) and Deerwester et al. (1990 Journal of the Society of Information Science)'s latent semantic analysis (LSA), which is biased toward associative similarity.

The implementation of competitive selection and priming draws heavily from research in ACT-R (Anderson et al., 2004), in particular the RACE/A model of lexical competition (van Maanen and van Rijn, 2009 Proceedings Of the 9th International Conference of Cognitive Modeling). In particular, competition is modeled using the Luce ratio, and priming relies on ACT-R's notion of practice and decay. The RACE/A is particularly suitable as van Maanen and van Rijn use it to explain between-trial effects in PWI, which bears some similarity to the SB paradigm.

Overall, the model finds a main effect for taxonomically related words in PWI simulation, but no interference due to associative similarity. In SB, however, we find interference for both. We conjecture it is because the blocked design gives the model time to spread activation which converges on competing concepts.

As competition is a key element to the model, the results undermine Mahon et al.'s argument that the absence of associative-related interference in PWI experiments preclude competition as a likely mechanism for lexical selection.
SINGULAR COMPLEXITY: MEG EVIDENCE THAT PLURALS ARE SEMANTICALLY UNMARKED

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Introduction

Two opposing views have emerged in the recent semantic literature on number, regarding whether singulars or plurals are semantically unmarked. One approach (Farkas & Swart, 2004) maintains the traditional view that plural nouns are marked for plural, while a singular interpretation arises by default in the absence of such marking. A different series of approaches (Sauerland et al., 2005; Zweig, in press) argue that it is actually plural nouns that are semantically unmarked and not specified for number. A plural interpretation arises through a pragmatic implicature; singulars are associated with an additional presuppositional requirement that the noun refer to just one entity.

These two theories make opposite predictions for the processing of singular versus plural nouns. If plurals are more semantically marked than singulars, the semantic composition of a plural noun phrase should require more effort. On the other hand, if singulars are the more marked case, more effort should be associated with semantic composition of singular than plural nouns.

Several recent magnetoencephalography (MEG) experiments have investigated the MEG correlates of semantic composition, results converging on a prefrontal midline component, the Anterior Midline Field (AMF), which localizes to the ventromedial prefrontal cortex (vmPFC) (Pykkänen & McElree, 2007; Brennan & Pykkänen, 2008; Bemis & Pykkänen, 2009). The AMF has consistently shown increases in amplitude for compositionally complex constructions relative to controls. Further, semantic violations, but not world-knowledge violations, similarly elicit increases in vmPFC activity relative to well-formed controls (Pykkänen et al, 2009), suggesting that vmPFC activity is sensitive to the effort of semantic composition, but not to the evaluation of plausibility.

In this work, we assessed whether the vmPFC would show effects of a simple number manipulation, and if so, in which direction. An increase in vmPFC activity for singulars would lend support to theories where plurals are unspecified for number, whereas an increase for plurals would conform to theories where singulars are semantically unmarked.

Experiment 1

Subjects read plural and singular phrases embedded in full sentences (1a-b). The stimuli were presented word-by-word with a sentence-judgment task following each sentence. A full-brain distributed-source analysis implicated the vmPFC as a locus of increased activity for singulars over plurals. We also conducted a region-of-interest analysis on the data, focused on the vmPFC. We found more vmPFC activity for singulars than for plurals 500msecs after the onset of the noun.

Experiment 2

In a second MEG experiment, we aimed to replicate our findings with a different experimental design. Using the same nouns, we presented just the noun phrases word-by-word (2a-b), followed by a picture-matching task after each trial. Preliminary results again show more activity in the vmPFC for singulars as opposed to plurals, although the effect now peaked at around 350msecs after noun onset.

Conclusion

We found more activity in the vmPFC for singulars than for plurals in two different experiments. Although the difference between the experiments in the timing of the effect remains to be resolved, these results lend support to theories where plurals are semantically unspecified for number.

(1) a. During the canoe trip the old friends captured three enormous lizards in the lake.
   b. During the canoe trip the old friends captured an enormous lizard in the lake.

(2) a. Three red lizards
   b. One red lizard
THE COSTS OF SILENT CAUSATIVITY: EVIDENCE FROM READING TIMES AND MEG

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Introduction: We aimed to investigate the processing of meaning that is not associated with any overt syntactic constituent. Linguists have observed that there is an additional causative component in the meaning of the verb “melt” in a sentence like “The sun melted the ice” as compared to “The ice melted,” even though there is no difference in the pronunciation [1]. How this contrast between verbs in the “causative-inchoative” alternation is linguistically represented is a matter of much debate; this meaning may be contributed by an unpronounced affix [1,2,3,4], or a semantic [5] or lexical [6] operation. Our objective is to determine whether we can identify behavioral and neural correlates of the processing of silent causativity in verbs that will shed new light on these questions. In our stimuli, we placed each verb in both a transitive (causative) context and an intransitive (inchoative) context. To control for the difference in number of arguments, we included conditions with optionally-transitive activity verbs, thus varying transitivity without varying causativity. Phrasing the stimuli as questions ensured that the transitivity of the sentence would be apparent by the time the verb was presented (1). Following work showing a processing cost for lexical semantic complexity [8,9], we predicted that causative verbs would show longer reading-times than inchoatives, and no such difference for activity verbs. To better understand this cost, we also examined the associated neural responses using MEG.

Self-paced Reading: 33 subjects read the stimuli in a self-paced moving window study. Data were analyzed using mixed effects regression [10], controlling for potential confounds such as subject-verb co-occurrence and gradient acceptability. A significant interaction effect was found on the word following the verb. Pairwise comparison showed that transitivity led to slower reading times for causative verbs, but not for activity verbs.

Magnetoencephalography: 16 subjects saw the same stimuli word-by-word during MEG recording. We estimated brain activity with a cortically-constrained distributed source solution and examined effects from 200-600ms after the verb in 13 anatomically defined left hemisphere regions of interest. ROIs included the superior temporal gyrus (STG), where activity has been associated with lexical access (the M350), Broca’s area, and ventromedial pre-frontal cortex (vmPFC), which has been associated with semantic processing. Using mixed-effects regression across time-points and regions, we observed interactions between verb type and transitivity in the STG, vmPFC, temporal pole, and Broca’s region. The latter effect matched the behavioral cost: transitivity led to increased activity for causative verbs but not for activities. The effects elsewhere appeared driven by increased activation for intransitive activity verbs, also consistent with the behavioral results.

Discussion: The effect of causativity in reading time data confirms our prediction that there is a processing cost due to the lexical semantic complexity of zero-derived causative verbs. The MEG data suggest that causative complexity modulated brain activity in Broca’s region, which has been associated with sentence complexity. By establishing a profile for silent causativity in processing, these findings provide groundwork necessary to bring such data to bear on our understanding of lexical semantic complexity.

(1) a. What did the explosion sink near the harbor? Causative-Inchoative Transitive (causative)
b. When did the boat sink near the harbor? Causative-Inchoative Intransitive (inchoative)
c. What did the professor read for the seminar? Activity Transitive (control)
d. When did the professor read for the seminar? Activity Intransitive (control)

STRUCTURAL SENSITIVITY FOLLOWING GARDEN PATH RECOVERY

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Recently it has been observed that when the parser is led down a garden path, the misanalyzed representation sometimes lingers after reanalysis, and it gives rise to an interpretation that is not compatible with the overall structure of the sentence. Such interpretations support the claim that the parser does not construct a detailed full syntactic structure and that instead a Good Enough Representation is built. The aim of this study is to investigate the type of representation that is built after the garden path, making use of anaphor binding as a probe for the representation built by the parser. As is well-known, a reflexive pronoun generally requires an antecedent in a certain structural configuration (often defined by c-command stated over syntactic structures, or co-argument relations). Experimental studies making use of gender mismatch effects have also shown that such structural representations are built during online parsing. Taking advantages of the reflexive’s sensitivity to the structural representation, an eye-tracking experiment was conducted to examine how much detailed structure is constructed after the parser is garden-pathed. Object/Subject ambiguity and the gender of the reflexives were manipulated as independent factors in 2x2 factorial design. A sample set of experimental stimuli are in (1,2).

(1) Ambiguous: Because the party guests/ applauded/…
   a. … Samuel's/ son/… [Gender Match]
   b. … Samuel's/ daughter/… [Gender Mismatch]
      danced/ clumsily and exposed/ himself/ unknowingly to ridicule./

(2) Unambiguous: Because the party guests/ applauded/…
   a. … Samuel's/ son/… [Gender Match]
   b. … Samuel's/ daughter/… [Gender Mismatch]
      danced/ clumsily and exposed/ himself/ unknowingly to ridicule./

(1a,b) are garden path sentences, with disambiguation at the main verb 'dance', and (2a,b) are comma controls. Reflexive gender matching was used to test the co-argument dependency between himself and the main clause subject (headed by son/daughter). If the garden path effect leads to an incoherent syntactic representation, the sensitivity to this gender manipulation should be reduced in the ambiguous conditions relative to controls—for example, the dependency may be erroneously formed between the reflexive and the structurally inaccessible antecedent Samuel. At the disambiguating verb (danced), a garden path effect was observed in all first-pass measures, including first fixation. The reflexive region (himself) showed an effect of gender, again in all first pass measures including first fixation, with a cost for the mismatching conditions (1b,2b) relative to the matching conditions (1a,2a). This effect did not interact with ambiguity; thus the sensitivity to gender matching was statistically independent of whether or not a garden path had taken place. The results show that recovery from a garden path in this construction is sufficient to support a coherent co-argument representation in the main clause. This finding supports the idea that the misrepresentation which lingers after garden-path reanalysis coexists with a more high-fidelity structure in which structural relations are properly established. Follow-up studies should be conducted to determine whether ease of reanalysis affects the likelihood of building this more faithful structure.
A fundamental issue in experimental pragmatics is the time course of scalar implicatures. Some studies focusing on the <all,some> scale find that the “pragmatic” interpretation for some, (some but not all) is arrived at more slowly than both its stronger alternative all and number terms such as two or three (Huang & Snedeker (2009) - HS). HS take this to support the Literal-First Hypothesis, the idea that the literal interpretation of some is computed before the pragmatic interpretation. In a reaction-time study, Degen et al (2009) replicated the slow implicature effect in the so-called gumball paradigm, but also found evidence that the literal interpretation of some requires more processing effort a) as the upper bound is approached and b) in the subitizing range. One potential explanation for this effect is that in both of these ranges there are lexical alternatives which more naturally pick out the set in question (all for the upper bound, number terms in the subitizing range). If this is the case, this suggests that the integration of contextual information and potential lexical alternatives occurs at the earliest stages of interpreting scalar items. We examine the claim that it is the naturalness of alternative lexical items that leads to a slowdown in the interpretation of some in both the subitizing range and close to the upper bound by modifying the paradigm used by Degen et al.

On each trial, subjects saw a gumball machine with an upper chamber filled with 13 gumballs and an empty lower chamber. After 2.5 seconds a “ka-ching” was followed by a new display in which either 0, 1, 2, 3, 4, 5, 7, 8, 11, 12, or 13 gumballs had moved to the lower chamber. Participants then heard a statement of the form You got X gumballs and rated on a scale of 1-7 how natural the statement was to describe the scene. They were instructed to click an additional FALSE button if they thought the statement did not describe the scene. We used the quantifiers some of the, some, all of the, and none of the, and the number terms one, two, three, seven, eleven.

Results. Mean ratings for number terms and the quantifiers none and all were almost at ceiling for their correct number, but close to zero for all other set sizes. Mean ratings for some (both the bare quantifier and in the partitive) peaked at 5-7 gumballs (means of 6.2 and 5.9, respectively). In the subitizing range, mean ratings dropped to 1.7. Above a set size of 7, mean ratings for the partitive gradually dropped to 2.1 as the full set was approached. For bare some, ratings only dropped to 3.8.

Discussion. The rating results reflect the reaction-time and judgment patterns found by Degen et al in at least two ways. First, we provide evidence that the slowdown effects found in the subitizing range and at the upper bound are indeed due to the reduced naturalness of using some to refer to these set sizes. Second, we replicate the difference in implicature generating potential between the bare quantifier and the partitive.
EVIDENCE FOR PARALLEL PROCESSING OF SYNTACTIC AMBIGUITY IN A DUAL-TASK PARADIGM

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In sentences like (1a) and (1c), the syntactic function of the NP “the colourful parrot” is temporarily ambiguous: either it is coordinated to “the ginger cat” and then functions as a direct object of “rescued” (1a) or it is coordinated to the preceding clause and then functions as the subject of a new clause (1c). The interpretation of this ‘coordinated NP’ is only disambiguated in the ‘disambiguating region’: “from the burning building (1a) or “escaped through the open window” (1c).

In the present study, we wanted to investigate whether the parser activates the two interpretations of the coordinated NP serially or in parallel. According to serial processing models, only one of both analyses is initially pursued. Only when the parser reaches the disambiguating region and notices that the information there is incompatible with the initial interpretation, the ambiguity is reanalyzed. Serial models thus predict extra computational work at the disambiguating region of ambiguous sentences. Parallel models, on the other hand, hypothesize that both interpretations are activated when reading the ambiguous coordinated NP and therefore predict extra computational work at that region.

In the present study, participants had to perform a tone discrimination task, which taxes the central executive of working memory (Szmalec, et al., 2005), while reading Dutch sentences with a coordinated NP that was either locally ambiguous (1a and 1c), or non-ambiguous (1b and 1d). A tone was presented on the first fixation of either the coordinated NP or the disambiguating region. Participants had to indicate whether the tone was high or low.

Analyses with linear mixed-effects models showed an interaction of the ambiguity of the coordinated NP with the presentation of a tone in that region, in the first fixation times on the coordinated NP, F(1,4733) = 4.21, p = .040. Pair-wise comparisons revealed that when a tone was presented, first fixations were longer when the NP was ambiguous (M = 385 ms) than when the NP was non-ambiguous (M = 366 ms), t = 3.17, p < .001. When no tone was presented, first fixations on ambiguous NPs (M = 244 ms) were as long as those on non-ambiguous NPs (M = 242 ms), t = 0.27, p = .786. In the disambiguating region, no evidence for reanalysis (and thus for serial processing) was found in any of the eye-movement measures.

The ambiguity effect in the ambiguous region suggests that the central executive of working memory has to perform extra computational work when the coordinated NP can be interpreted in two ways. This suggests that already during the early reading phase both interpretations of the ambiguous NP are activated and processed in parallel. However, the extra load the processing of the ambiguous coordinated NP lays on the central executive was only perceptible when the central executive was overloaded by means of the tone discrimination task. The dual task condition thus uncovered a parallel interpretation process, which was imperceptible in the single task situation in this and previous (e.g., Hoeks et al., 2006) experiments.

(1a) The fireman rescued the ginger cat and the colourful parrot from the burning building.
(1b) The fireman rescued the ginger cat as well as the colourful parrot from the burning building.
(1c) The fireman rescued the ginger cat and the colourful parrot escaped through the open window.
(1d) The fireman rescued the ginger cat, and the colourful parrot escaped through the open window.

COMPARISONS OF ONLINE READING PARADIGMS: EYE TRACKING, MOVING WINDOW, AND MAZE

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In sentence processing research involving the visual presentation of sentential stimuli, self-paced (non-cumulative, moving-window) reading (henceforth, SPR; Just, Carpenter, & Woolley, 1982) and eye tracking (see e.g., Rayner, 2009) have become the most widely-accepted experimental tasks. However, just as it is incumbent on sentence processing researchers to scrutinize prominent theoretical claims, it is also necessary to probe these accepted methodologies for weaknesses as well as to add new techniques to our methodological toolkits. The present study addresses these methodological concerns by comparing the findings from SPR, eye tracking, and two versions of the maze task (described below) on sentences involving temporary structural ambiguities. Of particular interest are (i) whether these tasks are capable of revealing processing differences among these sentence types and (ii) whether these effects are indicated precisely at the predicted region/word.

Four experiments (each one, N=32) investigated the processing of sentence types (1)-(3). Each experiment employed a different reading methodology – EX1: SPR; EX2: eye tracking; EX3: G-maze reading; and EX4: L-maze reading. In a maze task, each sentence is presented as a sequence of choices between two alternatives, only one of which is a possible continuation of the sentence. The participant’s task is to choose which alternative best continues the sentence as quickly and as accurately as possible. If both alternatives are words (a G-maze), one is a grammatical continuation of the sentence and the other is not. If one of the alternatives is a word and the other is a legal nonword (an L-maze), the participant must choose which of the letter strings is a word. (In the L-maze, although sentence processing is not strictly required, it is clear from previous experiments that participants respond far more rapidly when the sequence of words forms a sentence.)

For Adverb Attachment sentences, all four experiments revealed inflated reading times (RTs) at adverbs that attached to the higher verb phrase (e.g., tomorrow in (1)). All of the experiments also revealed processing difficulty for high RC Attachment. However, the strength and timing of this effect differed across the experimental paradigms. The SPR experiment showed a weak, delayed effect. Specifically, an RT difference was only obtained by averaging over the three words following the disambiguating reflexive (herself/himself). Similarly, the eye-tracking experiment revealed only a total time difference over the beginning of the RC, including the reflexive (e.g., who shot herself/himself). In contrast, both the G-maze and L-maze experiments showed RT differences at the critical disambiguating word. Finally, for NP vs. S Conjunction sentences, only the eye-tracking experiment revealed reliable differences between the sentence types – with longer first-pass and total time RTs at and after the temporarily ambiguous NP (e.g., the child in (3)).

The findings of these experiments have a number of methodological implications. Most importantly, it is clear that except for sentences that tap into clause-closure commitments, the maze task provides robust, “localized” indications of incremental sentence processing difficulty (relative to SPR and eye tracking). This and other implications (and the complete set of results) will be detailed in our presentation.

(1) Adverb Attachment: (a) Low, (b) High:
Jack will meet the friend he phoned (a)yesterday,/(b)tomorrow but he doesn’t want to.
(2) Relative Clause (RC) Attachment: (a) Low, (b) High:
The son of the actress who shot (a)herself/(b)himself on the set was under investigation.
(3) Noun Phrase (NP) vs. Sentence (S) Conjunction: (a) Unambiguous, (b) Ambiguous:
The nurse examined (a)the mother,/(b)the mother and the child played quietly in the corner.

THE ONLINE INSTANTIATION AND SYNTACTIC CONSEQUENCES OF THE CONSTRAINT ON PLURALS IN COMPOUNDS

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Recent research on the processing of compounds in sentences has shown that the dispreference for plural non-heads in compounds is reflected in eye movements at the compound head position (Cunnings & Clahsen, 2007). Other research suggests that a plural-marked first noun in an ambiguous noun-noun/noun-verb string influences the lexical category assignment of the second word (MacDonald, 1993). However, it remains unclear whether the violation of this morphological-level constraint influences the assignment of syntactic structure during real-time sentence processing.

Research on the processing of ambiguous noun-noun/relative-clause structures has also established a preference for compound structure and thus a concomitant slowdown when the sentence is ultimately resolved as a relative clause (Grodner et al., 2002). We adapted the noun-noun/relative-clause ambiguity paradigm to determine whether the presence of the plural morpheme on the potential non-head causes the parser to abandon the compound analysis of the ambiguous word string and pursue a relative-clause analysis. Using self-paced reading (N=48 native English speakers), we tested twenty-four sets of target sentences containing either a singular or plural potential compound non-head. These potential non-heads were subsequently disambiguated as beginning relative-clause structures. Unambiguous relative-clause conditions were generated by separating the potential non-head and head with the complementizer ‘that’ (see 1a-d). If a compound analysis is preferred in the ambiguous conditions, we expect a garden-path slowdown in the ambiguous vs. the unambiguous conditions when disambiguated in favor of a relative clause. If the dispreference for plurals in compounds is instantiated online, we predict a slowdown following the presentation of the potential compound head in the plural condition. Crucially, if the dispreference for plurals in compounds creates the expectation of a relative-clause structure, as suggested for classifier-noun mismatches (Yoshida, 2006), then the garden-path should be significantly reduced for the plural vs. the singular condition.

All three predictions were confirmed. At the potential compound head, reading times were significantly slower in the ambiguous vs. the unambiguous conditions and slowest for the plural non-head condition, showing a dispreference for plurals in compounds. A significant garden-path slowdown was observed for the ambiguous conditions in the spillover region following the disambiguating verb. Critically, this garden-path effect was significantly reduced when the parser had been presented with a plural potential non-head. Moreover, we observed significantly slower reading times for the plural, ambiguous condition than for its unambiguous counterpart. This difference possibly reflects the relative predictive strength of the complementizer vs. the plural non-head cue. Together, these results demonstrate that the constraint on plurals in compounds not only plays an immediate role in the processing of noun-noun sequences, but also that the parser takes advantage of the online instantiation of this morphological-level constraint in forming syntactic expectations.

1a) At the university, the particle chemists efficiently replicated broke the container. (Sing./Ambiguous)
1b) At the university, the particles chemists efficiently replicated broke the container. (Pl./Ambiguous)
1c) At the university, the particle that chemists efficiently replicated broke the container. (Sing./Unambiguous)
1d) At the university, the particles that chemists efficiently replicated broke the container. (Pl./Unambiguous)

Thematic Role Conflict and Locality in Mandarin Relative Clause Comprehension

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It has been argued that relative clauses (RCs) should be harder to process when the RC head plays different thematic roles in the relative and main clauses (Sauerland & Gibson, 1998). It is difficult to test this cleanly in English because main clause subjects and objects are in very different sentence positions. Mandarin has the same basic SVO order as English, but its RCs are head-final and it has some constructions in which main clause subjects and objects are both pre-verbal, allowing a closer comparison of sentences with RCs modifying main clause subjects and objects. The current study took advantage of these properties of Mandarin to investigate thematic conflict effects in RC processing.

The Mandarin constructions used here were the BA and BEI constructions. In both, a normally post-verbal argument moves to a pre-verbal position. In the BA construction, which focuses the object, the object moves from after to before the verb, producing the order S_BA_O_V (see example 1a below). BEI is a passivizing morpheme, and a Mandarin passive sentence has the order O_BEI_S_V (see example 2a below). Note that in the sentences combining these constructions with RCs (see examples 1b,c and 2b,c), the same words appear in the same order in both the BA and BEI sentences, but BA and BEI cause them to play different main clause roles. As a result, thematic mismatch between the head noun’s roles in the main and relative clauses arises in the subject relative in the BA construction (1c), but in the object relative in the BEI construction (2b).

Another issue we investigated was locality. Memory-based theorists (e.g., Gibson, 1998; 2000) have argued that the longer the distance between a gap and its filler, the more difficult it should be to process. However, there have been challenges to locality theory from head-final languages like German and Hindi (Vasishth & Lewis, 2006; Konieczny, 2000; Levy, 2007). In Mandarin RCs, it is subject relatives that have a longer distance dependency, so locality predicts greater difficulty for them, which is consistent with our previous studies on Mandarin RCs (Lin & Garnsey, 2009; in press). Here we can test whether the same general pattern holds when RCs are part of BA and BEI constructions.

Forty-five native Mandarin speakers read sentences like those in the b and c versions of examples (1) and (2) in a self-paced moving window paradigm and answered yes/no questions after each trial. Reading times were slower on words within the RC for subject relatives, regardless of whether they were in a BA or BEI construction, consistent with locality predictions and our previous results. However, starting at the head noun of the RC, which is at the end of the RC in Mandarin, it was thematic conflict that drove the results. When the RC head noun played different thematic roles in the relative and main clauses, reading slowed dramatically. Thus, both locality and thematic role mismatch influence the difficulty of Mandarin RC processing, but thematic role conflict appears to have the largest effect.

(1a) Simple BA: Teacher BA parent scold once (“The teacher scolded the PARENT once.”)
(1b) BA_OR: Teacher BA parent scold ___ DE student hit once
(1c) BA_SR: Teacher BA ___ scold parent DE student hit once
(conflict: RC: subject/MC: object)

(2a) Simple BEI: Teacher Bei parent scold once (“The teacher was scolded by the parent.”)
(2b) BEI_OR: Teacher Bei parent scold ___ DE student hit once
(conflict: RC: object/MC: subject)
(2c) BEI_SR: Teacher Bei ___ scold parent DE student hit once
DOES FREQUENCY OF OCCURRENCE MAKE RELATIVE CLAUSE PROCESSING EASIER IN JAPANESE?

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Reali & Christiansen (2007) conducted a large-scale corpus analysis of English relative clauses and found that frequency of exposure influenced the processing difficulty of relative clauses (RC). The corpus frequency of subject and object relative clauses (SRC and ORC, respectively) was reflected in the result of self-paced reading experiments. Since processing asymmetry of SRCs and ORCs had been reported in a number of different languages, their findings raise an interesting question about the universality of frequency-based account for RC processing. We examined the usage of Japanese SRCs and ORCs in a written Japanese corpus and conducted a self-paced reading experiment. Our results showed that corpus frequency failed to account for existing empirical results on Japanese RCs.

Due to the absence of a large-scale parsed corpus in Japanese, an automated morpheme analysis was conducted on 3 million words from a written Japanese corpus, KOTONOHA (developed by the National Institute for Japanese Language) using Mecab 0.98 (developed by Taku Kubo). NPs that contained modifying clauses were selected by ChaKi Ver.2.1.16 (developed by NAIST). Then, we manually classified them into SRC, ORC, and other structures. The results showed that the number of ORC was marginally larger than that of SRC in Japanese (SRC: 1546; ORC: 1641; x^2(1)=2.832, p=.091). If the distributions of SRCs and ORCs were the major factor for the processing asymmetry, it would not explain the results of previous studies, which showed that SRCs are easier to process than ORCs in Japanese (e.g. Miyamoto & Nakamura, 2003). Therefore, we considered animacy of RC head nouns, which plays an important role in RC processing (Mak et al., 2002) and reanalyzed the corpus data. The results showed that frequency of SRCs with animate head nouns was significantly higher than that of ORCs with animate head nouns (SRC: 1019; ORC: 137; x^2(1)=672.945, p<.01). The result of corpus counting modified by animacy thus enables us to account for the processing asymmetry between SRCs and ORCs. As for RCs with inanimate head nouns, ORCs with inanimate head nouns occurred more frequent than SRCs with inanimate nouns (SRC: 865; ORC: 1471; x^2(1)=157.207, p<.01). The frequency account predicts that ORCs should be read faster than SRCs. Thus, we conducted a self-paced reading experiment using RCs with inanimate head nouns as shown in (1), in order to verify whether the frequency account modified by animacy can account for the processing asymmetry between SRCs and ORCs. However, the results revealed that SRCs were still read faster than ORCs at the relative head region even when animacy of RC head was manipulated in favor of ORCs (F1(1,18)=6.241, p<.05; F2(1,21)=3.520, p=.075).

The present study shows that the simple frequency in corpora is not reflected in the reading times of relative clauses in Japanese even when animacy is taken into consideration. Taken together, corpus frequency alone cannot explain the result of existing empirical research on Japanese relative clauses. To investigate how experience reflected in corpora plays a role in sentence processing and to understand how the human processor uses experience, further research is needed on a wide variety of languages in the world.

(1a) SRC sigikai-no iinkai-o kouseisi-ta senmonbukai-ni-wa
the city council-GEN committee-ACC form-PAST section-at-TOP
“This section that formed the city council committee …”

(1b) ORC sigikai-noi iinkai-ga kouseisi-ta senmonbukai-ni-wa
the city council-GEN committee-NOM form-PAST section-at-TOP
“This section that the city council committee formed …”
ON THE STATUS OF INTERMEDIATE GAPS IN SENTENCE PROCESSING

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Introduction.

We report on the processing status of intermediate gaps (IGs). In a double-embedded sentence, an IG realized in [Spec,CP] maintains the filler-argument gap (AG) dependency. Gibson & Warren (2004) report a self-paced reading experiment in which sentences containing IGs (e.g. (1)) were read faster at the AG compared to single-embedded sentences without IGs (e.g. (2)). They explain this contrast by positing that IGs shorten the distance between filler and AG, thus facilitating eventual gap-filling. Here, we capitalize on well-established models of filler-gap dependencies (e.g., Fodor 1995) and hypothesize that if IGs are a feature of processing, the filler should be reactivated at the IG as well as at the AG.

Method

Filler reactivation was examined via a cross-modal lexical decision task (priming paradigm, Nicol et al. 1994) in sentences like (1). Given our hypothesis, filler reactivation was predicted at both the AG and IG positions. Nineteen subjects were tested on 40 experimental sentences containing three target positions (e.g. (3)) and using two kinds of (i.e., related and unrelated) targets.

Result

As predicted, priming was observed at the AG (p < 0.001) with no priming at the control position (p = 0.2). This finding replicates previous studies via otherwise memory-taxing sentences, demonstrating the psychological reality of gap-filling. In contrast, no priming was observed at the IG (p = 0.4).

Discussion

Our results suggest that at best, IGs do not have the same processing status as AGs. To reconcile these results with Gibson and Warren’s, we set aside the idea that the syntax of (1) – namely, the presence of an IG – has a facilitating effect on gap-filling, and instead propose that the syntax of (2) has a slowing effect on gap-filling. We suggest that this slowing is actually the result of an interaction between the costs of performing two tasks that simultaneously tax processing resources. The first task is processing the unresolved dependency (the captain who...GAP), while the second is building the structure between the subject head and the verb (prediction about the weather had frightened). Crucially, while this structure must be parsed, it is not relevant to the gap-filling operation. Such an interaction is not present for (1). This explanation taken together with the results presented here, which show no priming at the intermediate position, suggest that a theory of processing has no need for IGs. We capture these results in a model of processing whereby syntactic and semantic composition are implemented simultaneously, strictly guided by syntactic subcategorization and argument structure requirements.

(1) The captain who the sailor predicted yesterday (IG) that the weather would frighten (AG) turned back towards port.
(2) The captain who the sailor’s prediction yesterday about the weather had frightened (AG) turned back towards port.
(3) The captain who the sailor * predicted yesterday that * the weather would frighten * ……

(control) (IG) (AG)

Selected References

THE EFFECT OF CONTRASTIVE FOCUS ON KOREAN SENTENCE PRODUCTION: CONCEPTUAL ACCESSIBILITY VERSUS HEAD PROXIMITY

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Recent psycholinguistic research has demonstrated that contrastive focus increases a referent’s conceptual saliency, due to the implicit contrast made to the alternative members within a set [5, 6]. Separate work has found that conceptually more salient items are mentioned earlier than less salient items by the incremental sentence production system [1]. For example, the animate-before-inanimate preference found in Japanese and Korean has been attributed to a conceptual salience difference [1, 2]. The Conceptual Accessibility hypothesis therefore predicts that a contrastively-focused phrase will also be produced in sentence-initial (or early) position.

Yet in many head-final languages, wh-words—which are considered in focus—occupy the preverbal position [4], perhaps because that position is close to the sentential head. On this view, which we call the Head Proximity hypothesis, a contrastively-focused phrase will occupy the position immediately before the sentence-final verb, and thus occur late in the sentence. We tested these two opposing hypotheses in a Korean production study.

Contrastive focus was manipulated by attaching a focus marker (i.e., -man, ‘only’) to the indirect object, to the direct object or to neither phrase of thirty critical dative sentences as in (1). Eighteen native Korean speakers participated in a phrase-assembly task disguised as a sentence recognition task [2, 7]. Each of the critical sentences were separated into four phrases—subject (S), indirect object (IO), direct object (DO), verb (V)—to occupy four boxes on a computer screen. Participants silently created sentences from the parts for later recall. After a short distraction task, the verb was given as a prompt and the participants uttered the complete sentence. The primary dependent measure was the percentage of canonical order [S-IO-DO-V] in productions.

The results showed a strong effect of contrastive focus on the speaker’s word order choice as predicted by Head Proximity (F1=8.518, F2=8.225, p’s=.001). In the Broad Focus condition, participants produced the canonical order [S-IO-DO-V] for 60% of the trials. In the IO Focus condition, however, the canonical order preference was reduced to 50%; instead, there was a significant increase to [S-DO-IO-V] orders that placed the focused element next to the verb (t1: p=.07, t2: p=.01, for pairwise comparisons of the Broad Focus and IO Focus conditions). Lastly, the DO Focus condition boosted the preference for the canonical order to 76%, i.e., again there was a stronger preference for the contrastively focused element to be adjacent to the verb [S-IO-DO-V] (t1: p=.009, t2: p<.000). Only 2.5% of all productions placed focused items in sentence-initial position, supplying strong evidence against the Conceptual Accessibility hypothesis.

This pattern of data indicates that contrastively focused phrases in Korean prefer proximity to the verb. This differs from the earlier findings that Korean and Japanese animates, as well as Japanese phrases encoding given or repeated information, are placed early in the sentence [1, 2, 3]. With these results we argue that contrastive focus processing has effects beyond simply making the focussed phrase accessible. We will discuss the findings in terms of processing complexity for contrastive focus, within a multiple-constraint production system.

(1)  a. No contrastive focus marker (Broad Focus):
    Celebrity-NOM kindergarten-DAT big clock-ACC presented.

b. Contrastive focus marker on the DAT argument (Indirect Obj. Focus):
   Celebrity-NOM kindergarten-DAT-only big clock-ACC presented.

c. Contrastive focus marker on the ACC argument (Direct Obj. Focus):
   Celebrity-NOM kindergarten-DAT big clock-only presented.

GOOD-ENOUGH REPRESENTATIONS OF LOCAL COHERENCE IN NP CONJUNCTIONS

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Locally coherent strings within larger sentences have been shown to interfere with global sentence processing in garden-path sentences (Christianson et al., 2001) in both off-line (Christianson et al., 2001, 2006; Ferreira & Henderson, 1991) and on-line (Slattery & Christianson, sub.; Tabor et al., 2004) interpretation measures. These results have often been interpreted as indicative of good-enough representations (Ferreira et al., 2002) of sentence meaning derived from discrete sub-parse s of a sentence, the good-enough aspect being a failure to integrate the sub-strings into a global representation. A strong prediction of this account is that the final representations of even non-garden-path sentences should be influenced by locally coherent sub-strings within them.

Here we report results that support the existence of good-enough representations of non-garden-path NP conjunctions. Participants read both long and short versions of sentences like (1) in a self-paced reading paradigm, and then answered comprehension questions like (2). Length and frequency of the NPs in each sentence were equated. Significant differences in question response time and accuracy were observed when the question asked about the second NP. Specifically, there was a significant interaction such that people were slower to respond and less accurate answering questions about the second NP in long than in short questions (opposite what would be predicted based on a simple recency account). There was also a significant difference in reading time for the second NP (marginal by items), with inflated reading times in longer sentences (Table 1). Towards further exploration of these findings, we will also report results from a follow-up experiment comparing distance and interference from an intervening NP as potential explanations, along with results from an experiment using a different structure.

Taken together, the results support the good-enough processing assumption that locally coherent strings are processed more easily than non-locally coherent strings. Importantly, this appears to be true even when an argument of the verb is involved, as in the structures used here. This result is unexpected under current models of language processing, including those that incorporate some type of limited structural underspecification (e.g., Frazier & Clifton, 1996). As such, we interpret the results within a good-enough processing account, in which locally coherent sub-strings generate their own interpretations, not altogether unlike the "sausage machine" of Frazier and Fodor (1978); however, based on these and previous data, it appears that integration of sub-strings incurs an additional processing cost, and thus may not actually be carried out. In other words, the final representation might only be good enough, i.e., not completely faithful to the input.

(1) The cook added the nut (that had been carefully crushed) and the ham.
(2) Did the cook add the nut / ham?

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>RT on NP2</th>
<th>RT CompQ</th>
<th>CompQ Acc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>short</td>
<td>long</td>
<td>short</td>
</tr>
<tr>
<td>NP1</td>
<td>n/a</td>
<td>n/a</td>
<td>1763.3</td>
</tr>
<tr>
<td>NP2</td>
<td>429.3ms</td>
<td>452.7</td>
<td>1754.5</td>
</tr>
</tbody>
</table>
SCAN PATHS ON VISUAL SCENES PREDICT SENTENCE PRODUCTION

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Virtually all work using the visual world paradigm has focused on specific psycholinguistic processes (e.g., syntactic ambiguity resolution) and assumed that the resulting effects are local in that (a) they occur during specific parts of the linguistic signal (e.g., the attachment site), and (b) they trigger eye-movement patterns in specific regions of the visual stimuli. However, if the mapping between linguistic and visual information is continuous and bidirectional, then we expect not only localized linguistic effects on looks to certain regions. There should also be a global sequential correspondence between the two modalities. In this work, we show that similar scan paths, i.e., sequences in which participants fixate target regions, correspond to similar sentence productions.

We conducted an eye-tracking production study in which participants described photo-realistic indoor scenes after being prompted with a cue word (an object in the visual scene). We collected a total of 576 sentences for 24 different scenes, along with the scan paths that participants followed while generating the sentences. In order to determine the degree to which eye-movements and linguistic productions correlate, we need measures of similarity for both.

For the scan path data, we first transformed each trial into a single sequence of fixated objects (numerically coded), and then computed visual recurrence (VR) which is calculated by counting the number of matching looks to the same objects in two eye-movement sequences during the same temporal window. As a second measure, we used ordered sequence similarity (OSS, Gomez & Valls 2009), which is computed for pairs of sequences based on the number of objects they have in common and their relative distance. We normalized the eye-movement sequences for length before calculating VR and OSS. For the sentence productions, we computed a feature similarity measure (FS), after converting each sentence into a vector of features. These were mixture of syntactic, semantic, and contextual features, and included utterance length, presence of coordination, WordNet semantics of the main verb, verb frame, and scene type (bathroom, etc.). This resulted in vectors that mix categorical and numerical data, for which the Gower distance (Gower, 1971) is appropriate. We also implemented a linguistic similarity measure based on Latent Semantic Analysis (LSA), as generalized by Mitchell & Lapata (2009) to sentences. This measure treats sentences as bag of words and computes their similarity based on co-occurrence frequencies in a corpus (here: British National Corpus). The similarity measures are computed pairwise, i.e., every trial (sentence and scan path) was paired with every other trial.

The results show that sentence and scan path similarity correlate: the more similar two sentences are, the more similar the corresponding eye-movement sequences. This effect is significant for all combinations of similarity measures. Furthermore, the correlation were significant both globally, i.e., when computed on the whole data set, and locally, i.e., when grouped by scene or sentence type; local correlations had higher coefficients. These results suggest that the scan path a speaker follows on a visual scene is predictive of the sentence they will generate. This contrasts with finding in the visual cognition literature, where scan paths can be highly variable for standard tasks such as free viewing or visual search (Henderson, 2003)

Linguistic references, even to the same individual, can vary in terms of how much semantic content they provide and how syntactically complex they are. Previous findings establish that linguistic descriptions of greater syntactic and semantic complexity (e.g., "the wicked old man" vs. "the man") lead to faster processing at retrieval sites in long-distance dependencies (Hofmeister, 2009). But why should complex representations be easier to retrieve than simple representations?

Here, I address two possible (non-exclusive) sources of complexity-based retrieval facilitation: (i) increased attention and additional processing during the encoding phase; (ii) richer representations are less confusable with other representations in memory than simpler ones, i.e. similarity-based interference is reduced.

On the interference hypothesis, processing a complex phrase has several advantages if it is targeted for retrieval later: (1) facilitated processing at its retrieval point and (2) it should be less of a distracter if other confusable representations have to be retrieved. To test this hypothesis, participants in an experiment that combined self-paced reading with a recall task read a list of one or three nouns that describe individuals, (e.g. VILLAIN-SCHOLAR-MAID). Subsequently, they read a sentence with three definite NPs, one of which was either a simple or a complex object NP, as in (1).

After answering a comprehension question, subjects recalled the word(s) from the study lists. Hence, up to six nominals potentially compete at the sentential retrieval site and during the recall phase. But in the "complex" condition, one of the candidates is distinguished by its complexity. The results show that participants recalled the study words significantly better when the sentence contained a complex object NP ([1a]), despite the longer sentence length. Moreover, the reading time data demonstrate that, given a complex NP, participants processed the subcategorizing verb significantly faster.

Experiment II tests the hypothesis that increased attention and processing account for the complexity effects. The color of two words—the patient head noun ("prisoner") and the relative clause verb ("supplied") in sentences like [1b]—was varied between congruous (white) and incongruous (green); all other words were in white. On the attention-based hypothesis, retrieval should be easier given a perceptually anomalous, attention-grabbing noun. But, despite significantly longer reading times at the target item when it appeared in green, reading times averaged over the verb and subsequent word were numerically fastest when no words appeared in green. The results also indicate a significant interaction at the retrieval region: comprehenders read faster when the verb and noun color match. This potentially stems from facilitated retrieval due to feature-matching or reinstatement of the encoding conditions.

In sum, semantically rich representations appear to reduce retrieval interference. In contrast, increasing superficial uniqueness and attention directed at critical words did not improve memory retrieval. Accordingly, while both semantic complexity and superficial features can theoretically make a constituent unique, only semantic complexity benefits memory retrieval. Uniqueness (and by extension, similarity-based interference) in language comprehension thus matters at the level of meaning-related features and not representational features more broadly.

PREDICTING DIFFERENCES IN SENTENCE PROCESSING DIFFICULTY WITH AN IMPLEMENTED COMPLEXITY METRIC

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Is locality, or increased processing difficulty with increased distance, an effect of syntactic structure differences? Or is it simply caused by the number of intervening words?

Two self-paced reading experiments demonstrate opposing results: Grodner & Gibson [2] find an increase in reading time, or a locality effect, on the critical word "scolded" for sentences (1a)-(1c). Jaeger et al. [3] find a decrease in reading time, or an antilocality effect, on "bought" in (2a)-(2c). We argue these results are best explained by syntactic structure differences.

We present a complexity metric detailing how syntactic structure contributes to difficulty during incremental processing for both cases. We use a dependency parser (Boston et al. 2008 [1]) to construct syntactic structure for the experimental material. The parser builds dependency-head relations for sentences, such as the relation between "scolded" and its dependent "administrator" in (1.1). In a second step we map these dependency structures onto tensor product representations (Smolensky & Legendre 2006 [5]). For each incremental step of the parser, we observe a corresponding shift in the graphs of the representations. When comparing two sentences, the deviation of the resulting trajectories is used to quantify differences in processing difficulty.

We find an overall increase of complexity on the matrix verbs "scolded" and "bought" with more intervening material. For the examples of [2] the increase of embedded material between "administrator" and "scolded" is 3 words between sentences (1a) and (1b), and 2 between (1b) and (1c). In (1a) there is no intervening PP or RC, while in (1b) one PP is added and in (1c) a second RC is embedded into the first RC. Our model exactly predicts an increase of complexity of 63 for (1a) to (1b) and 52 for (1b) to (1c).

For [3], the number of words between "player" and "bought" is 3 between both (2a) to (2b) and (2b) to (2c). Although the amount and type of added material is unchanged, our results predict a difference in complexity for the sentences. The complexity increase is 75 from (2a) to (2b), and 93 from (2b) to (2c).

The findings for [2] and [3] result from the different dependency structures for the embedded material. In (1a)-(1c) the verb "supervised" has to be connected to its dependent "nurse" with a left-arc, while the embedded verb "met" connects to the PPs with a right-arc operation. Here, the integration of new material (right-arc) is interpreted as more cognitively costly than a structural integration of old material (left-arc) by the tensor product representations, in such a way that it assigns a higher complexity value to a right-arc parser action compared to a left-arc operation. This intuition follows from the assumption that speakers of head-final languages (e.g. German, Dutch) seem to be more sensitive of upcoming material than speakers of head-initial languages (such as English). Behavioral evidence for this claim comes from verb-particle constructions in Dutch and English (Kuperman, Wasow and Piai 2009 [6], CUNY Poster).

Although the representations do not model antilocality results for [3], they are sensitive to the syntactic structural differences in ways that Dependency Locality Theory [4] is not.

Our work defines an explicit relationship between a broad-coverage, incremental parsing procedure and tensor product representations. This relationship provides a precise measure of complexity for syntactic structures. Our findings argue against the characterization of locality and antilocality effects based merely on the amount of intervening words as argued by [2].

(1a) The administrator who the nurse supervised scolded the medic.  
(1b) The administrator who the nurse from the clinic supervised scolded the medic.  
(1c) The administrator who the nurse who was from the clinic supervised scolded the medic.  
(2a) The player that the coach met at noon bought the house near the gym by the river.  
(2b) The player that the coach met by the river at noon bought the house near the gym.  
(2c) The player that the coach met near the gym by the river at noon bought the house.
TRANSPARENT EFFECTS OF PARTIAL PRIMING OF COMPOUND WORDS

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Compound words have more than one free morpheme (morphemes that can stand alone). Transparent compounds appear to have compositional meaning in that the meaning of the whole word is derived from its morphemic constituents (e.g., the relationship of roadside to road and side is transparent). In contrast, for opaque compounds there is no clear relationship between the whole word and its morphemic constituents (e.g., the relationship of butterfly to butter and fly is opaque). Much research has examined early processing of morphologically complex words but there is disagreement about whether morpho-orthographic decomposition occurs independently of meaning, particularly since transparency of compounds appears to yield conflicting results in lexical-decision and reading-time studies. Lexical-decision studies have typically used masked-priming to investigate the extent of morpho-orthographic decomposition in compounds while reading-time studies have typically compared processing of transparent and opaque compounds. Here we use a partial repetition-priming technique to assess whether constituent morphemes within a compound are accessed during comprehension, and the role that constituent access plays in transparent and opaque compounds.

The experiment examined 20 transparent compounds and 20 opaque compounds, which appeared in two types of sentences: primed first constituent or unprimed first constituent (see examples below). The first-constituent prime words (e.g., road and butter) had matched frequency across transparency conditions, and the unrelated primes (e.g., town and pan) matched the within-sentence plausibility of the first-constituent primes.

Forty-two subjects read 40 experimental sentences (with type of prime counterbalanced across subjects) intermixed with 80 fillers in a phrase-by-phrase, self-paced reading task. Results for the critical phrase containing the target compound are shown in the table below. There was a significant priming-by-transparency interaction such that reading times were faster in the first-constituent-primed than the unprimed condition, while reading times for phrases containing opaque compounds were slower in the first-constituent primed than the unprimed condition, F(1, 41) = 6.48, p < 0.02.

This pattern of results supports the conclusion that during sentence processing lexical access occurs for the first morphemic constituent in a compound, at least when the lexical accessibility of that component morpheme is increased through priming. Further, the results suggest that accessing this constituent facilitates comprehension of the compound when the meaning of that constituent contributes transparently to the meaning of the compound. However, accessing the first constituent interferes with comprehension of the compound when the contribution of that constituent to the meaning of the compound is opaque. The overall pattern indicates that at the level of orthographic form, compounds may be processed in terms of their constituent words. The meanings evoked by these constituent words support comprehension of semantically consistent compounds and compete with the comprehension of semantically inconsistent compounds.

Transparent: After my car stopped | in the middle of the road/town, | I walk to the roadside gas station.
Opaque: When I took out | the butter/pan to make dinner, | I saw a beautiful butterfly | through the window.

DISCOURSE REPRESENTATION VS. FIRST MENTION BIAS IN PROCESSING NULL AND OVERT PRONOUNS IN SPANISH.

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Antecedent salience plays an important role in anaphoric processing. Although salience can be affected by both the surface characteristics of the discourse and by the discourse representation, there is some disagreement about the relative importance of these two types of factors. For example, Carreiras & Gernsbacher (1995) claimed that first mentioned antecedents are accessed the fastest, but Gordon, et al. (1999) argued that conjoining two referents into a complex noun phrase results in a representation of a complex referential object that is more salient than the first mentioned entity.

We conducted two self paced sentence-by-sentence reading experiments that contrasted these views by examining the processing of overt and null pronouns in Spanish. Previous research reported an Overt Pronoun Penalty (OPP), such that sentences containing overt pronouns referring to salient antecedents are read slower than sentences with null pronouns. Here we used the OPP as an index of salience to test the role of structural and discourse representation factors in Spanish anaphora comprehension.

Experiment 1 contrasted singular reference to antecedents that were embedded or not in a complex noun phrase. Sentence 1 introduced two entities in a single (John met Mary) or conjoined structure (John and Mary met). Sentences 2 (the critical sentence) made reference to either entity using an overt or null pronoun. Overall, this was a 2 x 2 x 2 design with factors Antecedent Structure (Conjoined vs. Single), Order of Mention (First vs. Second) and Pronoun Type (Null vs. Overt). In the Single conditions, sentences with null pronouns were read faster than sentences with overt pronouns when referring to the first mentioned entity, while sentences with null and overt pronouns were read with similar speed when referring to the second mentioned entity, F1(1,39)=8.48, p<0.05, F2(1,39)=7.96, p<0.05. There was no interaction between Order of Mention and Pronoun Type in the Conjoined conditions.

Experiment 2 examined the difference between plural and singular references to entities in a complex noun phrase. Sentence 1 was identical to Experiment 1. Sentence 2 made reference to either the first entity or the conjoined phrase by means of an overt or null pronoun. This was a 2 x 2 x 2 design with factors Antecedent Structure (Conjoined vs. Single), Anaphor Number (Singular vs. Plural) and Pronoun Type (Null vs. Overt). We found an interaction between Antecedent Structure and Number in Null conditions, F1(1,39)=14.61, p<0.001, F2 (1,39)=7.28, p<0.05, such that plural pronouns were read faster when referring to a conjoined phrase while singular pronouns were read faster when referring to a single phrase.

Overall, the OPP was elicited (a) for overt singular pronouns referring to single subjects and (b) for overt plural pronouns referring to conjoined NPs. Importantly, the OPP was not elicited for overt singular pronouns referring to the first element of a complex NP. Thus, when reference was made to a conjoined noun phrase, the plural collective entity was more accessible than the first of its two components. This supports the view that discourse representation factors play the most important role in anaphoric processing.

Examples

Sentence 1                Juan se encontró con María./Juan y María se encontraron.
                          Juan met with María./Juan and María met.

Sentence 2  (Exp. 1)                      […]/Él/Ella estaba contento/a.
                          Null He/Overt He/Null She/Overt She was happy.

Sentence 2  (Exp. 2)                      […]/Ellos/Él/ estaba/n contento/s.
                          Null They/Overt They/Null He/Overt He was/were happy.


HE AND SHE, YOU AND ME: AN EXPLORATION OF THE AUTOMATIC PROCESSING OF ANAPHORA

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Researchers have recently emphasized that anaphoric processing, like other aspects of language processing, is frequently shallow and incomplete (e.g., Ferriera et al., 2002) such that pronominal referents may not be automatically and correctly identified (Klin et al., 2006; Stewart et al., 2007; Garnam et al., 1992; Greene et al., 1992). Rigalleau et al. (2004) however, argue that even under shallow processing participants are automatically sensitive to gender disagreement. They propose an automatic coindexication process, by which gender is matched to accessible referents in working memory.

Our work further explores this notion of automatic gender sensitivity, expanding Rigalleau et al.’s findings using different paradigms. In Experiment 1, participants read short stories like the one below in a task that encouraged shallow processing (i.e., at normal speed, without comprehension questions specifically directed toward who did what), with probe recognition test words inserted at the points marked ^.

Tracy and Arthur had been smuggling drugs for years. / They were quite proficient with a well-practiced routine. / Tracy got the drugs from Arthur to hide in a first aid kit, / and then ^ she carried the bag past customs.^ 

At the second of the test points compared to the first, there is no advantage for the referent of “she” over the nonreferent: there is no advantage for the test word “Tracy.” (An additional experiment controls for the sensitivity of the procedure, finding an advantage for the referent when his/her role in the story is emphasized).

In Experiments 2, 3, and 4, though, we do find evidence of automatic gender sensitivity. Experiment 2 is identical to Experiment 1, but participants are probed with gender-stereotypical words (e.g., pink, blue) in a lexical decision task. We find that even under our shallow-processing conditions, participants are faster to decide that the gender-matching probe is a word. This suggests that the feature of gender is automatically accessible after he or she, even if resolution is not correctly completed. In Experiment 3, participants who are engaged in self-paced reading are slower to read a final sentence (e.g., Arthur winced because the bag was heavy) when it is inconsistent with the pronoun than when it is consistent. Experiment 4 presents the stories in blocks of four, with true/false questions following each block. We find that participants are quite accurate at true/false questions that require knowing whether Tracy or Arthur carried the bag. Experiments 3 and 4 suggest that this feature is at least partially encoded into the representation of the story.

Experiments 4-8 compare the processing of 3rd-person pronouns to the processing of 1st and 2nd-person pronouns. Importantly, gender information is not inherent to these pronouns, and thus a referent’s gender can only be understood in the context of the story. Indeed, the experiments using 1st and 2nd person pronouns produce a very different pattern of results. Overall, we present evidence that gender information, when a superficial feature of the pronoun, is automatically accessible and to some extent utilized during shallow processing.

References:
ALL LONG-DISTANCE DEPENDENCIES ARE CREATED EQUAL BUT ...

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Filler-gap dependencies are subject to island constraints, e.g., the dependency is illicit if the wh-filler ('what', see (1)) is outside and the gap ('_') is inside a relative clause (a Complex-NP island [1]). [2,3,4] show that this type of restriction is immediately respected in online sentence processing. A traditional view states that the prohibition on dependency formation across a relative clause is due to a grammatical restriction [1]. An alternative ‘processing complexity-based’ account claims that the Complex-NP island arises from processing considerations: postulation of a gap inside a relative clause incurs a high (even, unbearable) processing burden on the parser [5,6]. If a complexity-based account is correct, the parser should not be able to form any long-distance dependency into a Complex-NP island due to the associated processing burden. In a self-paced reading experiment we examined whether pronoun-antecedent dependencies are disrupted by a Complex-NP island similarly to filler-gap dependencies. Our results show that pronoun-antecedent (aka cataphoric) dependencies are not affected by islands and thus argue against a complexity-based account of islands.

Somewhat problematically for a complexity-based account, off-line acceptability judgments suggest that complex-NP islands do not hinder anaphoric dependencies [1], e.g., in (2) his may be interpreted as Jeffrey. Yet, one could argue that such interpretation results from some delayed pragmatic coercion, and does not reflect the process of online parsing. Our experiment tested whether the parser can form backwards anaphora dependencies inside a complex-NP island (such as between his and Jeff) in real-time, at an early stage of processing.

The experiment used gender manipulation to elicit evidence for dependency formation and followed a 2x2 design with factors pronoun-antecedent constraint (no-constraint/Principle C) and gender (match/mismatch) (3). Pronouns initiate an active search process for an antecedent; if the gender of the earliest potential antecedent mismatches that of the pronoun, it causes a reading time slowdown at the antecedent (‘gender-mismatch effect’, GMME, [7]). If a pronoun-antecedent dependency can be formed across an island (contrary to a complexity-based account), we expect a GMME at the first potential antecedent for the sentence-initial pronoun, i.e. at the relative clause subject (Jeff). (3c,d) in which the dependency between the pronoun and Jeff is constrained by Principle C of the Binding Theory were used as controls: no GMME is expected if Principle C applies in real-time [8].

The results of linear-effect modelling (68 participants) revealed a significant interaction constraint×gender (β=19.2, t(1926) = 2.56, p = .014) at the critical region, the antecedent (Hood). The interaction was due to a GMME in the no-constraint pair (50ms difference, 3a-422ms vs. 3b-472ms) but not in the Principle C pair (3c - 434ms, 3d - 437ms). These results suggest that backwards anaphora formation is not affected by islands (although it does abide by Principle C): The parser can form some (pronoun-antecedent) but not other (filler-gap) dependencies across a complex-NP island, i.e., there are two distinct types of dependencies which are subject to different constraints. A unique processing complexity-based account of islands that does not differentiate between long-distance dependencies is therefore unfeasible.

(1) *We wondered what [ComplexNP the studio that notified Jeff about _ ] was robbed?
(2) His assistants discovered that [ComplexNP the studio that notified Jeff about the role] was robbed.
(3) A simplified set of stimuli from the online experiment
a/b: No-constraint, gender-match / no-constraint, gender-mismatch
His/her assistants discovered that the studio that notified Jeff Hood about the role was robbed, but Rachel had already known this.
c/d: Principle C, gender-match / Principle C, gender-mismatch
He/she discovered that the studio that notified Jeff Hood about the role was robbed, but Thomas/Rachel had already known this.

Syntactic priming refers to the facilitated processing of a syntactic structure via previous experience with that structure. Syntactic priming has been observed in production (Bock, 1986; Pickering & Branigan, 1998; and others) and comprehension (Arai et al., 2007; Pickering & Traxler, 1995). However, these effects in comprehension appear to be largely lexically dependent, meaning that they are only observable when prime and target sentences share the same verb and syntactic structure (Arai et al., 2007; Carminati & van Gompel, 2008; Tooley et al., 2009). In production, both lexically independent and lexically dependent (lexically boosted) syntactic priming occurs, but lexically independent syntactic priming persists across intervening structures and the lexical boost does not (Hartsuiker et al., 2008). This dichotomy may suggest that different mechanisms produce these two types of syntactic priming effects. The time course of syntactic priming effects in comprehension may shed light on this possibility. The current study investigated whether lexically dependent syntactic priming in comprehension persists across intervening sentences. If these effects are quick to decay, this would imply that they are not caused by the same mechanism as lexically independent syntactic priming (i.e. implicit learning), and are likely caused by a mechanism with short-lived effects (e.g. explicit memory or residual activation). Forty- eight native English speaking participants had their eye movements recorded while reading 48 prime–target sentence pairs, half with one filler sentence between the prime and target (Lag 1), and half with three filler sentences between the prime and target (Lag 3). Primes and targets always had the same initial verb and reduced-relative syntactic structure. The experiment was counterbalanced such that each sentence appeared as a prime and a target in both Lag conditions (across four versions), and each participant saw only one version of each sentence. This fully matches primes and targets for length and frequency variables and allows direct comparison of primes and targets. Hierarchical linear models were used to estimate first-pass and total fixation times on the critical regions of the reduced-relatives (verb and by-phrase) for the two Lag conditions. At the critical by-phrase region, the total time estimate of the effect of the Lag1 variable (-38.6) was significant by participants (p = 0.016) and items (p = 0.043). The total time estimate of the effect of the Lag3 variable (-37.8) was also significant by participants (p = 0.026), and marginally significant by items (p = 0.068). No other significant effects were observed. The Lag estimates indicate that sentences were processed about 40 ms faster in the target position versus the prime position. Critically, the magnitude of this effect was the same at Lag 1 and at Lag 3, suggesting the priming effect is still robust when there are three sentences between the prime and target. These findings provide strong evidence that lexically dependent syntactic priming effects in comprehension are not quick to decay. This implies that these effects are likely caused by a mechanism with (relatively) long-lived effects, though more research is needed to precisely identify the exact mechanism producing these effects.

Examples:

Lag 1
Prime: The mouse watched by the cat was hiding under the table.
Filler Sentence: The mistress accepted the gift from the secret admirer.
Target: The director watched by the cop was in a bad part of town.

Lag 3
Prime: The mouse watched by the cat was hiding under the table.
Filler Sentence: The mistress accepted the gift from the secret admirer.
Filler Sentence: The bank that approved the loan negotiated a good interest rate.
Filler Sentence: The maid that washed the sheets used too much bleach.
Target: The director watched by the cop was in a bad part of town.
SIMULTANEITY OF PLANNING INCREASES INTERFERENCE DURING SUBJECT-VERB AGREEMENT PRODUCTION

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Studies examining the mismatch effect in agreement production (more errors when subject noun phrases (NPs) contain a singular head and plural local nouns) have disagreed whether the underlying processes of agreement computation can be explained by accounts relying on structural properties or timing of planning. Bock and Cutting (B&C, 1992) found that the mismatch effect was larger for local nouns in prepositional phrase (PP) modifiers than local nouns in clausal modifiers. They suggested that the planning unit in production is the clause, and number information cannot interfere across separate planning units (clause boundedness). Solomon and Pearlmutter (S&P, 2004) provided evidence that semantic integration (the degree to which elements are conceptually linked) affects error rates, independent of boundedness, hypothesizing that tightly integrated elements are planned closer together and are more likely to interfere with each other. Gillespie and Pearlmutter (2009) examined the role of timing of planning using NP PP PP stimuli and found that local nouns’ linear distance from and semantic integration with the head affected error rates, independent of syntactic structure, with local nouns planned closer in time to the head more likely to interfere. B&C and S&P found evidence of boundedness for PP and relative clause (RC) preambles when integration and linear distance were controlled, which supports structural accounts; but their PP and RC stimuli varied on a number of properties potentially relevant to the timing account.

Experiment 1 tested the boundedness and timing hypotheses using 24 stimulus sets like (1), equating semantic integration and varying modifier type (PP vs RC) and local noun number. Boundedness predicts a modifier type × local noun number interaction. ANOVA and weighted empirical logit linear regression revealed identical patterns: Mismatch effects were present, but the interaction did not approach significance. Exp 1’s results do not replicate the boundedness effect, and instead may be better explained by the timing account, with local nouns in both modifier conditions being planned at the same temporal distance from the head (based on linear distance and semantic integration), creating equal interference.

In B&C and S&P, length was equated by adding adjectives to PP conditions ("certified" in (2)), unlike Exp 1. Because B&C found that adding adjectives to PPs increased the mismatch effect (e.g., in (3)), extra adjectives in PP conditions may have been responsible for boundedness effects previously observed. Experiment 2 was thus designed to replicate B&C’s length effect using Exp 1’s PP versions. Long versions were created by adding an adjective (e.g., (4)). Analyses revealed a local noun number × length interaction in the opposite direction from B&C’s length effect: The mismatch effect was larger in short preambles. Differences between the stimuli in B&C and Exp 2 that may have contributed to the inconsistency will be discussed. This finding suggests that a boundedness effect arising due to differing numbers of adjectives is unlikely. If Exp 2’s results reflect length’s actual effect on error rates, these findings support the timing account because local nouns appearing further from the head produced less interference.

Together, these studies challenge structural accounts of agreement production and lend support to the timing account: Simultaneity of planning increases the chance of interference.

(1) The desk with the sliding drawer(s) (PP)
(2) The desk that had the sliding drawer(s) (RC)
(3) The office of the certified accountant(s) (PP)
(4) The office that belonged to the accountants(s) (RC)
(5) The concept behind the killer (nuclear) satellite(s)
(6) The desk with the (creaky) sliding drawer(s)

STRENGTH OF WORD-CATEGORY EXPECTATION AS A CONSTRAINT ON WORD-FORM TYPICALITY EFFECTS

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In two separate self-paced reading studies, Farmer et al. (2006) found that how typical a word’s phonology is of other words in its lexical category influences the reading times of nouns and verbs in predictive contexts. When a preceding context generated a strong expectation for an upcoming noun (example 1, below), target noun-like nouns were read faster than verb-like nouns, and when context predicted a verb (2), verb-like verbs were read faster than noun-like verbs. Further, in an MEG study, Dikker et al. (in press) found that the magnitude of the M100 response (sensitive to category-expectation violations) was modulated by phonological typicality: when a mismatch existed between whether a context strongly predicted a noun and the noun’s degree of typicality, a heightened M100 response occurred in visual cortex, indicating that sensory processes may be involved in determining whether word-form is congruent with built-up category expectations. Here, we examined whether these word-form effects occur in all cases where a noun or verb is possible, or whether they are more robust in cases where expectations are strong, and thus visual word-form information may be enough to facilitate lexical categorization.

The importance of word-category expectation for eliciting effects of word-form typicality was examined through a lexical decision task using a blocked (Experiment 1) versus interleaved design (Experiment 2). 72 nouns and 72 verbs were selected, and for each category, half were highly typical of each category and the other half were atypical. Words and non-words were presented randomly, and participants were assigned to either the noun or verb condition in the blocked design. Response accuracy was analyzed using a linear mixed-effects model with subjects and items as crossed random factors and Grammatical Category (GC; noun/verb), Typicality (noun-like/verb-like) and the GCxT interaction as fixed effects. Critically, there was a GCxT interaction (p=.03) in the blocked experiment, such that responses were more accurate for nouns when they were noun- instead of verb-like, and for the verb-like than noun-like verbs, but there was no significant interaction or main effect in the interleaved design.

In Experiment 3, the original Farmer et al. items (1-2, below) were interleaved within a self-paced reading study. Due to structural overlap in the preambles of the items, the bias conferred by the main verbs of the sentences to be followed by a structure containing either a noun or verb is likely reduced over time (i.e. through repeated exposure, participants learn to identify the item-type, gradually altering the strength they have for noun and verb expectation as the study progresses). Linear mixed-effect modeling revealed a non-significant GCxT interaction. However, there was a significant GCxTxPresentation Order interaction (p<.05). Early in the experiment, the GCxT interaction was significant, with atypical words processed more slowly, but toward the end, the interaction disappeared.

These effects highlight the role that perceived word-form typicality may play in grammatical categorization: when category expectations are strong, something as simple as how typical a word looks or sounds of other words in an expected lexical category may be enough to facilitate accurate categorization.

(1a) The curious young boy saved the marble that he … (Noun-like Noun)
(1b) The curious young boy saved the insect that he … (Verb-like Noun)
(2a) The very old man attempted to assist his elderly wife ... (Verb-like Verb)
(2b) The very old man attempted to vary his daily routine ... (Noun-like Verb)
SIMULATION OF VISUAL AND AUDITORY DISTANCE IN SENTENCE PROCESSING

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Recent behavioral and neuroscientific studies indicate that during sentence processing, language comprehenders engage their perceptual systems to perform mental simulations of described scenes ([1-2]). These mental simulations encode fine perceptual detail [3-4], leading some researchers to suggest that comprehenders virtually place themselves inside simulations of described scenes as “immersed experiencers” [1]. Alternatively, however, comprehenders might simply activate perceptual correlates of each described entity or events in a piecemeal fashion. If this is the case, perceptual simulations could not be responsible for comprehenders grasping the content of utterances, since comprehenders construct coherent, and not fragmented, mental representations of described scenes.

The two views can be discriminated through mental simulation of distance. The immersed experiencer account predicts that objects mentioned or implied to be nearby should be represented as perceptually closer in mental simulation (visually larger and auditorily louder) than distant mentioned objects. If perceptual simulation is performed piecemeal, however, mentioned objects should not differ in their simulated size or volume, regardless of their distance.

Two behavioral studies investigated whether mental simulations do indeed depict distances. Both employed a 2X2 factorial design, in which we manipulated Sentence-Distance and Picture/Sound-Distance. In Experiment 1, 19 participants saw 32 sentences in a Near condition (You are looking at the olive oil in the kitchen cabinet) or a Far condition (You are looking at the olive oil on the far shelf), followed by images of objects whose size, contrast, and sharpness was manipulated to make them appear nearer or farther. Participants had to decide as quickly as possible whether the depicted object had been mentioned in the sentence. In Experiment 2, 18 participants saw 24 sentences in a Near condition (Right next to you, the dog is barking) or a Far condition (In your neighbor’s yard, a dog is barking), followed by sounds of objects or animals whose amplitude and spectral tilt was manipulated to appear nearer or farther from the hearer. Participants performed a sound-matching task, deciding whether each thing they heard had been mentioned in the sentence.

In Experiment 1, participants were on average 30ms faster when the distance of the sentences and the pictures matched than when the distances mismatched; see (1). Repeated measures ANOVAs revealed a significant interaction of Sentence Distance and Picture Distance by subjects (F1(1,18)=6.318, p=0.02) but not by items (F2(1,30)=1.865, p=0.18). In Experiment 2, participants were on average 121ms faster in the matching than in the mismatching conditions. The interaction between Sentence Distance and Sound Distance was significant by participants (F1(1,16)=5.562, p=0.031) and nearly significant by items (F2(1,21)=3.167, p=0.09). We anticipate that with additional participants still to be run, the items-analyses are likely to reach significance as well.

These results suggest that comprehenders automatically mentally simulate how far away mentioned objects would be from them if they were present in the described scenes. These findings are not compatible with a piecemeal account of perceptual system activation, suggesting instead that comprehenders construct mental simulations as though they were immersed experiencers in the described scenes.

EMERGENCE OF LANGUAGE COMPREHENSION FROM MULTIPLE TASK INTEGRATION – A CONNECTIONIST INVESTIGATION

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We present a connectionist model of emergent syntax and semantics acquisition and processing. Our starting point is language grounding: the linking of linguistic expressions to the environmental aspects they refer to. The model’s aim is to map sequential expressions of a micro-language to static scenes in a visual world by developing common ground representations.

Scenes are presented as constellations of up to three of four simple objects, each consisting of three adjacent dots on a two-dimensional visual grid. The task is to map these scenes on a reduced prototypical version of the spatial relation of only two selected objects. To accomplish this, the network has to acquire a notion of connectedness of dots on the visual grid forming objects, classify those objects into four classes, and acquire their spatial relationship. Sentences refer to the derived prototype of the presented scene and are presented word-by-word. The task is to predict the next word. The model has to establish a connection between sequences of words to spatial states and objects in the visual scene.

The architecture combines two concepts: dual-route models (Cangelosi, 2005) for cross-modal task integration, and simple recurrent networks (SRNs, Elman, 1990) for sequence processing. Both tasks are performed in parallel via a recursive integration layer that provides the means for common representations. The model differs from other current connectionist models on comprehension (e.g., Rohde, 2002; Mayberry, 2003) in two important aspects: (a) it starts without any explicitly structured semantic representation, since its task is to develop a grounded semantic representation on its own, (b) the model is trained in a parallel integrative fashion on all subtasks, since this is the prerequisite for the emergence of its representations and properties.

We trained the model for 20 epochs using back-propagation through time algorithm. Training stimuli contained 60% of up to 131.000 possible object constellations, the remaining constellations were used for testing. The model was robust over a range of variations on parameters and layer specifications.

We tested the model in three modalities: (a) both input types given, representing situated language comprehension, (b) only linguistic input given, representing decoupled language comprehension, (c) only visual input given, representing language production.

Comprehension can be demonstrated as incremental construction of corresponding prototype constellations, leaving missing information as underspecified activation of possible scene features. In production, the model generates correct sequences, that contained only objects and spatial relations present in the accompanying visual scene. However, many sequences were elliptical and repetitive. Effects of attention shifting and inference occurred during situated language processing: Whenever inferences were possible, the model immediately reduced the range of possible target prototypes (e.g., if only one above-constellation is present, it is chosen as soon as the word above appears). As language output, only words that matched the visual scene and the preceding sentence were predicted.

The results show the capability of connectionist architectures to make use of cross-modal information and to detect covert information. Moreover, the model developed emergent features like attention shifting and inference drawing that were not trained explicitly.

References:
1. Though the study of quantifiers has a long tradition in formal semantics, little is known about how quantificational statements are verified. This study investigates whether verification of quantified statements is sensitive to a fundamental difference in formal complexity (1st order definability) that separates simple counting quantifiers like more/fewer than n from proportional quantifiers like more/less than half, which are not definable in 1st-order terms (Barwise&Cooper 1981).

2. McMillan et al. (2005) first investigated this issue in a simple verification paradigm. They found that 1st order quantifiers are easier to verify than higher-order quantifiers (see also Zymanik&Zajenkowski 2009), that verification is easier for both types of quantifiers when the difference between the actual count and the minimum/maximal number required for verification is larger, and that this is enhanced with higher order quantifiers. Our study replicates and extends McMillan et al.’s findings.

3. In Experiment 1 participants verified statements as in (1) relative to dot arrays displayed on a computer screen. Arrays varied in the total number of dots (15-19) and the distance between the critical number, n, and the actual number of red dots, N. In the “Low” condition, N is minimally above (below for false items), while in the “High” condition N is at least 3 above/below n (keeping the ratio constant across items). We observe a main effect of “Distance” st. “Low” items take longer to verify than “High” items and a “Distance-by-Complexity” interaction st. the effect of Distance is larger for proportional quantifiers (13 participants, p<.05).

4. Experiment 2 uses the same dot arrays as Experiment 1. However, the arrays are uncovered in a novel paradigm, Self-paced-counting (SPC). In a self-paced manner, dots are uncovered in groups of 1, 2 or 3 as participants press the spacebar. We observed a main effect of Order (Proportional > 1st Order) on spacebar presses 2-5 and an interaction on the answer frame st. Distance has a large effect on proportional quantifiers (Low_prop >> High_prop) but no effect on 1st Order quantifiers (15 participants, p<.05).

5. Discussion: The SPC results extend earlier results showing that the counting phase itself is more difficult for proportional quantifiers. We argue that this reflects the fact that with proportional quantifiers, two quantities need to be continuously updated (the number of red dots and the total number of dots) while 1st order quantifiers require only a count of the red dots. Furthermore, the fact that only the decision stage shows a Distance by Order interaction can be understood if we assume that the proportional quantifier meanings are represented by the approximate number system, which is subject to Weber ratio effects (Pica et al, 2004), while 1st order quantifier meanings can be represented on the natural number line. We argue that these differences are a direct result of a compositional semantic treatment of these quantifiers.

(1) a. More/less than 6 of the dots are red.
   b. More/less than half of the dots are red.
EFFECTS OF SYNTACTIC COMPLEXITY ON SENTENCE PROCESSING IN GERMAN: A MIXED MODEL ANALYSIS

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Theories about the influence of syntactic complexity on on-line sentence processing have a long tradition in psycholinguistics (Frazier, 1985). Besides their usage to explain the resolution of syntactic ambiguities there is a growing interest to employ syntactic complexity as a predictor of reading times in natural text corpora. The present study investigated whether indices of syntactic complexity derived from the Dependency-Locality Theory (DLT, Gibson, 2000) are able to predict self-paced reading times in German. There are two distinctive grammatical features that make sentence parsing particularly challenging in German: the placement of finite verb depends on the clause type (verb-initial for questions, V2 in main clauses, and verb-final in dependent clauses) and the phrase ordering is very flexible. Therefore, we expected complexity effects to vary with the specific linguistic context.

One hundred twenty high-school students read ten texts comprising 1391 words organized in 75 sentences and 189 clauses in moving-window paradigm. Mixed model analysis was used to test the effects of the DLT memory and integration cost components on single word reading times as well as the variability of their effects due to text-, sentence-, and clause-level characteristics while controlling for word length, lexical frequency, and word repetition. In contrast to Demberg and Keller (2008), we found small but reliable DLT integration cost effects on word reading times. We also found an interaction between integration and storage cost with stronger integration effects when memory load was high. Most importantly, however, integration cost effects varied considerably between different types of clauses: Integration cost was only able to predict reading times in V2 main clauses but not in verb-initial or verb-final clauses. In contrast, integration cost effects did not vary with the phrase ordering of the clause and did not change when clauses contained constituents that were fronted or scrambled.

The results are discussed with regard to the difference between locality- and expectation-based measures of syntactic complexity (Levy, 2008) and their utility to predict complexity effects in different clause types in German.


THE INVOLVEMENT OF VERBAL SHORT-TERM MEMORY IN LANGUAGE LEARNING: THEORY AND APPLICATION

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We will present a theoretical framework (Page & Norris, 2009) which proposes that language learning relies on the short-term memory mechanisms responsible for representing verbal serial order information, including empirical evidence from both healthy participants and adults with dyslexia.

In a first study (Szmalec, Duyck, Vandierendonck, Barbera-Mata, & Page, 2009), participants saw sequences of nonsense syllables, following a standard Hebb learning procedure. Then, they performed an auditory lexical decision task on nonwords that had been constructed from the syllables included in the repeated Hebb sequences. Interestingly, these Hebb-based nonwords yielded slower lexical decision times than control nonwords. This demonstrates that the repeated sequences of syllables, which were implicitly learned in a Hebb procedure, have generated the representation of novel phonological word-forms in memory. This finding does however not allow us to decide whether these familiar word-forms have also generated a novel entry in the mental lexicon.

Therefore, in a second study (Szmalec, Page, & Duyck, 2010), we used a stringent test of lexicalization, namely the engagement of novel word-forms into lexical competition (Gaskell & Dumay, 2003). In a first experiment, participants recalled sequences of visually presented syllables, with one particular (Hebb) sequence (e.g., la-wi-na-me-ri-tu-pa-ra-da) repeated throughout the experiment. Twenty-four hours later, in a second experiment, the same participants performed an auditory lexical decision task and a pause detection task, involving a subset of Dutch words (lawine, merite, parade) that overlapped with the nonsense materials repeated in experiment one. Interestingly, reaction times were slower for this target subset of existing words, indicating a development of lexical competition between the words and the syllable sequences that were implicitly learned in the Hebb experiment. In order to test the assumption that lexicalisation of novel word-forms requires an incubation period that is crucially associated with sleep (e.g., Davis, Di Betta, MacDonald, & Gaskell, 2009), the third experiment was designed in order to trace the time course of the lexical competition effects after Hebb repetition learning. The relative effects of time and sleep on lexical competition were dissociated in two experimental groups that underwent lexicalisation tests on three different moments spread over 24 hours.

Finally, we will present a third study in which we applied the Hebb repetition paradigm as the interface between verbal short-term memory for serial order and word acquisition, in order to investigate serial order learning in adults with dyslexia (Szmalec, Loncke, Page, & Duyck, 2010). Interestingly, we found that people with dyslexia showed reduced Hebb learning, compared to a group of matched controls, while short-term memory capacity was not affected in the same group. This finding was replicated with verbal materials, presented both visually and auditorily, as well as with visuospatial materials. This study shows that people with dyslexia are selectively impaired in the implicit learning of serial order information, across modalities, on the basis of which we put forward a learning account which proposes that dyslexia and many of its associated dysfunctions can be traced back to a selective impairment in serial order learning.

STRUCTURAL FORGETTING IS INFLUENCED BY NOUN PHRASE TYPE IN FRENCH

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Double centre-embedded structures such as (1) seem ungrammatical to many human readers. Using an offline complexity judgement task, Gibson and Thomas (1999) demonstrated that people found such sentences no more difficult to understand when the second verb phrase (VP2) was omitted (as in 2), relative to a condition where all the required VPs were present (as in 1).

According to resource-based theories of sentence processing (Gibson, 2000; Lewis, Vasishth, & Van Dyke, 2006), this syntactic illusion is determined by the high working memory cost associated with the integration of the VP2. Following Warren and Gibson (2002), this cost could be reduced by replacing the third noun phrase (“the municipality”) by the first-person pronoun “I”, as in (3) and (4), making the reader more sensitive to the omission of the VP2. This hypothesis was tested in two eye-tracking experiments using French sentences.

In Experiment 1, the third noun phrase (NP3) was either a noun (“the municipality” in 1 and 2) or the first-person pronoun “I” as in (3) and (4). The VP2 (“caught”) was either present (1 and 3) or absent (2 and 4). Participants had to read these sentences and to evaluate their complexity. The complexity ratings showed that when the NP3 was a noun, participants found the missing VP2 condition (2) easier than the all-three VPs condition (1). However, when the NP3 was a pronoun, the missing VP2 condition (4) was rated more difficult to understand than the all-three VPs condition (3). Moreover, the eye movement analyses on the last VP (total time, number of fixations, number of regressions) also showed that the missing VP2 effect was influenced by the type of NP3.

In Experiment 2, participants had to complete sentence fragments where the NP3 was a noun as in (5) or the first-person pronoun as in (6). The results showed that more sentences were completed with 3 VPs when the NP3 was a pronoun than when it was a noun phrase. The online analyses about writing (pauses and writing speed) and the eye movement analyses are in progress.

The results suggest that human beings are able to process double centre-embedded structures when the most embedded NP is a pronoun. The overall results are consistent with resource-based theories of sentence processing (Gibson, 2000; Lewis et al., 2006).

(1) The fish that the sailor who the municipality congratulated caught was one metre in length.
(2) The fish that the sailor who the municipality congratulated was one metre in length.
(3) The fish that the sailor who I congratulated caught was one metre in length.
(4) The fish that the sailor who I congratulated was one metre in length.
(5) The fish that the sailor who the municipality...
(6) The fish that the sailor who I...


The claim that increasing the distance between the argument (nurse) and the verb (supervised) in sentences like (1a,b,c) results in greater integration difficulty due to greater integration cost arising from decay and/or interference (Gibson 2000, Lewis & Vasishth 2005), has recently been challenged. Levy (2008) suggests that "more preverbal dependents gives the comprehender more information with which to predict the final verb’s identity and location, and comprehension should therefore be easier” (2008:1144). Such facilitation (antilocality) effects can be found in studies involving (among others) German: Konieczny 2000 showed that delaying a verb in a relative clause facilitates processing at the verb.

Although it is clear that both factors play a role (Levy 2008), it is important to demonstrate how integration cost and expectation interact. We suggest that in structures where it is well-known that facilitation effects occur, integration cost can end up dominating if working memory cost is high.

We investigated structures like (2); here, once a relative clause begins after the argument Direktor, the appearance of the verb in the relative-clause verb is guaranteed (as in Konieczny 2000). The expectation-based account predicts that delaying the appearance of such a clause-final verb should sharpen the expectation for it (this is how Levy 2008 explains the Konieczny 2000 results). However, examples (2) have the property that the presence of multiple proper names in all three conditions (2a,b,c) makes the retrieval of Direktor (the argument of the verb) more difficult due to consistently high interference, independent of the increasingly larger number of interveners between the argument and the verb in (2a) vs (2b) vs (2c). This experiment design raises working memory cost across all conditions (independent of the locality manipulation). The interesting question is whether this generally increased load on memory results in integration cost dominating over expectation-based facilitation.

We conducted three German experiments (one self-paced reading study, n=50; one eyetracking study, n=30; and one ERP study, n=16) where we compared sentences like (2a,b,c); here, the verb (ignoriert) was positioned increasingly further away from its argument (Direktor). The expectation-based account predicts facilitation at the verb if more preverbal dependents give the comprehender more information with which to predict the final verb’s identity and location (Levy 2008:1144), and the integration-cost account predicts greater difficulty in processing the verb as distance increases.

In the SPR study we found significantly longer reading times in (2c) compared to (2a,b) at the verb region (ignoriert in (2)); in the eyetracking study this region showed significantly longer re-reading times in (2c) vs (2a,b); and in the ERP study a negativity was seen in (2b,c) vs (2a) and (2c) vs (2b) in the left-anterior region (300-600 ms window post-onset of the verb), which suggests increased integration cost.

In sum, this work demonstrates that the relative strengths of integration cost and expectation-based facilitation may depend on the amount of working memory load experienced while parsing the sentence. If working memory load is high, a net facilitation does not occur even when more preverbal dependents are present.

1a. The administrator who the nurse supervised...
   b. The administrator who the nurse from the clinic supervised...
   c. The administrator who the nurse who was from the clinic supervised...

   b. Paula und die Schwester von Sophie grüßten den Direktor, den Maria und die Mutter von Franziska ignoriert hatten.
   c. Paula und Sophie grüßten den Direktor, den die Schwester von Maria und die Mutter von Franziska ignoriert hatten.

UNIQUENESS CONSTRAINTS ARE ASSOCIATED WITH DEFINITE NOUN PHRASES, BUT NOT DEFINITE ARTICLES

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It is widely accepted that definite noun phrases such as "the can" assume that their referent is uniquely identifiable. We might then expect that listeners would be able to make use of this information to make anticipatory eye movements to elements that are type-unique in the context. However, in several studies that could have shown such an effect, it has instead been found that listeners do not make anticipatory eye-movements to a uniquely identifiable referent as soon as they hear a definite article. One possibility is that the presence of a definite article does not, by itself, provide strong uniqueness constraints. We focus on a special class of definite NPs called "weak definites" (Carlson & Sussman 2005) and suggest that definiteness is a property of entire constructions, and cannot be determined based simply upon the presence of a definite article. Previous work has demonstrated that "weak definites," unlike regular definites, do not require their referent to be unique, and unlike regular indefinites, they do not appear to introduce a new referent into the discourse model (Klein et al. 2009). In the current work we explore whether weak definites convey semantically enriched meanings, evoking a conventional event or activity rather than referring to a uniquely identifiable discourse entity. If so, this enriched interpretation may eliminate the ordinary uniqueness presuppositions associated with the definite article.

In Study 1, we examined the interpretation of weak definites, and in Study 2, we explored "weak" indefinites, whose referential behavior in earlier studies has been somewhat different from that of regular indefinites. The studies used an interview-style paradigm, in which participants were instructed to read sentences and then asked two questions about the scene they imagined after reading each one. Each sentence was constructed using an agent with associated prototypical activities as the subject, and the NP of interest as the object. The first question asked whether the agent was performing their prototypical activity in the scene the participant imagined. The second question asked the participant to describe that scene. For sentences involving weak definites (Study 1), participants were much more likely to say the agent was NOT performing their prototypical activity, and to give an enriched interpretation for the NP in their description, than for sentences involving regular definites (p < 0.05 by subjects & items). Interestingly, a similar pattern holds in Study 2 for weak indefinites (p < 0.05 by subjects). This is likely due to the lexical nature of weak definites; nouns that evoke enriched interpretations when paired with the definite may also be likely to evoke them when paired with the indefinite in the context of the appropriate verb. The overall pattern of results suggests that the anomalous referential behavior observed in previous studies may be due to enriched interpretations associated with the weak definite (and indefinite) NPs.

These studies provide evidence that weak definites convey enriched meanings. These meanings, associated with the entire construction, may lead to different referential behavior, making the definite article alone a poor cue in reference resolution.

Example Sentence & Questions:
The Fed Ex driver had to go the/a hospital/farm. Q: Was the Fed Ex driver making a delivery in the scene you imagined? Describe the scene you imagined.

References:
BILINGUAL SENTENCE PROCESSING: THE ROLE OF SYNTACTIC CONSTRAINTS IN MODULATING CROSS-LANGUAGE LEXICAL ACTIVITY

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Many recent studies demonstrate that bilingual word recognition is language nonselective with information about words in each language activated in parallel even when reading or listening to a word in one language alone (e.g., Dijkstra, 2005; Marian & Spivey, 2003). Cross-language activation of the language not in use is observed even when bilinguals are highly proficient in the second language (L2) and even for the more dominant first language (L1). A critical question is whether language nonselectivity in bilingual word recognition is only a consequence of processing words out of context. A series of studies, using a range of language pairs and measures has shown that lexical nonselectivity is still present when words are recognized within sentence context (e.g., Duyck et al., 2007; Libben & Titone, 2009; Schwartz & Kroll, 2006; Van Hell & De Groot, 2008). Sentence context in one language alone is not sufficient in and of itself to override cross-language activity. The only factor that has been identified that effectively eliminates the cross-language effect within sentence context is semantic constraint.

In the present study we asked whether syntactic constraints within sentence context can effectively eliminate the parallel activation of the language not in use. Bilinguals highly proficient in both Spanish and English read sentence contexts in each of the two languages in separate blocks. Half of the Spanish sentences contained language-specific syntax that was structurally specific to Spanish in two ways: (a) the indirect object of a ditransitive verb was realized pleonastically with the proclitic le and with its corresponding noun phrase; and (b) the grammatical subject of the object relative clause was not expressed overtly. This is illustrated in Las monjas (a)le llevaron las mantas que (b)(pro) habían bordado a la directora del orfanato. [The nuns took the quilts that they had embroidered to the director of the orphanage.] The English translations of these sentences were controls in the sense that the initial phrase of the sentence was not syntactically specific to English. Bilinguals silently read sentences presented one word at a time and then named a target word aloud. The critical target words were language ambiguous cognates (e.g., bus in English and Spanish). A set of unambiguous control words (e.g., hairspray-laca) were matched to the cognates in each language.

If the presence of language-specific syntax allows bilingual readers to selectively access or to “zoom in” to the target language (e.g., Elston-Güttler et al., 2005), then lexical access for critical target cognates following language-specific information should be no different than for unambiguous controls. Preliminary findings provide support for this prediction, suggesting that language-specific syntax may function to attenuate cross-language activation when the language of the sentence can be selectively processed. We examine the implications for claims about the interactions between structural, semantic, and lexical factors in bilingual sentence processing and for models of code-switching between languages.

References
THE ROLE OF SELECTIVE ATTENTION IN IMPLICIT LANGUAGE LEARNING: AN ERP STUDY

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Using artificial grammar learning paradigms, researchers have documented implicit learning of the statistical relationships between linguistic elements that characterize word boundaries [1,2], phrase structure rules [3-6], and verbal subcategorization [7]. What remains unclear is attention's role in implicit learning. Studies employing secondary tasks to vary attentional load during implicit language learning [8,9] have yielded contradictory results. Studies that have examined implicit learning in other domains [10-12] suggest that "attentional load" does not determine whether learning takes place, but "selective attention" directed to the dimension of the stimulus encoding the to-be-learned pattern. We adopted the type of selective attention manipulation employed in [10-12]-but entirely absent from the language learning literature—by comparing ERP responses to violations of systematic regularities that were either attended or unattended during exposure to an artificial language. During training, subjects read 384 sentences of an SOV split ergative artificial language and completed a 2-alternative-forced-choice task at the main verb, with feedback following every response. This task, designed to explicitly instruct the subjects on the agreement system, focused attention on the co-variation between a verbal prefix and a suffix on the agreeing noun as in (1): Ba flerbit-OT po klamon-il iti KOG-glim boke ton ol. Training materials contained an additional set of regularities that formed the language's verbal subcategorization system. Verbs obligatorily selected for an adjacent auxiliary verb (local pattern), and were obligatorily transitive or intransitive (global pattern). The subcategorization system was both independent of the agreement system and task-irrelevant, and therefore unattended during training. After training, learning of both systems was assessed by having subjects read sentences and make end-of-sentence grammaticality judgments during EEG recording. Subjects read and judged the grammaticality of grammatical sentences and violations (agreement, local subcategorization, and global subcategorization), 40 per condition. The main verb was the critical position in all conditions, as it determined the grammaticality of the sentence (verbs could render sentences ungrammatical by violating the agreement or subcategorization systems). Preliminary analysis of the data of monolingual native English speakers (aged 18-24) revealed the following results: i) Subjects successfully learned the explicitly trained upon agreement system (2AFC training data) ii) Subjects performed above chance only on grammatical sentences and agreement violations (grammaticality judgment testing data) iii) Compared to grammatical controls, agreement and only local subcategorization violations elicited sustained late positivity (500-900 ms, p < .05). Global subcategorization violations did not differ from grammatical controls in any time window. These and other results [10-12] are consistent with the assertion that implicit learning is strongly constrained by selective attention. However, unlike [10-12], the elicitation of late positivity by the local subcategorization violations suggests that learning may indeed be possible outside of attention's focus, as the brain appears sensitive to parameters unattended during learning. Yet, it appears that this type of learning outputs weak representations and may be limited to the most simple of patterns.

References:

SYNTACTIC PRIMING AS AN INDEX OF CHILDREN’S SYNTACTIC KNOWLEDGE: EVIDENCE FROM VISUAL WORLD EYE-TRACKING STUDY

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Syntactic priming is a widely observed phenomenon that a previous experience to a specific syntactic structure facilitates subsequent processing of the same structure. It has been shown that syntactic priming occurs in comprehension as well as in production, suggesting that it taps into representation of syntactic knowledge that is commonly accessed between production and comprehension [7]. It has also been shown that the effect can be rather long-lasting [2]. Following these results, some researchers claim that syntactic priming underlies the process in which we, both children and adults, acquire syntactic information through processing (“learning-as-processing assumption”, [3]). Such an account naturally assumes a close relationship between priming of a syntactic structure and language user’s ability to process the structure. However, there is little evidence for the link between learning/processing and syntactic priming. One reason is that previous studies have focused on priming of already familiar, thus easy to process, structures with adults (for exception, see [5]). There are in fact several studies that showed syntactic priming with young children but none of the studies demonstrated a relationship between children’s processing ability and syntactic priming [1, 4, 10]. The current study investigated this by using visual world eye-tracking paradigm [9]. We tested 5- and 6-year-old children with Japanese passive construction as this particular syntactic structure is known to be difficult even for children of this age [8]. In the experiment, the participants first heard a prime sentence, which was either an active or a passive sentence while seeing a visual scene which depicts a simple event. They then heard a target sentence such as (1) while seeing a new unrelated scene. The target scene depicted two events, where a central character was involved in both events as an agent for one and as a patient for the other [6]. Importantly, before hearing the second noun, the sentence is ambiguous between active and passive construction. To examine their ability to process the passive construction, we included comprehension questions following passive targets. The results from comprehension questions showed that 6-year-olds made more correct responses and produced more passive constructions compared to 5-year-olds, which suggests that 6-year-olds processed the passive construction better than 5-year-olds. The results of eye-movements showed the effect of priming with the passive construction, which manifested as more visual attention given to the agent object following passive primes than active primes. More importantly, the results of eye-movements reflected the difference in processing ability found with the comprehension questions; the magnitude of the priming effect was much greater for 6-year-olds than for 5-year-olds. The results demonstrate a close relationship between syntactic priming and language user’s processing ability which is grounded on their syntactic knowledge.

1a. Saru-san ga kyuni Kirin-san wo tutuita.  (ACTIVE TARGET)
   monkey (agent) suddenly giraffe (patient) poke 'The monkey suddenly poked the giraffe'
1b. Saru-san ga kyuni Buta-san ni tukamareta.  (PASSIVE TARGET)
   monkey (patient) suddenly pig (agent) grabbed 'The monkey was suddenly grabbed by the pig'

CHILDREN AND ADULTS USE SPEAKER INFORMATION TO CONSTRAIN ON-LINE INTERPRETATION

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Recent work in spoken sentence processing suggests that adult listeners use various extralinguistic cues to constrain sentence interpretation (discourse information, visual scene, speaker identity1), while children are less sensitive to such cues.2 Nonetheless, speaker identity would be an extremely useful cue for language processing in the child’s environment: for instance, the referential domain of X in “I want X” varies greatly depending on who “I” is. Given that adults routinely integrate linguistic and extralinguistic cues in on-line processing, it is of crucial importance to understand how this integration develops.

Two experiments used the visual-world paradigm and remote eye tracking3 to assess whether children (3-5 years) and adults use speaker acoustics to predict upcoming referents, and at what level they are using that information. In a training phase, each talker stated a preferred color: Anna preferred pink, and Billy blue. Thirty-two test trials followed. In Experiment 1, voice perfectly predicted target color: Anna always asked for a shape that was pink, and Billy, blue. Each trial depicted four shapes (e.g. pink circle, pink square, blue star, blue triangle), and one speaker requested a shape, as in (1). If listeners use speaker information to infer preferred color, they should fixate the same-color (e.g. pink) distractor more than different-color (blue) ones. Both children (t(23)=6.43, p<.0001) and adults (t(23)=4.03, p=.0005) looked more to shapes of the talker’s preferred color than to the non-preferred color prior to hearing the shape name. Thus, both age groups used talker information to narrow the referential possibilities. However, it is unclear whether they are (1) identifying the speaker and inferring her preference (a high-level solution), or (2) associating speaker-acoustic information with color (a low-level solution).

In Experiment 2, speaker alone is uninformative but the sentence’s agent cues color perfectly. On “first-person” trials (n=16; Example 2), the talker requests a preferred-color shape. On “third-person” trials (n=16; Example 3), they request their nonpreferred color for the other individual. If listeners simply learned acoustics–color associations, they should not look more to the agent’s preferred color, because acoustics is an unreliable cue. However, if listeners use acoustics flexibly to determine the sentential agent, they should fixate the agent’s preferred color on both trial types. Adults fixated preferred color on both first-person (t(31)=4.36, p=.0001) and third-person trials (t(31)=2.51, p=.02), before shape-name onset. Child data (in progress) show later but similar effects, with looks to the same-color distractor after shape-name onset on both trial types (t(14)=3.26, p=.006; t(14)=2.65, p=.02). This suggests that both age groups use speaker-derived information (“1Anna”) as well as reference (“Anna”) to discern whose preferences constrain referential domain.

These results inform the literature on the development of sentence processing in showing that children and adults use speaker acoustics to infer meaning on-line. Unlike some other extralinguistic cues, children successfully and rapidly integrate talker-acoustic information with linguistic cues. Children’s success here may be due to task simplicity and knowledge of gendered color preferences. More broadly, this study suggests continuity in children and adults’ incremental integration of cues in real-time comprehension.

(1) [Anna]: Can you show me the circle?
(2) [Anna]: I want to see the circle.
(3) [Billy]: Anna wants to see the circle.
THE ROLE OF INFORMATION DISTRIBUTION & INHIBITORY CONTROL IN PRESCHOOLER'S SENTENCE PARSING

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Preschool-aged English-speaking children show disproportionate reliance on verb constraints in sentence parsing (Trueswell et al., 1999). In comparison, Korean (a verb-final language)-speaking children showed parsing errors related to their reliance on morphosyntactic than verb constraints (e.g., considering napkin-on as a destination in "napkin-on tomato-acc pickup," even when the verb requires it to be a noun modifier) (Choi & Trueswell, 2006). Such difference could have arisen from cross-linguistic variability in cue validity and the differential treatment of these cues by children within each language (e.g., morphosyntax carries more predictive power in Korean due to its head-final nature and affects the child's parsing as such). Alternatively, the difference could be explained by a common developmental factor, immature inhibitory control among preschoolers. This proposes that the child's parsing errors stem from their difficulty with inhibiting their early interpretation to override it with later information. This made children in both languages appear relying more on early-arising syntactic evidence: verb in English and case-marking in Korean.

To test these predictions, we examined the role of information distribution and inhibitory control in child parsing, by delaying the presentation of typically early-arising information to later in the sentence within each language. In Exp.1, 16 English-speaking 4-5-year-olds and 26 adults acted out temporary ambiguous sentences in Verb–Initial (e.g., Put the frog on the napkin into the bucket) and Verb–Final (e.g., The frog on the napkin into the bucket put) conditions, situated in a context that a silly puppet utters these sentences. Their actions were coded as Correct (moving the frog placed on the napkin into the bucket) or Error (taking 'on the napkin' as a destination). Similarly, in Exp.2, 18 Korean-speaking 4-5-year-olds and adults acted out temporary ambiguous sentences such as "napkin-on tomato-acc put/pickup", across four conditions: (1) Pickup–Final, (2) Pickup–Initial, (3) Put–Final, & (4) Put–Initial (see Examples). When children's actions indicated that 'napkin-on' was taken as a destination than a modifier, it was coded as Correct in Put trials but as Error in Pickup trials and vice versa. Both groups of children also completed a Snow–Grass task to measure their inhibitory control abilities.

When verb information was delayed to the end of the sentence, English children were less likely to make parsing errors than when the verb was presented sentence-initially (see Table 1). Similarly, Korean children made fewer errors when pickup was presented before than after case–marking information. When the verb was put, Korean children performed similar to adults (94%), regardless of whether the verb was presented sentence-initially or sentence-finally. This was expected, given that the verb information did not conflict with the child's preferred interpretation of napkin-on as a destination.

Overall, regardless of the acquiring language, children's final interpretations reflected sentence-initial information more than sentence-final information, suggesting that the child's parsing errors observed in both languages are associated with their immature cognitive control. However, no significant correlations between an inhibitory control measure and child's parsing errors were observed in each language and when both groups were combined (r=-.07, p=.67).

Examples of Sentences Used in Korean:
1) Pickup–Final: napkin-ey tomato-rul cipuseyo (napkin-on tomato-acc pick up; Pick up the tomato on the napkin)
2) Pickup–Initial: cipuseyo napkin-ey tomato-rul (pick up napkin-on tomato-acc; the tomato on the napkin Pick up)
3) Put–Final: napkin-ey tomato-rul nohuseyo (napkin-on tomato-acc put; Put the tomato on the napkin)
4) Put–Initial: nohuseyo napkin-ey tomato-rul (put napkin-on tomato-acc; the tomato on the napkin Put)

Table 1. Percent Goal and Modifier Action in Verb–Initial & Verb–Final conditions.

<table>
<thead>
<tr>
<th></th>
<th>English (n = 16)</th>
<th>Korean (pickup trials) (n = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Verb Initial</td>
<td>Verb Final</td>
</tr>
<tr>
<td>Four-Five-year-olds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error (goal action)</td>
<td>50%</td>
<td>23%</td>
</tr>
<tr>
<td>Correct (modifier action)</td>
<td>49%</td>
<td>77%</td>
</tr>
<tr>
<td>Adults</td>
<td>(n = 26)</td>
<td></td>
</tr>
<tr>
<td>Error (goal action)</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>Correct (modifier action)</td>
<td>99%</td>
<td>99%</td>
</tr>
</tbody>
</table>
BIAS IN THE CLOZE TASK

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The two most widely used techniques in psycholinguistics for estimating language users’ implicit probabilities—in order to relate them to behavioral or neural correlates of online language processing—are Cloze sentence-continuation tasks (Taylor, 1953) and relative-frequency estimation based on corpus counts. However, no systematic study has attempted to relate these two techniques. Here, we compare Cloze and corpus probability estimates by using a large corpus to calculate ‘gold standard’ corpus-based probability distributions and comparing them to distributions produced by Cloze-task participants. If participants’ subjective probability estimates accurately match corpus statistics, and their cloze responses are produced by probability matching, then these two distributions should be identical. Any deviation from this ideal thus reflects either a bias in their probability model or an artifact of task strategy. The former possibility would give insight into participants’ internal linguistic representation; the latter would have important methodological consequences for psycholinguistics.

Method: We selected 300 hand-screened four-word sentence-initial stems from the Web 1T 5-gram corpus (Brants & Franz, 2006) of one trillion words of web text (median count 1906, minimum count 250). Stems were required to be clearly not spam or high-frequency stereotyped phrases (e.g., “Designated trademarks and brands”); to induce a minimum perplexity in a separate BNC-trained trigram model; to induce mostly open-class word continuations; and to varying substantially in the range of probability for their most-likely and second-most-likely continuations. Corpus-based probability distributions were obtained using relative-frequency estimation from Web 1T 4-gram and 5-gram counts. Cloze probability distributions were based on a computerized sentence-continuation study with 134 participants.

Results: Overall agreement between cloze probabilities and corpus probabilities is only moderate ($R^2 = 0.34$). To examine this relationship, we used corpus probability and a variety of psycholinguistic measures (Wilson, 1988; Brysbaert & New, 2009) in a log-linear model predicting cloze probabilities. We expected that subjects might have a bias towards picking the most probable continuation, but the model revealed the opposite: they “flatten out” the distribution, giving high probability responses less often than expected, and low probability responses more often. This pattern is stronger for high-constraint and common stems. Modulating this overall distributional shift are significant biases to produce words that are familiar, concrete, acquired late, and have high contextual diversity. Non-significant predictors were imageability, word length, and word frequency. (Word frequency was ‘knocked out’ by age of acquisition; compare Morrison, Ellis, & Quinlan, 1992.)

Several of these effects may be artifacts of the cloze task; e.g., many participants reported a strategy of re-using the same words from sentence to sentence, which might explain the bias towards words with a high contextual diversity and flattening of the overall distribution. The flattened distribution may also result from the inclusion of stems used in unfamiliar contexts (e.g., journalistic language). However, this would not predict the bias towards familiar, concrete, and late-acquired words, and further work will be necessary to determine whether such effects are task artifacts we should be correcting for, or a reflection of the brain’s true probability model.

DEAF SIGNERS READING WRITTEN ENGLISH SENTENCES: SYNTAX AND AGE-OF-ACQUISITION AFFECT READING TIMES

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Very little is known about the way deaf signers process written language (Emmorey, 2002). Deaf signers who learn to read English do so with limited knowledge of the phonology, lexicon and morphosyntax of English. Nonetheless, some deaf signers acquire a high degree of skill reading English. The goals of our study were twofold.

First, we investigated whether the age of acquisition of American Sign Language (ASL) is related to English reading ability (Mayberry & Lock, 2003) for English sentences that have different syntactic structures in English versus ASL. We compared deaf readers who differed in age of first exposure to ASL: 22 native signers, 24 "early" signers (who began to acquire sign language in elementary school and before puberty), and 22 "late" signers (who began to acquire sign language after puberty). Second, we investigated whether deaf signers respond to syntactic properties of written English sentences the same way native speakers of English do.

We tested these hypotheses in three self-paced reading experiments. In the first and second experiments, deaf signers read sentences containing subject-relative and object-relative clauses, such as those in (1a)-(1b) and (2a-2d) (Mak et al., 2002; Traxler et al., 2002, 2005). Hearing readers process object-relative clauses slower than subject-relative clauses, and the size of this difference is influenced by semantic factors. We used multi-level modeling to assess the effects of sentence type (e.g., object-relative vs. subject-relative sentences) and group (native vs. early vs. late signers) on reading times.

In Experiment 1, in which the sentences had semantically reversible nouns in critical positions, native signers showed a trend toward the frequently-obtained object-relative penalty during processing of the relative clause (t (21) = 1.73, p < .1); but early and late signers did not.

In Experiment 2, in which sentences had semantically distinct nouns in critical positions, analyses including participants from all three groups showed the usual object-relative penalty (t(67) = 3.1, p < .001); and each participant group showed the object relative penalty when analyzed separately. In addition, animacy of the subject noun and clause type interacted (t (67) = 2.43, p < .02). The interaction occurred because having an inanimate subject noun reduced the size of the object relative penalty, as has been previously documented in native English speakers.

Experiment 3 involved the reading of active and passive sentences, such as those in 3a-b. Deaf signers read the object noun phrase faster in passive sentences than in active sentences, most likely reflecting increased predictability of that constituent in passive sentences.

In all three experiments, average reading times, regardless of sentence type, differed by group. Native signers had the fastest reading times overall, early signers read more slowly, and late signers read slowest. These results indicate that deaf readers respond to some aspects of English much the same as native speakers do, that they read faster when constituents are predictable, and that reading skill correlates with age of onset of learning sign language.

1a. The lawyer that phoned the banker filed a suit.
1b. The lawyer that the banker phoned filed a suit.
2a. The director that watched the movie won an award.
2b. The director that the movie pleased won an award.
2c. The movie that pleased the director won an award.
2d. The movie that the director watched won an award.
3a. The farmer tricked the cowboy into selling the horse.
3b. The farmer was tricked by the cowboy into selling the horse.

Uniform Information Density (UID; LevyJaeger06), a recent information-theoretical account of sentence production, holds that speakers structure their utterances in order to maintain a uniform rate of information transmission. Initial evidence for speakers’ sensitivity to information density comes from various levels of structure, including pronunciation weakening, syllable/word reduction, and optional that-insertion. These findings have so far been restricted almost solely to English. We present the first evidence for UID from a language of a radically different structural type, Yucatec (Maya), a verb initial, polysynthetic language of Mexico. Yucatec possesses a morphosyntactic variation of a type not previously investigated experimentally. In revealing effects of UID in this domain, our experiments not only amplify the cross-linguistic relevance of UID, but also contribute more generally to the urgent task of expanding the typological base of psycholinguistics (ChristiansonFerreira05).

We used Yucatec relative clause production to test UID. For the onset of subject relatives (RCs), speakers can choose between a synthetic (inflected) verb form, or a reduced form without such morphology. UID predicts that speakers prefer the reduced form, the less information the RC onset carries (and hence the more probable the RC). Both experiments were analyzed using mixed logit regression (w/ speaker & item random effects).

Experiment 1 (31 subjects, 24 items, 32 fillers) employed a recall paradigm to compare RC production after universally quantified vs. definite vs. indefinite NPs: universally quantified and definite NPs have a higher probability of being modified by an RC than indefinite NPs for pragmatic reasons (cf. WasowETAL06). Participants heard a target item, followed by a distractor video description task. Then verb recall was cued aurally by the stimulus onset. Compared to indefinite NPs, speakers preferred the reduced form after definite NPs (β=2.1 p<0.0001) and universally quantified NPs (β=1.6 p<0.02). This conforms to the predictions of UID: the less probable the relative clause, the more likely speakers are to use the synthetic verb form.

Experiment 2 (28 subjects, 24 items, 32 fillers) replicated the effect using a different methodology and with a control condition. In a computer-based translation task, participants heard sentences in Spanish and translated them into Yucatec. We varied NP type (definite vs. indefinite) and dependency complexity (with an embedded complement clause or without). Dependency minimization accounts (Hawkins04) predict that the reduced form is less likely with additional embedding. Indeed, the reduced form was less likely in the embedded compared to simple RCs (β=0.32; p<0.001). As predicted by UID, the reduced form was preferred after definite compared to indefinite NPs (β=2.3; p<0.01).

These results suggest that Yucatec speakers are sensitive to information density at the morphosyntactic level, thereby extending the documented effects of UID to a language and a variation type radically different from any previously investigated. It also reveals morphosyntactic reduction in Yucatec to be conditioned by dependency complexity, as predicted by Dependency Minimization. Perhaps most crucially, these experiments contribute to the emerging interdisciplinary enterprise of field-based psycholinguistics (ChristiansonFerreira05) and the expansion of the typological base of psycholinguistics (Hawkins07).
THE ROLE OF GRAMMATICAL ROLE ASSIGNMENT IN PRODUCTION IN THREE LANGUAGES

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Speakers’ choices of active object relative (The book that the woman is holding) or passive relative (The book that is being held by the woman) vary with the animacy of the head noun (e.g., book, Gennari & MacDonald, 2009). This result might reflect a role for animacy in grammatical role assignment (functional processing) in production planning, but it could also stem from animacy effects on surface word order (positional processing). We investigated these alternatives using Japanese and Korean, which both have head-final relative clauses with identical word order in object relatives and passive relatives. Moreover, Korean has a restriction on passives which provides an opportunity to examine active and passive structure choice in two syntactically similar languages that vary in structure preferences.

Experiment 1a used a picture-based relative clause production task with English speakers. Participants (N=18) answered questions (such as "what is orange?") presented auditorily about color illustrations that contained humans acting upon human and inanimate entities. The pictures depicted several people and objects, so participants often used relative clauses in their responses. Questions about inanimate entities elicited a mix of active object relatives (The toy that the girl is hugging) and passive relatives (The toy that’s being hugged by the girl). Animate: 98.6% passive; Inanimate: 52.6% passive.

Experiments 1b-c used identical pictures and methods to test relative clause production in Japanese and Korean. Both Japanese (N=18) and Korean (N=17) speakers produced more passive relatives to animate than inanimate targets (Japanese: Animate: 99.4%, Inanimate: 27.3%; Korean: Animate: 65.2%, Inanimate: 9.6%). All languages showed a reliable effect of animacy. Further, there was a reliable language-by-animacy interaction.

To understand the animacy effect even in the absence of word order variation, we investigated the role of topicalization (a known factor in passive usage) on structure choice in Experiments 2a-c. Participants (English, Japanese, N=12; Korean, N=10) saw pictures of simple actions (a girl hugging a man; a girl hugging a toy) and answered questions that topicalized the patient/theme, such as “Tell me about the man (animate)/toy (inanimate).” In the proportion of passives in main clauses (The man is being hugged by the girl), the relative effects of animacy of language showed a similar pattern to RC productions (English: Animate: 96.5%, Inanimate: 97.3%; Japanese: Animate: 96.4%, Inanimate: 74.8%; Korean: Animate: 76.3%, Inanimate 66.5%). Thus animacy affects structure choice in all languages, but what differs is the extent to which each language necessitates that topics are assigned subject grammatical roles.

The Experiment 1-2 data can be interpreted as a choice of grammatical role assignment rather than noun or word order. This is particularly clear given that word order but not grammatical role assignment is identical in actives/passives in Japanese and Korean. The results also show that grammatical role assignment is itself quite complex. Lexical factors like animacy and discourse factors like topic status jointly affect role assignment, with language-specific patterns that bias the extent to which these factors contribute to structure choice. Investigation of these factors without word order variation is an important step in understanding early stages of grammatical encoding in production.

THE INFLUENCE OF TOPICALITY ON CHINESE WORD ORDER PROCESSING

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The recent literature has shown that Chinese, like all other languages hitherto examined, shows a “subject-preference” – i.e. the tendency to analyze an initial ambiguous argument as a subject (actor) – in simple sentences with NP-V order (i.e. SV is preferred over OV) [1]. However, word order in Chinese is often described as pragmatically-driven, with the sentence-initial position viewed as a topic rather than a subject position [cf. 2]. The observed subject-preference may therefore have been influenced by the default association between topics and subjects. The present ERP study aimed to examine whether a subject-preference is still observable in Chinese when the initial argument is not topicalized by the context.

The critical sentence conditions are illustrated below. While the basic word order in Chinese is SVO, OV is also possible (either as the result of topicalizing O or focusing O). In the present study, initial NPs were always ambiguous between a subject and an object reading. Because Chinese lacks grammatical means of disambiguation such as case or agreement, disambiguation was effected at the verb via an animacy restriction (i.e. in condition (a), verbs required an animate subject but the initial NP was inanimate). The subject-initial control (SV) is shown in (b). Both critical conditions (a, b) were embedded in topicalizing contexts (1) and (2), such that initial NPs were either topicalized/given (1a, 2b) or not topicalized/new (1b, 2a). These manipulations allowed us to examine whether a topic context influences the sentence-internal subject-preference.

Twenty-seven native speakers of Mandarin Chinese (Beijing dialect) participated in the experiment. The sentences were presented auditorily to underscore the dialogue-like nature of the critical question-answer pairs. For the initial NP, ERPs revealed an interaction of topicality and animacy: a posterior negativity (350-600 ms) for new vs. given NPs was observable in both contexts, but more pronounced in an animate topic context (2a vs. 2b > 1b vs. 1a). We attribute this asymmetry to the preference for animate arguments to precede inanimate arguments, which is violated when an animate argument is given by the context, but the target sentence begins with an inanimate argument. At the position of the disambiguating verb, object- vs. subject-initial conditions showed a biphasic N400 – late positivity pattern in both contexts (i.e. 1a vs. 1b, 2a vs. 2b). Finally, an additional LAN was observed for the inanimate object-initial condition in an animate topic context (2a vs. 2b).

Our results suggest that a topic context cannot override the subject-preference in Chinese: the N400-late positivity for OV vs. SV was elicited independently of context (1a vs. 1b, 2a vs. 2b) (Note that the finding of an N400 is compatible with previous results [1]). In addition, this context induced an additional LAN at the position of the verb, presumably reflecting a disambiguation to a word order against both given-before-new and animate-before-inanimate preferences (2a vs. 2b). Hence, our results support a subject-preference during the processing of simple sentences in Chinese that is independent of the processing of information structure and expectations based on it.

Literal English translations of the critical Chinese sentence stimuli:

Contexts:
1. Inanimate topic: What is about the novel?
2. Animate topic: What is about the actor?

Target sentences:
   a. Inanimate Object-initial condition: Novel understood a little. (OV)
   b. Animate Subject-initial condition: Actor understood a little. (SV)
      [+ several additional control and filler conditions with various word orders]

References
ON THE PROCESSING OF LOCATIVE INVERSION IN CONTEXT

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In English locative inversion (henceforth: LI), the canonical surface ordering of subject and locative PP is swapped (cf. (1.b,d)). This marked word order instantiates a paradigmatic case of a syntactic reflex to pragmatic constraints. Accordingly, it has been subject to much syntactic and pragmatic theorizing (see e.g. Rochemont & Culicover, 1990; Bresnan, 1994; Birner, 1994; Levin & Rappaport-Hovav, 1995). The empirical claims made in favor of different analyses have so far been validated mostly on corpus data (see Birner, 1994; Levin & Rappaport-Hovav, 1995). These studies have identified as the pragmatic function of LI the need to have discourse-given information precede discourse-new information.

To our knowledge, these claims about the pragmatic source of LI have so far not been tested in psycholinguistic experiments. Given the evidence from a self-paced reading study on German locative PP-fronting (Hörnig et al., 2005) showing that the marked order PP-object < copula < subject in German is licensed in a context which renders the PP-object given and the subject new—licensing meaning that in such a context the marked order is preferred over its unmarked counterpart in terms of shorter RTs—we wanted to assess the contextual licensability of English LI by carrying out the German study in English.

The experiment was a spatial reasoning task in which participants read two premises (P1, P2; s. (1) below) describing the spatial arrangement of three objects in a self-paced sentence-wise fashion, and judged a pictorial conclusion for validity (given the premises). We tested 24 participants and 64 items. The critical variable was the P2 reading time. The design was 2 (WORD ORDER: S-V-PP vs. PP-V-S) x 2 (ANAPHOR: PP-object=anaphoric vs. PP-object=nonanaphoric). Given the German evidence and the theoretical claims made for English LI, we predicted an interaction of WORD ORDER and ANAPHOR: while the unmarked word order should be largely unaffected by ANAPHOR (1.a vs. 1c), a P2 with marked order should be processed significantly faster than its unmarked counterpart if the sentence-initial PP-object was anaphoric (discourse-given; condition 1.d), while it should be processed significantly slower if the PP-object was non-anaphoric (discourse-new; condition 1.b).

This prediction was borne out by the data. P2s with marked word order were found to be comprehended significantly faster than their unmarked variants if the context licensed the marked order by making it comply to a Given-New ordering. This result matches nicely with the findings obtained for PP-fronting in German (see Hörnig et al., 2005) which showed the same Given-New licensing pattern for the marked construction. Further evidence comes from a parallel English–German single-item study on the production of spatial relational assertions which showed that marked word order is preferred as a device for establishing a Given-New ordering. This preference was considerably stronger in German (6:1, marked:unmarked) than in English (1.5:1).

To summarize: whereas the production data suggest that English LI is more marked than German PP-fronting, the comprehension data do not corroborate such a difference in markedness. Despite being more marked, English LI can still be contextually licensed.

(1) a. P1: The bear is to the left of the duck./P2: The duck is to the left of the dog.
b. P1: To the left of the duck is the bear./P2: To the left of the dog is the duck.
c. P1: The duck is to the right of the bear./P2: The dog is to the right of the duck.
d. P1: To the right of the bear is the duck./P2: To the right of the dog is the duck.

DO YOU KNOW WHO THAT IS? REAL-WORLD REFERENCE AND COREFERENTIAL PROCESSING
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Readers establish mental representations of entities they encounter during discourse comprehension. Subsequent references to such entities are known as anaphors; the anaphors’ referents are known as antecedents. Establishing coreferential relations between anaphors and their antecedents is crucial to discourse comprehension. Successful coreferential processing allows comprehenders to track “who did what to whom”, facilitating the construction of an accurate discourse model; failure to establish coreference may result in ambiguity and comprehension failure. Many studies have been conducted to identify the factors that influence coreferential processing. The current study investigates a factor that has been largely ignored in most examinations of coreferential processing: the role of “real-world” reference.

In the example below, comprehenders must first establish reference for two characters in memory: Bill and John. Like most characters commonly used in experimental stimuli, Bill and John are more similar than they are different (they are both singular males). This poses a problem, because research has shown that processing difficulty can arise when potential antecedents are semantically similar. For example, sentence comprehension was impaired when two characters were established with the same type of noun phrase, with the greatest difficulty evident when two proper names are used (Gordon et al., 2001). Despite the fact that anaphors used in research rarely refer to actual people, objects or events, it is often the case that readers possess substantial semantic information about discourse entities. Consider the mental representation that might result if a comprehender knew that Bill was Bill Clinton, and John was John Travolta. For most readers, these names are associated with considerable information from long-term memory; at minimum, the resulting mental representations would be richer in semantic detail than would be the case if readers had no prior knowledge about them.

In the current study event-related potentials (ERPs) were recorded as participants read sentences that contained a pronominal anaphoric reference (either “she” or “he”); these anaphors contain important semantic information about the sex of their antecedent. When such pronouns mismatch their antecedents (e.g., “she” referring to a male) the result is a P600 effect (van Berkum et al., 2007), and evidence suggests that the amplitude of this effect is sensitive to multiple sources of information (Hammer et al., 2005). In order to investigate the influence of real-world information on coreferential processing, each trial began with an introductory statement identifying the entities in the subsequent sentence. Antecedent entities were either fictional or real, famous people. In addition, sentential pronouns either matched or mismatched their referents. Referentially failing anaphors elicited a P600 effect; this effect’s amplitude was significantly greater when sentence characters were real. Also, in congruent conditions we observed a P600-like effect to pronouns with fictional referents relative to real ones. Our results suggest that the presence of high-quality representations in a discourse model facilitates the processing of coherent coreference, and magnifies the processing penalty for referentially failing anaphors. These semantic P600 findings are consistent with others (Burkhardt, 2007) suggesting that the P600 effect may index discourse-level processes.

Example Introductions (semantically similar entities or semantically "richer" real-world entities)
FICTIONAL: Bill Smith and John Jones          FAMOUS: Bill Clinton and John Travolta

Example Target Sentence (pronoun matches/mismatches antecedent)
Bill handed John some tickets to a concert and he/she asked for nothing in return.

SEGMENTATION OF CHUNKS AND HIERARCHIES IN ARTIFICIAL GRAMMAR LEARNING TASK: A NEURO-BEHAVIORAL APPROACH

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One of the challenges newborns and language learners face in acquiring a language is to find meaningful boundaries in continuous speech, because speech rarely contains reliable acoustic cues for segmentation. Behavioral studies suggested that infants and adults readily learn statistical defined patterns in auditory input sequences (Saffran et al., 1996, 1999). ERP studies also provide neurophysiological evidences that ERP components reflect the process of online word segmentation and statistical learning (Sanders et al., 2002; Abla et al, 2008, 2009).

In the current study, to investigate the neural changes associated with chunk (segmentation) and improved performance in online artificial grammar learning (AGL), we have carried out an event-related potentials (ERPs) study during a new designed serial reaction-time task (SRT) in which we used a finite-state grammar stimuli and piano keyboard. AGL is a form of implicit learning (nondeclarative memory) that involves the nonconscious acquisition of rule-based knowledge (Gomez and Gerken, 1999).

Participants responded to a visual musical note (C, D, E, F, G, A, B, C5) by pressing MIDI-keyboard that was spatially corresponding. Unbeknownst to them, a recurring loop of ten grammatical strings was presented as repeated sequence per block. Grammatical strings were generated using finite-state grammar, each with 4 to 6 chunks and each chunk consisted of three musical notes. Nine blocks were presented in total, in which, first and seventh blocks were presented as random sequences while others as repeated grammar sequences.

Results showed that reaction times (RT) gradually decreased as the AGL learning blocks progressed and increased when it was switched to a random sequence, indicating that participants have acquired specific knowledge about the sequential regularities of the sequences. The RT decreased at medial and final positions of chunks, but increased in chunk-onset (initial position). Chunk-onset elicited larger ERP (P3) component at the window of 300–400 ms after stimulus onset over middle-frontal and -central scalp areas during grammar sequence, but not during random sequence. The P3 component was larger at the chunk-onset (low-predictable position) than the middle and final position (high-predictable) of chunk. This hierarchical structure of RT and ERP indicated a word segmentation (chunking) processes. The P3 amplitude elicited larger with more learning and were highly correlated with the RT across all blocks. The dipole sources of this learning-related ERP component indicated that the Cingulate cortex play an important role in implicit learning of hierarchical sequence.

Our result suggested that ERPs might more accurately reflect implicit learning and continuous change in knowledge, and provided neurophysiological evidence for online artificial grammar learning processes.

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THE EFFECT OF CONTEXT ON THE ONLINE PROCESSING OF NEGATION: AN EVENT-RELATED POTENTIAL STUDY

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Using event-related potentials (ERPs) Nieuwland and Kuperberg (2008) have shown that when an appropriate context for negation is used, false words rather than true words elicit a larger N400. This finding is contrary to previous negation results where no context was used (i.e., Fischler, 1983). This suggests that the context allows readers to relate the incoming words to the negation information immediately. However, it is still unclear what constitutes an appropriate context for processing negation. The current study explores what aspects of context are relevant for the processing of negation. Our hypothesis is that at least three factors contribute to the immediate processing of negation. First, whether the negated word is prominent in the discourse. Second, whether the negated word is related to “the implied set of likely worlds” and third, whether the use of negation adds new information.

Across three ERP studies participants listened to a five-sentence discourse context followed by one of six continuations that tease apart the correlated influence of prominence, the implied set of likely worlds and new information. For example, one context introduced a police dog who loved getting biscuits and had been trained to sniff out illegal goods. The dog recently helped the police seize a package and the context implies that the package did not contain explosives. The discourse context was followed by one of the following continuations:

The package didn’t contain:

a) biscuits as...
(not prominent, not in implied set, new information)

b) drugs as...
(prominent, in implied set, new information)

c) bombs as...
(prominent, was in implied set, old information)

d) pianos as...
(semantic anomaly: not prominent, not in implied set, not really new information)

-OR-

e) The package did contain drugs as...
(Affirmative control: prominent, in implied set, new information)

f) The package did contain bombs as…
(Affirmative control: prominent, in implied set, old information)

Overall our results support our hypothesis, when all three factors (prominence, in implied set and new information, (b)) are included in a context, the amplitude of the N400 to a negated word is equal to that of an affirmative sentence (e). However, unexpectedly the results also show that when the negated word reiterates previously implied information and therefore gives no new information (c), it is even easier to integrate than when it adds new information (b). When the negated word is not prominent and not on the implied set but is coherent (a) it is as difficult to integrate as a semantically anomalous word (d) and a discourse incoherent affirmative word (f), suggesting that the correlated factors of prominence and being in the implied set contribute to the immediate processing of negation. Overall this suggests that with a relevant context negation is not necessarily more difficult to process. Furthermore, at least three factors appear to be relevant; prominence, the implied set of likely worlds and new information.
THE IMPACT OF STRUCTURE AND MEANING ON SEQUENTIAL IMAGE COMPREHENSION

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Just as syntax allows us to differentiate coherent sentences from scrambled strings of words, the comprehension of sequential images must also use a cognitive system to distinguish a coherent narrative sequence from a random string of images. Such a structure in the graphic domain would parallel grammars in the other conceptual expressive modalities of verbal and manual languages. In a classic study of language comprehension, Marslen-Wilson et al. (1) demonstrated the online use of syntactic structure by measuring reaction times (RTs) as participants monitored for target words in (a) sentences with scrambled words, (b) sentences with syntax but no meaning (“Colorless green ideas…”) and (c) normal sentences. RTs decreased across these three conditions. In addition, RTs decreased across ordinal position in sentences with, but not without, syntax. These data suggested that syntactic structure offered a processing advantage beyond lexico-semantics that built over the course of a sentence. In an ERP study using similar stimuli (2), the amplitude of the N400 was larger to targets in scrambled and syntactic-only sentences than in normal sentences. These findings suggested that, at least in the absence of semantics, the presence of syntax was ineffective in reducing the amplitude of the N400 — a waveform sensitive to semantics. We conducted two analogous experiments to examine the effects of structure in processing sequential images.

Four types of novel 6-frame long comic strips were created (160 sets) using individual panels from Charles Schulz’s Peanuts: 1) Normal sequences with both narrative and meaning, 2) Semantic Only sequences with semantically related panels but no narrative, 3) Structural Only sequences featuring a narrative arc but no coherent meaning between panels, 4) Scrambled sequences of randomly-ordered panels. Structure in the strips used Cohn’s (3) model of visual narrative. In Experiment 1, participants monitored target panels (counterbalanced across conditions) as each sequence was presented one frame at a time (1500msec presentation, 300ms ISI). In Experiment 2, ERPs were measured at the same critical panels and, at the end of each sequence, participants judged whether or not it made sense.

In Experiment 1, RTs to monitor target panels were slowest in Scrambled sequences, intermediate in both Structural Only and Semantic Only sequences, and fastest in Normal sequences. In Experiment 2, the N400 to target panels was largest in both Scrambled and Structural Only sequences, intermediate in Semantic Only sequences and smallest in Normal sequences. Consistent with previous studies of image processing (4), this N400 effect had an anterior distribution. In addition, a decrement in the amplitude of the N400 was observed across ordinal position of panels only in the Normal sequences.

The results of Experiment 1 suggest that the semantics of individual panels and overall structure across panels each offer advantages to sequential image processing. Experiment 2 further suggests that the processing advantage offered by structure, in the absence of semantics, had little impact on reducing the N400. Taken together, these findings suggest that sequential image comprehension uses a global grammar that extends beyond semantic associations between individual frames. We suggest that the comprehension of graphic narrative is guided by an interaction between structure and meaning, akin to that between syntax and semantics in language.

I WOULD IF I COULD BUT I CAN’T: DIFFERENT TYPES OF NON-PROTOTYPICAL ACTOR ARGUMENTS ARE PROCESSED IN A QUALITATIVELY SIMILAR MANNER

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A current model of language comprehension, the extended Argument Dependency Model (eADM) [1,2] posits that sentence comprehension is driven by the processing system’s endeavour to unambiguously identify the participant primarily responsible for the state of affairs, the Actor. Increased competition for the Actor role renders processing more effortful and occurs, for example, when the Actor is low in prototypicality. It has been demonstrated for several languages (including German, English, Chinese and Tamil) that inanimate Actors engender an N400 effect in terms of event-related brain potentials (ERPs) and that this effect can be reduced neither to lexical differences between animates and inanimates nor to the infrequency of inanimate Actors (see [2] for an overview). Inanimate Actors are non-prototypical because inanimate entities are principally incompatible with the Actor properties sentience and volition [3]. It is not clear from previous research, however, whether similar non-prototypicality effects arise when the Actor is animate and hence potentially optimal, but identified as non-volitional in the situation being described.

To examine this question, the present auditory ERP study contrasted sentences involving inanimate Actors and animate but dative-marked Actors in Tamil. In addition to marking indirect objects, dative case can mark subjects (Actors) in Tamil with a particular class of stative verbs describing psychological states (e.g. to be pleasing to, to know). Here, the dative Actor argument is an Experiencer and therefore non-volitional and reduced in prototypicality.

Thirty native speakers of Tamil listened to question-answer pairs such as those in examples (1/2) and answered comprehension questions about them. The context questions ensured that dative arguments would be interpreted as Actors rather than as indirect objects. All sentence types were also presented in neutral contexts. Furthermore, the critical dialogues were interspersed with a range of fillers including intransitive and pro-drop sentences and sentences with dative indirect objects.

ERP results revealed N400 effects for dative-marked Actors and for inanimate Actors. For the datives, the effect was only observable in a specific context, i.e. when the Actor status of the dative was clear from the context. For the inanimates, the effect was present in both neutral and specific contexts, but more pronounced in a neutral context. Furthermore, and as in previous studies, the inanimacy effect was strongest at NP2. At this point the Actor status of the inanimate NP becomes clear; in the Tamil case system, an inanimate nominative NP1 could also be the only argument of an intransitive verb or a transitive (non-specific) Undergoer. Crucially, the position effect shows that the N400 cannot be due to lexical differences between animates and inanimates.

We conclude that Actors that are principally incompatible with prototypical Actorhood (inanimates) are processed in a qualitatively similar manner to Actors that are flagged as non-prototypical by their dative case marking. This finding supports the eADM’s notion of Actorhood as a cluster concept which is subject to influences from a range of sources including semantic prominence features (e.g. animacy) and morphological case marking.

(1) a. Yaːrakkːu yaːrai theriyum? (Specific) / Sollavandhadhai surukkamaːga sol! (Neutral)
   Who-DAT who-ACC knows? (Who knows whom?) / Say what you wanted to briefly!
   b. Shankarukku Guruvai theriyum.

(2) a. Edhu yaːrai ezhuppiyadhu’? (Specific) / (Neutral context as above.)
   What-NOM who-ACC woke up? (What woke up whom?) / Say what you wanted...
   b. Vel.ichcham Guruvai yezhuppiyadhu.
      Brightness-NOM Guru-ACC woke up. => Brightness woke Guru up.

WHEN DISAGREEMENT IS GRAMMATICAL: ERP CORRELATES OF UNAGREEMENT IN SPANISH

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Agreement is a relation holding between two constituents with identical feature specifications. Cross-linguistically, agreement constructions are however found in which a featural mismatch between subject and verb is allowed. In this study we focus on one such phenomenon in Spanish – Unagreement- in which the presence of a Person mismatch nonetheless produces a well-formed sentence, as in (1).

Unagreement’s relevance resides in the presence of a reversed checking procedure that permits the copying of the relevant Person information from verb to subject and the interpretation of the nominal as “We journalists”, ensuring the grammaticality of the sentence. Verbal Person shouldn’t be therefore regarded as a copy of nominal Person, but it may have an interpretable status (contra Chomsky, 1995).

Unagreement and truly anomalous sentences with Person and Number violations (respectively: El periodista3.sg escribiste2.sg/escribieron3.pl un articulo muy interesante/The journalist wrote a very interesting article) were compared to Control sentences (Los periodistas3.pl escribieron3.pl un articulo muy interesante/The journalists wrote a very interesting article). Twenty-five participants read a total of 240 stimuli (experimental and filler sentences) and expressed an acceptability judgment at the end of each sentence.

Between 300-500ms, both Unagreement and Person anomalies elicited a negativity whose maximum effect is in the left posterior areas, although in the second case the effect spreads also over central areas. Number violations instead elicited an anterior negativity. Between 500-800ms, Unagreement generated a less positive effect in centro-posterior areas, while Person anomalies elicited a P600 effect evident both in the posterior and anterior areas. The P600 effect for Number anomalies was instead posteriorly-distributed. Between 800-1000ms, no differences were found between Unagreement and Control, while the two violations produced a posteriorly-distributed P600, whose amplitude was significantly larger for the Person than for the Number violation.

The mechanisms operating in the comprehension of agreement may not be rigidly dependent on the asymmetrical relation assumed to exist between subject and verb, in terms of directionality of checking operations and interpretability of features. Unagreement may be initially parsed as ungrammatical, but the application of reverse Agree and the interpretation of Person on the verb may solve the conflict without triggering repair strategies. This seems to follow from the less positive effect found between 500-800ms, suggestive of the inhibition of a diagnosis process, and the absence of differences between Unagreement and Control between 800-1000ms. The differences in the topographical distribution of the effects indicate a Person-Number distinction that is associable to different interpretive properties for the two features. While Number is interpreted locally in relation to the numerosity of the nominal referent, Person needs to establish a link with the speech act participants’ representation (Sigurdsson, 2004), to which Person agreement makes reference (1stperson=Speaker, 2ndperson=Addressee, 3rdperson=neither of them). Different checking and diagnosis/repair mechanisms may thus follow for the two features, to comply with the different interpretive requirements imposed.

(1) Los periodistas escribimos un articulo muy interesante
    The journalists3.pl wrote1.pl an article very interesting
    "We journalists wrote a very interesting article"

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Two event-related brain potential (ERP) experiments were conducted to investigate whether syntactic processes are functionally prior to semantic processes, such that semantic interpretation can only occur after syntactic attachments have been made (for theoretical alternatives, see Boland, 1997; Ferreira & Clifton, 1986; Frazier, 1987; Frazier & Fodor, 1978; Frazier & Rayner, 1982; Friederici, 2002; Hagoort, 2003, 2005; Kuperberg, 2007; MacDonald et al., 1994; Townsend & Bever, 2001; Trueswell et al., 1994). Previous ERP studies in German and French have found that combined syntactic category and semantic violations, as in the German version of “The door lock was in the eaten”, elicit a left anterior negativity (LAN), followed by a P600, but no N400 effects (Friederici et al., 1999, 2004; Hahne & Friederici, 2002, Experiment 1; Hahne & Jescheniak, 2001; Isel et al., 2007), suggesting that failed syntactic category processing blocks the process of semantic integration. The present study investigated the functional primacy issue in Chinese, a non-Indo-European language with very limited inflections and no grammatical morphology marking syntactic category or syntactic features such as person, number, gender, case, and tense; these linguistic properties of Chinese have led to the conjecture that sentence comprehension in Chinese relies more on semantic analyses compared to Indo-European languages (e.g., Xu, 1997; see Li, 1998; Ye et al., 2006).

In both experiments, we found that semantic interpretation proceeded despite the impossibility of a well-formed syntactic analysis due to a wrong syntactic category. In Experiment 1, a yes/no comprehension question task was used and the critical sentences were either correct, semantically anomalous, syntactically anomalous, or both semantically and syntactically anomalous (see (1) for examples). We found an N400 difference at the critical words, which were not ambiguous as to syntactic category. There was a larger N400 in the combined violation (‘piano’) than in the single syntactic violation condition (‘knife’). This finding is inconsistent with earlier German and French studies showing that semantic integration does not proceed for words of the wrong syntactic category.

Experiment 2 used a 2 (correctness of syntax) by 2 (correctness of semantics) design, together with an overall acceptability judgment task, both of which were very similar to those used in earlier German and French studies. As in (2), semantic anomalies were realized by violating verb’s selectional restriction for its object, and syntactic category anomalies were realized by inserting the degree adverb hen (‘very’) immediately before the first object noun of the sentence. Semantic violations still evoked an N400, irrespective of a simultaneous syntactic category violation. Moreover, we observed a P600 effect that indexes a failure of syntactic analysis, for conditions containing syntactic anomalies (i.e., the combined violation conditions in both experiments and the single syntactic violation condition in Experiment 2).

We argue against processing models that do not allow for semantic integration of a word unless it can be grammatically attached to the developing phrase structure tree. Rather, language experience may modulate the mode of interplay between syntax and semantics.

(1) Li Wei|ba|xin bian de|yali|man man|di|xue/xie po/dao zi/gang qin|le|liang ge.
Wei Li|PREP|fresh|pears|slowly|peeled/intimidated/knife/piano|PERF|two.
Wei Li peeled/intimidated/knife/piano two fresh pears slowly.

(2) nu hai|mai/chi|le|(hen)|qun zi|he|shout ao.
girl|bought/ate|PERF|(very)|skirt|and|gloves.
The girl bought/ate a (very) skirt and gloves.

Note. PREP: preposition; PERF: perfective marker.
READING COMPOUND WORDS: DOES MORPHEME ORDER MATTER?

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The importance of maintaining the canonical reading order – that is, identifying words in the order they appear on the page during reading – has been the subject of considerable debate (Reichle, Liversedge, Pollatsek & Rayner, 2008; Kennedy & Pynte, 2009). A similar question can be applied to bimorphemic compound words: Does it matter which of the morphemes is identified first? It is possible that readers process compound words one morpheme at a time, in which case the early availability of information about the first morpheme should be critical for identifying the compound word. Alternatively, the compound might be processed as a whole, with both morphemes being identified in parallel. In this case, information about both morphemes would be needed at an early stage in processing. In a fully parallel account of compound word identification, the order in which information about the compounds is obtained might not even be relevant at an early processing stage. In order to investigate this question, we asked subjects to read compound words embedded in sentences while monitoring their eye movements. Using the boundary paradigm (Rayner, 1975), we manipulated the preview that subjects received of the compound word before they fixated it. In particular, the morpheme order of the preview was either normal (“cowboy”) or reversed (“boycow”). Additionally, we manipulated the preview availability for each of the morphemes separately. Preview was thus available for the first morpheme only (“cowtxg”), for the second morpheme only (“enzboy”) or for neither of the morphemes (“enztxg”, see Table 1 for an example sentence). We report three major findings: Firstly, there was an effect of morpheme order on gaze durations measured on the compound word, indicating that, as expected, readers obtained a greater preview benefit when the preview presented the morphemes in the correct order than when their order was reversed. Secondly, gaze durations on the compound word were influenced not only by preview availability for the first, but also for the second morpheme. Finally, and most importantly, the results show that readers are able to extract some morpheme information even from a reverse order preview. In summary, we show that readers obtain preview benefit from both constituents of a short compound word, even when the preview does not reflect the correct morpheme order. This indicates that while both morphemes seem to be processed in parallel, the order in which they are presented is important even at early processing stages.

Example item and display change procedure
Before readers fixate to the right of the invisible boundary (to the right of “infamous”):

<table>
<thead>
<tr>
<th>Correct morpheme order</th>
<th>Reverse morpheme order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morpheme 1 preview</td>
<td>Morpheme 1 preview</td>
</tr>
<tr>
<td>available</td>
<td>available</td>
</tr>
<tr>
<td>available</td>
<td>available</td>
</tr>
<tr>
<td>denied</td>
<td>denied</td>
</tr>
<tr>
<td>denied</td>
<td>denied</td>
</tr>
<tr>
<td>Morpheme 2 preview</td>
<td>Morpheme 2 preview</td>
</tr>
<tr>
<td>available</td>
<td>available</td>
</tr>
<tr>
<td>denied</td>
<td>denied</td>
</tr>
<tr>
<td>denied</td>
<td>denied</td>
</tr>
<tr>
<td>Example sentence</td>
<td>Example sentence</td>
</tr>
<tr>
<td>Everyone scattered as</td>
<td>Everyone scattered as</td>
</tr>
<tr>
<td>the infamous</td>
<td>cowboy drew his gun.</td>
</tr>
<tr>
<td>Everyone scattered as</td>
<td>Everyone scattered as</td>
</tr>
<tr>
<td>the infamous</td>
<td>enzboy drew his gun.</td>
</tr>
<tr>
<td>Everyone scattered as</td>
<td>Everyone scattered as</td>
</tr>
<tr>
<td>the infamous</td>
<td>txgenz drew his gun.</td>
</tr>
<tr>
<td>cowboy drew his gun.</td>
<td>enztxg drew his gun.</td>
</tr>
<tr>
<td>txgcow drew his gun.</td>
<td>boyenz drew his gun.</td>
</tr>
<tr>
<td>boycow drew his gun.</td>
<td>txgcow drew his gun.</td>
</tr>
<tr>
<td>Everyone scattered as</td>
<td>Everyone scattered as</td>
</tr>
<tr>
<td>the infamous</td>
<td>txgcow drew his gun.</td>
</tr>
<tr>
<td>Everyone scattered as</td>
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</tr>
<tr>
<td>the infamous</td>
<td>txgcow drew his gun.</td>
</tr>
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<td>Everyone scattered as</td>
<td>Everyone scattered as</td>
</tr>
<tr>
<td>the infamous</td>
<td>txgcow drew his gun.</td>
</tr>
</tbody>
</table>

After readers fixate to the right of the invisible boundary (to the right of “infamous”): Everyone scattered as the infamous| cowboy drew his gun.

References
IMMEDIATE OR DELAYED USE OF FRENCH GRAMMATICAL GENDER DURING ONLINE PRONOUN RESOLUTION: EVIDENCE FROM THE VISUAL WORLD

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Research has shown that we employ a variety of cues to establish pronoun reference including structural cues such as order of mention, as well as semantic and grammatical gender. The current research explores how and when native French speakers employ grammatical gender distinctions in order to establish pronoun reference. Although it has been shown that grammatical gender distinctions facilitate the resolution of pronouns with multiple potential referents (Garnham Oakhill Ehrlich & Carrières, 1995) some researchers have questioned at what stage gender information is used during this process (Greene, McKoon & Ratcliffe, 1995). Research by Arnold et al (2000) suggests that native speakers of English immediately and automatically use natural gender information and order of mention in order to identify pronoun referents during pronoun processing. Because natural gender information is potentially a more salient cue than grammatical gender, it is unclear whether grammatical gender, like natural gender, is used during the initial stages of pronoun resolution or whether it is employed at a later co-indexation stage.

The present studies employ a visual world paradigm in order to explore whether native French speakers automatically use grammatical gender information in order to establish pronoun reference. Experiment 1 employed a passive listening task that did not require participants to explicitly determine the referent of a pronoun. While viewing a corresponding visual scene, participants listened to an auditory discourse, as in (1) and (2), that introduced a character having a natural gender and an object having grammatical gender. Each discourse contained a pronoun that referred ambiguously, as in (2) or unambiguously, as in (1), to one of two potential referents. In this task, where participants were not required to make an overt decision about a pronoun’s referent, they made more frequent and longer looks at both potential referents than towards a distractor in the display. Crucially, there was no difference in the number or duration of fixations to the two potential referents in the ambiguous and unambiguous conditions. In Experiment 2, where participants were overtly asked to indicate the referent of the pronoun, their eye-movements rapidly converged on the first mentioned object in the ambiguous condition. In the unambiguous condition the number and duration of fixations was the same for the second mentioned entity that had the same grammatical gender as the pronoun AND the first mentioned referent that differed in gender from the pronoun. Results are consistent with a delayed use of grammatical gender during pronoun resolution. Furthermore, and in contrast with Hemforth (2009), results suggest a strong preference for first mentioned entities.

(1) Gender unambiguous
La rose a été plantée par Batman il y a environ un mois. Il est dans l’autre champ.
The rose(fem) was planted by Batman about a month ago. He is in the other field.

(2) Gender ambiguous
La rose a été plantée par Catwoman il y a environ un mois. Elle est dans l’autre champ.
The rose(fem) was planted by Catwoman about a month ago. She is in the other field.
VARIABLE BINDING AND COREFERENCE IN SENTENCE COMPREHENSION: EVIDENCE FROM EYE MOVEMENTS

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In linguistic theory it has been posited that the interpretation of pronouns such as he and she can be resolved in two distinct ways, either via a variable binding process assumed to occur in the syntax, or via coreference assignment in the discourse representation (Reuland 2001). Whereas variable binding is only possible between a pronoun and an antecedent that c-commands it, non c-commanding antecedents can only be linked to a pronoun via coreference. Therefore, in ‘Every man who saw James said that he was tired’, while every man c-commands the pronoun and can thus be linked to it through variable binding, the non c-commanding potential antecedent James can only be linked via coreference. Crucially for psycholinguistic investigation, syntactic variable binding relations are hypothesized to be checked before discourse-mediated coreference assignment (see Koornneef 2008).

We tested this hypothesis in an eye-movement experiment. 27 native English speakers (9 males, mean age 20.9) read 24 experimental and 60 filler texts whilst their eye movements were monitored. Experimental sentences contained a pronoun and two potential antecedents, a c-commanding quantified noun phrase (QP), and a non c-commanding proper name, as in (i). We manipulated the gender congruence (match vs. mismatch) between the pronoun and the two potential antecedents in a 2x2 design yielding four experimental conditions. Gender congruence for the coreference relation used proper names (James/Helen), while gender congruence between the pronoun and the QP used a pre-tested stereotypical gender manipulation (Every soldier… that he/she; see Sturt 2003).

(i) Every soldier who knew that James/Helen was watching was convinced that he/she should wave as the parade passed.

If variable binding relations are computed before discourse-based coreference relationships (Koornneef 2008, Reuland 2001), readers should initially link the pronoun to every soldier rather than the proper name. In this case, reading times at the pronoun should be longer when it mismatches the QP’s stereotypical gender in comparison to when there is a gender match. Our results failed to support this hypothesis. At both the pronoun and spill-over regions (that s/he and should wave respectively in (i)), we found reliable main effects of the gender of the proper name in a number of early and later eye-movement measures (all p1s < .05, all p2s < .05), with reading times being longer when the proper name mismatched the pronoun’s gender compared to when it did. No reliable main effects of the QP’s gender were observed in any measure, although numerical trends suggested that participants had most difficulty when there was potentially no gender matching antecedent in the discourse.

Our finding that participants initially linked the pronoun to the proper name rather than the QP is not compatible with the hypothesis that variable binding relations are computed before discourse-based coreference assignment. Instead, we interpret our findings as suggesting that the resolution of the pronoun-antecedent relations examined here may rely on discourse-based mechanisms rather than syntactic considerations (see e.g. Burkhardt 2005).

References


DIFFERENTIAL PROCESSING OF GRAMMATICAL GENDER IN A SENTENTIAL CONTEXT: EYE-TRACKING EVIDENCE FROM SPANISH MONOLINGUALS AND SPANISH-ENGLISH BILINGUALS

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It is well known that word recognition is affected by grammatical gender information on a preceding determiner or adjective. Lew-Williams & Fernald (2007) confirm this at the lexical level in Spanish in a Visual World study (VW; Tanenhaus et al., 1995). They presented Spanish speakers with 2-picture visual scenes with objects matched or mismatched in gender. On different gender trials, participants oriented their eyes towards target items more quickly than on same gender trials, demonstrating an anticipatory effect.

Most gender processing studies on comprehension have been conducted out of sentence context. Here, we investigate if the anticipatory effect occurs in sentential contexts during monolingual processing. Additionally, because the first language (L1) of bilinguals immersed in a second language (L2) has been shown to be affected by the L2 (Dussias, 2003), we ask whether bilinguals whose L1 has, but whose L2 lacks, grammatical gender are affected in the way they process gender in their L1. Following the design of Lew-Williams & Fernald, 16 Spanish monolinguals and 24 Spanish-English bilinguals listened to 28 sentences in Spanish. To encourage semantic and syntactic processing, participants were asked to provide plausibility judgments after each trial.

In our analysis, we adopt a change point analysis (Cudeck & Klebe, 2002). The timecourse of proportions of eye fixations was divided into 3 phases from target onsets: pre-convergence, convergence, and post-convergence. Our mixed-effects model fitted 3 linear regressions, calculating change points marking shifts in phase between regressions. The first signals the point when participants begin to converge on targets. This change point was then compared across conditions. Both the change point and y-intercept, i.e. baseline effects, were included as random effects, attenuating individual differences (Mirman et al., 2008).

Monolingual results replicated the anticipatory effect of Lew-Williams & Fernald. For feminine targets, same gender competitors yielded a change point of 290 ms; different gender competitors revealed a change point of 170 ms (p < .001). For masculine targets, same gender competitors elicited a change point of 256 ms, whereas different gender trials yielded a change point of 130 ms (p < .001).

However, bilingual participants only showed an anticipatory effect for feminine targets in different gender trials (a change point of 199 ms for different-gender trials compared to 315 ms for same gender trials; p < .001). The change points for masculine targets in same and different gender trials, 268 ms and 345 ms respectively, did not differ significantly (p > .05).

We interpret these differences as an effect of the L2 experience on L1 processing, indicating the permeability of the L1 system at the morpho-syntactic level. This interpretation is a possible combination of increased usage of masculine as the default article in Spanish-English code-switching or increased proficiency of English.
CONCEPTUAL-SEMANTIC INFORMATION IN THE RESOLUTION OF INDIRECT REFERENCE

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Despite the common assumption that a prototypical pronoun refers to the most salient explicitly given antecedent, explicit antecedents are not necessary and can many times be only implicit (e.g., the dialogue below). In such cases of indirect reference, the pronoun may be associated with an antecedent via inferential semantic relations or by relying on other cues such as its presence in the situation (e.g., Gundel et al., Language 1993; Yule, J Semantics 1982). Accessing such a referent can be smooth if the referent is a defining semantic argument of the central predicate in the discourse, while processing may be slowed down when the referent’s relation to the predicate is that of a means or an instrument (peripheral) (Cornish et al., JML 2005). However, it is unresolved at which point during the course of processing the referential link is established, and, importantly, whether the visual presence of antecedents could lead to facilitation when accessing (peripheral) referents. A self-paced listening and a visual world eye-tracking experiment were carried out to resolve these questions.

The self-paced listening experiment confirmed Cornish et al. (2005) results in spoken language comprehension: While reference to explicitly mentioned antecedents was smooth, implicit reference was unproblematic for nuclear, but not for peripheral referents. Importantly, the more detailed, segment-by-segment procedure used in this experiment (indicated for the critical region by “/” below) revealed that this effect appeared only on the past participle. That there was no difference between the conditions before this region suggests that comprehenders resolved the pronoun to explicitly mentioned, or, in the implicit case, to nuclear antecedents.

The visual world eye-tracking experiment investigated whether people would consider both nuclear and peripheral referents to the same extent if the referents were available in the visual environment. The visual scenes included four pictures: the protagonist of the action, the central referent, the peripheral referent, and a distracter. Analyses from pronoun onset on revealed that participants looked more at explicitly mentioned antecedents, and, in the implicit case, more at central than at peripheral antecedents. This interaction suggests that the visual presence of referents did not affect the processing preferences observed in self-paced listening. Moreover, a main effect of centrality showed that central referents were looked at more, even in the explicit cases.

The results showed that reference resolution can go on smoothly despite the absence of an explicit antecedent: a delay occurred only when the referent was not directly related to the event at hand. The delay occurred only after decisive semantic information became available; and, even when the referent was available in the visual context. The importance of conceptual-semantic information was further highlighted by the fact that peripheral referents were activated later regardless of prior mention and visual presence.

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NUCLEAR

***EXPLICIT ANTECEDENT***

Der Feuerwehrmann hat gestern ganze Arbeit geleistet.

Das Feuer war schnell gelöscht. Er musste all die Arbeit allein tun.

***IMPLICIT ANTECEDENT***

Speaker A

Speaker B

Hat er / es / wirklich allein so zügig / gelöscht / ist das möglich?

Speaker A

Ja, das hat er! Er war danach sehr erschöpft.

PERIPHERAL

Speaker A

Er kam mit dem Feuerwehrauto. Er musste all die Arbeit allein tun.

Speaker B

Hat er / es / wirklich allein so zügig / vorgefahren / ist das möglich?
REVISITING ADULT NEW WORD LEARNING: ACRONYMS, BLENDS, DERIVATIONS, AND THE PARTY EFFECT

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Various factors influence how new words are processed and remembered by adult speakers. Previous work (Markson & Bloom 2001; Dumay & Gaskell 2007) examines how adults remember monomorphemic words. However, our survey of new words in Urban Dictionary (urbandictionary.com) suggests that adults often encounter morphologically complex words, in the form of derivations (base + affix) and initially transparent blends and acronyms, inter alia. In addition to morphological structure, speakers’ attitudes about new words, such as a word’s perceived utility, could play a role in memory retention. This study finds that both speaker attitudes and morphological structure influence memory retention of new words.

We ran a combined lexical decision and eye-tracking experiment with actual new acronyms, blends, and derivations taken from websites, media outlets, and television. A norming study determined that participants were unlikely to have seen these words beforehand. In the learning phase, participants were familiarized with the new words; this included responding to questions about a word’s perceived utility (Corbin 1987), emotional content (Kensinger & Corkin 2003), humor, and register. The testing phase of the study investigated how the new words were read and to what extent they were recalled. For half of the participants, testing occurred after one night’s sleep, allowing us to examine the consolidation of new words into long-term memory.

We fit mixed-effects models for reaction time (RT), lexical decision accuracy, number of fixations, number of regressions, and free recall. Control variables included participant sex, age, and education level, word length, and frequencies of initial component words. Although shorter in length overall, acronyms took significantly longer than blends or derivations to read, and decision accuracy for acronyms was significantly lower than for blends and derivations. Both groups of participants fared worse on acronyms, as an intervening night’s sleep significantly shortened RTs for only blends and derivations. No significant difference between blends and derivations appeared in any dependent variable. Furthermore, the only significant attitudinal question that was consistently significant was, “Would you use this word at a party with your friends?” The more participants said they would use a new word at a party, the shorter their RT and the better their accuracy and free recall. Hypothetical use in other social contexts like “at work or school” was only a significant predictor for free recall. Although derivations with prefixes did not take significantly longer to process than suffixed derivations, there were significantly more regressions to prefix areas than to suffix areas. However, the overall number of regressions was not significantly different in prefixed and suffixed words.

These findings suggest that morphological structure is important when processing new words, and that speakers attend to the distinction between base and affix when processing new derivations. From these results, it can be concluded that adults employ domain-specific knowledge when presented with new, morphologically complex words. The findings concerning speaker attitudes highlight the importance of social context in remembering – and perhaps producing – new lexical items. “The party effect” could be an exciting link between individual cognitive entrenchment and in-group linguistic preferences.

A growing number of recent studies have demonstrated that conversational implicatures are accessed in incremental interpretation [1-3]. Quantity implicatures (QIs) are of particular interest, as where (1a) can be understood to imply (1b) or (2a), (2b) in certain contexts (e.g. as in II below).

A sample Gricean derivation for (2b) is given in (I-V) below:

I. For all (2a) means, John could have put many other things on the shelf.
II. Given that the speaker is telling me what John put on the shelf and that he gives as much information as is relevant (subject to his epistemic abilities and preferences),...
III. this must be all the speaker knows on the question.
IV. The speaker knows the full answer to the question
V. (2b)

Although popular, this account of QIs has been challenged [4-5] and has been questioned as the basis for on-line access of implicatures, given the supposed complexity of the reasoning and the rapidity of effects that have been found [6]. In previous research, we establish that QIs like (2) are accessed on-line in virtue of passing through step II above. In this paper we use a novel interactive communication paradigm to show that QIs as in (2) are only derived where IV can be assumed- the so-called epistemic step.

We report an interactive visual world study, where two communicators watched short videos on separate computer monitors and subsequently described the events to each other. Videos depicted a series of transfer events, where an actor moved objects (e.g. spoons and forks) into one of two boxes (labelled A and B). We tracked ‘listeners’ eye-movements around the final visual scene, time-locked to related auditory descriptions provided by the ‘speaker’ (confederate). For example, in target items, videos showed the actor move a spoon into one box and another spoon into the other box, pause and then move a fork into just one of the boxes; the speaker’s description would then begin: ‘The man put a spoon into box...’. Critically, on half the trials a screen blocked the speakers’ (but not the listeners’) view at the pause point in the video; therefore establishing different levels of knowledge for the two communicators. Both communicators were explicitly aware of this manipulation.

Analysis of the baseline condition (where communicators shared knowledge of events) revealed that following the object offset (‘spoon’), listeners’ anticipatory eye-movements showed a significant bias to the appropriate single-object box (i.e. box containing only a spoon) [t>2.69, p<.01]. This suggests that participants have rapidly integrated the QI. In contrast, in the ignorance condition (where the listener held privileged knowledge of events), no significant bias between single- and double- (box containing both a spoon and a fork) object boxes was found [t<1.78, p>.08]. We will argue that this finding adds support to the view that on-line pragmatic effects can be the result of full Gricean reasoning about speakers’ intentions in context, but does not fit with accounts proposed in [4] and [5].

1. a. John ate some of the cookies
   b. John did not eat all of the cookies
2. a. John put a book on the shelf
   b. John put nothing else on the shelf

BILINGUAL VISUAL WORD RECOGNITION IN A SENTENCE CONTEXT

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Recent research on bilingualism has shown that lexical access in isolated visual word recognition by bilinguals is not selective with respect to language. In this series of experiments, we investigated whether non-selective lexical access also occurs when bilinguals are reading sentences, which constitutes a strong unilingual linguistic context. In the first study, we investigated second-language (L2) sentence reading by Dutch–English bilinguals in an eyetracking paradigm. Results revealed that bilinguals were faster to recognize cognate words (i.e. translation equivalents that are similar in form, e.g., banaan–banana), even when these words were presented in sentences. In the second study, we investigated language selectivity of lexical access in the same population of bilinguals reading sentences in the native language (L1). Again, a cognate effect was obtained in eyetracking times: bilinguals showed shorter fixation durations for L1 words that have form-similar L2 translations. This cognate effect became stronger as the degree of orthographic overlap between translation equivalents increased (i.e. a larger cognate effect for banaan than for donder [thunder]). In the third eyetracking study, we investigated Dutch–English bilinguals reading L2 sentences that semantically constrained towards the same cognate target words (e.g. Salsa has become a popular dance [Dutch: dans] in Belgium). Again, fixation times showed a cognate effect. Together, these results suggest that the linguistic and semantic contexts provided by sentences do not nullify cross-lingual lexical interactions during early visual word recognition by bilinguals, even if those bilinguals are reading in their native language. As such, these findings support bilingual models of visual word recognition in which lexical access is not language-selective and in which cross-lingual interactions are only weakly affected by top-down factors. These results are interpreted within the BIA+ (Bilingual Interactive Activation) model of Dijkstra and colleagues (Dijkstra & Van Heuven, 2002).

A DIFFICULT MOUNTAIN: COERCION IN THE INTERPRETATION OF NOUN PHRASES.

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There is now ample evidence that complement coercion, in which an aspectual verb like begin is paired with a non-event denoting complement like book, requires extra processing (for an overview, see Frisson & McElree, 2008). There is also good evidence that this cost reflects the employment of enriched compositional operations which allows the complement to be interpreted as an event, as in began [reading the book], rather than the time needed to retrieve or infer an appropriate activity, to select an activity amongst several, to resolve competition between alternative interpretations, or to access a deferred interpretation (McElree et al., 2006a). A related effect is found for adjectival predicates when the adjective is derived from event-selecting verbs (McElree et al., 2006b; Pylkkänen et al., 2009). For example, in small clause constructions such as The climber imagined the fall/ice survivable, the adjective survivable appears to semantically require an eventive subject NP. Hence, a subject NP that does not denote an event, e.g. the ice, should be more costly to process than one that does, e.g. the fall, because it must be coerced into a plausible event (e.g., “climbing of the ice”). Supporting this account, both behavioural (McElree et al, 2006b) and neural (Pylkkänen et al., 2009) data showed increased processing costs for non-eventive versus eventive subject NPs.

All of the cases of enriched composition investigated to date, including other work on aspectual coercion (Pickering et al., 2006) and concealed questions (Harris, et al., 2008), have focused on clause-level interpretations. However, one might expect that similar compositional operations might be required at the phrasal level. We investigated adjective-noun combinations in which an NP-internal adjective was hypothesized to trigger an eventive interpretation of an otherwise non-event denoting noun.

The adjective difficult selects for an event. In (1), the noun does not refer to an event, so coercion may be necessary to arrive at a satisfactory interpretation involving an event. If true, (1) should be more difficult to process than (2) where the noun denotes an event, because an appropriate activity (e.g., climb) must be selected and incorporated into the semantic interpretation of the NP, e.g., difficult [to climb] mountain.

(1) The athlete is convinced that the difficult mountain will require all his strengths...

(2) The athlete is convinced that the difficult exercise will require all his strengths...

This is indeed what was found in an eye-tracking experiment involving 36 participants and 20 items like (1) and (2). The items were controlled for length, frequency, and acceptability. Results showed a relatively early first-pass regression effect on the spillover region (will require), with more regressions following a coercive adjective-noun combination (difficult mountain) compared to the non-coercive combination (difficult exercise). Regression-path durations on the spillover region were also longer for the coerced construction. The noun region showed similar effects in second pass duration and total percentage of regressions into this region.

The results are consistent with those found with adjectival predicates and suggest further that similar enriched compositional operations are operative at the phrasal level.

**CONVERGING NEURAL EVIDENCE FOR STRATEGIC DECISION-MAKING DURING RESOLUTION OF PRONOUN REFERENCE**

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Pronouns are extraordinarily frequent, yet little is known about the neural mechanisms that support resolving a pronoun’s referent. We propose a two-component model for pronoun resolution in a discourse like “The client chased the king. She ran”. First, a core language network is required to support the identification of semantic gender information of a noun (e.g., “king” must be male?) and syntactic positional bias information (e.g., Is the subject or object the preferred referent?). Middle temporal cortex (MTC) has been implicated for evaluating grammatical gender and inferior frontal cortex (IFC) for evaluating positional information. Second, a strategic decision-making network is required to support probabilistic (e.g., Is “client” a male or female) and risk-related (e.g., choosing “client” is risky because its gender is not obvious) mechanisms. Dorsolateral prefrontal cortex (dlPFC) has been implicated as a probability mechanism and orbitofrontal cortex (OFC) as a mechanism involved in evaluating risk. We hypothesized that IFC and MTC will be recruited to support core language processes and dlPFC and OFC will be recruited to support decision-making demands for resolving a pronoun’s referent.

In Experiment 1, an fMRI study, young adults (n=16) were presented with 200 sentence pairs, including two nouns and one pronoun; participants identified each pronoun’s referent. Nouns were biased by definition for one gender (e.g., “king” must be male) or gender-neutral (e.g., “client” is equally male or female) according to pretest norms. Sentences were generated using pairs of nouns that yielded a Directly-Determined (1), an Indirectly-Determined (2), a Partially-Determined (3), or an Undetermined (4) referent. All conditions relative to Directly-Determined baseline revealed IFC and MTC activation, consistent with a core language network. In Underdetermined sentences, when the probability of a gender of a gender-neutral noun (e.g., “client”) must be evaluated, we observed dlPFC activation. In Indirectly-Determined sentences, when a gender-neutral noun must be selected because the definitionally-gendered noun is incorrect, we observed OFC activation, consistent with the risk of choosing a gender-neutral referent for a gender-biased pronoun.

In Experiment 2, the same stimulus materials were presented to behavioral-variant frontotemporal degeneration (bvFTD) patients (n=9) who have mental flexibility limitations but no aphasia due to dlPFC disease, and healthy seniors (WNL; n=14). For Directly-Determined items, bvFTD are less accurate for pronouns referring to the object than the subject position [t(8)=2.33, p<0.05]. For Partially-Determined items when a gender-biased noun is in the object position, bvFTD select the subject noun (24% of responses) more than WNL (5%; t(21)=2.84, p<0.01]. bvFTD thus appear to rely on positional bias information more than WNL. We also evaluated Oral Trails performance, a task requiring mental flexibility, in bvFTD and observed a correlation with the proportion of subject-noun responses(r=-0.70, p<0.05): degraded mental flexibility results in increased subject-noun choices.

These findings are consistent with our hypothesized large-scale neural network that integrates core linguistic and decision-making information to resolve a pronoun’s referent.

Sample Stimulus Materials:
(1) Directly Determined: “The king chased the nun. She cried”
(2) Indirectly Determined: “The king chased the client. She cried”
(3) Partially Determined: “The king chased the client. He cried”;
(4) Underdetermined: “The client chased the visitor. She cried”.

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Sample Stimulus Materials:
(1) Directly Determined: “The king chased the nun. She cried”
(2) Indirectly Determined: “The king chased the client. She cried”
(3) Partially Determined: “The king chased the client. He cried”;
(4) Underdetermined: “The client chased the visitor. She cried”.
EXPERIENCE-DRIVEN SIMULATIONS OF EYE GUIDANCE IN READING
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Although current models of eye movement control in reading include parameters that are fitted to empirical eye-tracking data, the influence of experience on eye movements has not generally been a focus of attention. We consider a novel approach to modeling eye movements in reading where saccadic decisions are mediated by experience. This approach assumes that eye movement control relies on cognitive and neural processes to effectively assess and combine information in the present context with past experience in deciding where to move the eyes. In this context, we employ supervised learning methods to learn the saccadic eye movements of individual readers based on samples of their reading behavior. Thus, we present a model that predicts the pattern of eye movements of an individual reader reading a specific text, using as training data the eye-tracking record for the same person reading other texts. Specifically, the current model is based on three components: (i) a transition-based system for representing saccadic eye movements; (ii) a log-linear classifier that predicts the next saccade target; and (iii) a search algorithm driven by the classifier to derive complete fixation sequences over sentences.

In a first series of simulations the model is trained on data from ten different readers and evaluated with respect to its performance in simulating the eye movements of each reader when reading previously unseen text. In these simulations, the selection of the next fixation target is based on a small set of relatively low-level features such as the length and frequency of words in the perceptual span. We show that for each of the ten readers, the model performs significantly better than a simple baseline (p < 0.05, paired t-test). In a second series, we show that these results can be improved by enriching the feature space with higher-level lexical and syntactic features. In particular, classifier decisions are now additionally based on part-of-speech, bigram frequency and parsing cost quantified in terms of syntactic surprisal (Hale, 2001). We show that the advanced model adapts well to the fixation distributions of individual readers, improves significantly over the previous model (p < 0.05, paired t-test), and importantly, produces lexical frequency effects on eye movements similar to human readers. In the final simulation series, we consider whether it is possible to train general models that apply across multiple readers, including readers who are not part of the training data. Intuitively, we evaluate how well, on average, the model predicts the saccadic behavior of a given reader that was left out during training. It is shown that error rates do not increase when training such cross-reader classifiers compared to when training reader-specific classifiers.

In sum, we present a model of saccade behavior in reading that combines low-and higher-level features in an experience-driven account of saccade target selection. The model applies individually and across readers, a result that illustrates its potential use in revealing individual differences as well as more general, reader-independent characteristics of saccadic eye movements in reading.

TEASING APART STRUCTURE-BUILDING AND SEMANTIC COMPOSITION DURING STORY-READIN

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Introduction: Sentence comprehension involves a host of highly interrelated processes, including syntactic parsing, semantic composition, and pragmatic inferencing. In neuroimaging, a primary paradigm for examining the brain basis of sentence-level processing has been to compare brain activity elicited by word lists vs. sentences (e.g. 1, 2). These studies find a focal effect of increased activity for sentence processing in the anterior temporal lobe. These focal results are, however, unexpected given the variety of computations engaged during sentence comprehension. We first examined whether a broader network of regions could be identified for the sentence vs. word list contrast using magnetoencephalography (MEG), the temporal resolution of which better matches the rapidity of language processing. We then aimed to distinguish the sub-computations associated with observed activity using a novel approach to dissociating syntax and semantics. Linguistic compositionality forces a tight relationship between structure-building and semantic composition, making it extremely difficult to tease apart these two operations. We hypothesized that syntactic and semantic structures may be incrementally built at different rates during comprehension (cf. 3). Assuming that semantic rules apply only after sufficient structural information is available, there is a dissociation in the number of syntactic and semantic operations engaged word-by-word. Although not a necessary property of the human parser, this plausible dissociation provides a novel and intriguing approach to distinguishing these computations in the brain.

Methods: Nine participants were presented with a story using RSVP during MEG recording. In a block design, participants also saw the same words presented in pseudo-randomized lists. Subjects answered comprehension (story) or recall (lists) questions periodically during the experimental blocks to assess attention. We employed a cortically constrained distributed source model to estimate brain activity in 13 anatomically defined left hemisphere ROIs.

Results, Sentences vs. Lists: Data for 3-6 character open-class words were averaged within subjects and activity from 100-600ms after stimulus onset was compared. Increased activation for the story condition was found in Broca’s region, the superior temporal and anterior middle temporal gyri, superior temporal sulcus, and orbitofrontal cortex (adjusting for multiple comparisons using simulation).

Results, Syntax vs. Semantics: Our second analysis focused on preposition phrases where a standard syntactic and semantic analysis (e.g. 4) using a context-free grammar could be straightforwardly applied. We modeled incremental parsing using a left-corner algorithm (5) in which syntactic and semantic rules were interleaved (3). Correlating the predictions of this parser with word-by-word single-trial data showed that the application of syntactic rules correlated with activity in the superior temporal sulcus, and semantic composition rules with the orbitofrontal cortex, consistent with recent work on semantic processing (6).

Summary: Using MEG, we identified a broad network of regions associated with sentence level processing. We then used a novel approach to distinguishing highly correlated sentence-level processes (syntactic vs. semantic composition) during reading by regressing predictions from a word-by-word model of these processes against single-trial MEG data.

BEFORE THE N400: EARLY VISUAL EFFECTS OF LEXICAL-SEMANTIC PREDICTIONS IN MEG

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There is an increasing body of research demonstrating that language processing is facilitated by context-based predictions (e.g., Kamide et al. 2003; Lau et al. 2006; DeLong et al. 2005). Recently, Dikker et al. (2009, in press) reported data suggesting that the brain generates estimates about the likely physical appearance of upcoming words based on syntactic predictions: words that do not ‘look like’ the expected syntactic category show increased amplitude of the visual M100 component, the first salient MEG response to visual stimulation. Here we ask whether violations of predictions based on lexical-semantic information might similarly generate early visual effects.

Previous research suggests that lexical-semantic predictions do not affect early sensory processing but rather later activity, peaking around 400ms (the N400 in EEG, see e.g., Kutas & Federmeier 2000 for review). If only syntactic predictions elicit effects at the M100, this could indicate that syntactic predictions have some type of special status. But there are alternative possible reasons why lexical-semantic violations might have previously failed to generate early effects. For example, while syntactic categories have been found to map onto certain feature combinations in a word’s form (e.g., Kelly 1992; Farmer et al. 2006), there is typically no straightforward mapping between lexical-semantic fields (e.g., flowers) and visual or auditory forms (e.g., tulip, rose, magnolia), unless a single lexical item is predicted. Studies do not generally control for both lexical and visual/auditory cloze-probability. To ensure correspondence between a lexical-semantic predictions and the expected visual form, we used a simple match/mismatch paradigm, where pictures set up expectations either for a specific noun or a general semantic field. Brain responses to the nouns were measured with MEG.

Method/Design. MEG signal was recorded while 11 subjects performed a picture-NP matching task in a 2 x 2 design with the presence of a specific prediction (+/-PRED) and the satisfaction of that prediction (+/-MATCH) as factors. The +PRED conditions set up an expectation for a specific visual form whereas the –PRED conditions only set up an expectation for a semantic field, as shown in (1).

Analysis/Results. (a) Analysis in sensor space revealed increased activity at 100ms for words that did not match the picture in the +PRED conditions (1a vs. 1b) in left–posterior sensors (in addition to sustained enhanced activation in both left–and right anterior sensors from ~250-500ms). No early effects were found for mismatching words in the –PRED conditions (1c vs. 1d). (b) Dipole analysis of the visual M100 peak, consistently localizing in visual cortex (N=9), confirmed that the early effect reported above (1a vs. 1b) reflected a modulation of the M100 response.

Conclusion. This research shows that, just like syntactic predictions, lexical-semantic predictions can affect early visual processing around ~100ms, provided that these predictions can be ‘translated’ into visual form estimates (i.e., when a specific lexical item is predicted). These results suggest that the M100 response is not exclusively tuned to recognizing visual features relevant to syntactic category analysis. Rather, the brain might generate predictions about upcoming visual input whenever it can.

Stimuli CONDITION PICTURE (900ms) NP (300ms on/off)
1a. + PRED/ + MATCH [APPLE] “+ / the / apple”
1b. + PRED/ - MATCH [TOMATO] “+ / the / apple”
1c. - PRED/ + MATCH [GROCERY BAG*] “+ / the / apple”
1d. - PRED/ - MATCH [NOAH’S ARK*] “+ / the / apple”

*participants were told that an image depicting a grocery bag stood for “anything food item”; an image of Noah’s ark for “any animal”.

Speakers and listeners efficiently exploit prosodic information to make the meaning of syntactically ambiguous sentences explicit (Lehiste, 1993; Lehiste et al. 1976). However, quantifiable phonetic properties of prosody in speech production (segmental-, pause duration and fundamental frequency (f0)) stand in a complex relationship to the percept they invoke in the auditory domain. Not all measurable prosodic differences are actually used in sentence parsing. This study investigates the prosodic cues used by speakers to disambiguate a German case ambiguity in order to examine to which degree the individual cues contribute to disambiguation in perception. In a series of three perception experiments sentences were separately manipulated to verify whether segmental-/pause duration or pitch was one of the cues used by listeners in assigning a syntactic structure.

For the production experiment, locally ambiguous sentences (in (1a) DP 2 is a possessive modifier of DP1, whereas in (1b) DP2 represents a dative object) were presented to 18 female speakers as question-answer-pairs on the computer screen. Participants were asked to produce the sentence as response to a question in broad focus. Time normalized pitch tracks as well as durational measurements of DP1 up to DP3, reveal that speakers significantly alter their production of the utterance in ways that were consistent with the intended structure (i.e., providing a higher pitch excursion on and a longer duration of DP1 plus a subsequent prosodic break between DP1 and DP2 in the dative condition (1b) as opposed to the genitive condition (1a)).

To test the extend to which listeners use the prosodic information in auditorily parsed sentence fragments to predict upcoming entities, 20 sequences of each case condition (DP1 up to and including DP3) were presented to listeners in a forced-choice task. Participants listened to each sequence and were asked to complete the fragments by choosing the better fitting of two possible continuations in a questionnaire. In Exp. 1 natural stimuli were presented. In Exp. 2 natural stimuli taken from Exp. 1 were manipulated in that the f0-contour was flattened at a 120 Hz-level. In Exp. 3 the durational properties of the natural stimuli were manipulated by having each constituent carry the mean of the length of the original sounds. The results of Exp. 1 and Exp. 2 reveal that independent of the presented auditory sequence, listeners select the prosodically correct sentence continuation significantly more often, confirming the actual use of prosodic cues to identify the intended syntactic structure. The perception of durational manipulated stimul (Exp. 3) show that listeners preferably choose the dative over the genitive sentence continuation (83% selection of dative verb for a dative sequence; 85% selection of dative verb for a genitive sequence). Thus, duration alone, but not f0 alone, guides ambiguity resolution.

Prosody, more precisely, durational information, incrementally affects parsing decisions in that ambiguous nominal elements are preferably interpreted as single participants of a ditransitive event in the absence of durational information. Once durational cues are available for the processor, the parser correctly interprets ambiguous nominal elements and assigns the intended syntactic structure.

(1a)
Neulich hat der Mann der Nachbarin # ein Haus gesehen, das zerrfallen war.
“Recently the man of the neighbour saw a house, that was decaying.”

(1b)
Neulich hat der Mann [der Nachbarin] # ein Haus geschenkt, das zerrfallen war.
“Recently the man gave the neighbour a house, that was decaying.”
Research on individual differences in sentence processing traditionally concentrates on how general cognitive traits, like working memory ability, contribute to syntactic ambiguity resolution. Recent research highlights the importance of cognitive control—primarily general conflict resolution abilities—when readers/listeners commit to an interpretation, but must override that interpretation when late-arriving input conflicts with it [1]. This view is inspired by evidence that children and patients with circumscribed Broca’s area damage have trouble revising parsing commitments [2,3]. Both populations also fail to resolve incompatible representations during non-parsing cognitive control tasks like Stroop [3,4,5]. Here, we examine whether introducing extra demands on healthy adults’ cognitive control, by inducing performance pressure, influences syntactic ambiguity resolution during reading. This is motivated by prior findings showing that pressure impairs individuals’ cognitive abilities, particularly on difficult processing tasks [6]. We therefore hypothesize that variation should emerge between “pressured” and “non-pressured” readers in sentence regions where new evidence conflicts with one’s developing analysis (the disambiguating region), necessitating cognitive control to implement recovery processes. Consistent with this, we show increased processing difficulty related to garden-path recovery for pressured participants across two real-time measures.

Twenty-one healthy adults completed a non-syntactic cognitive control task (Stroop) followed by a syntactic ambiguity resolution task. Participants were divided into two conditions: performance pressure (N=10; administered after Stroop) versus controls (N=11). We induced pressure by instructing participants that the present tasks were designed to measure intelligence. Controls received no instruction. We recorded eye-movements during the reading task, which manipulated ambiguity using reflexive/transitive materials (see Examples; [7]). In (A), spit up conflicts with one’s developing transitive interpretation (Anna dressed the baby). Readers must then recover the alternative reflexive analysis (Anna dressed herself); such revision is hypothesized to involve cognitive control [1]. No such conflict is present in unambiguous forms (B). No group-differences emerged in pre-pressure Stroop performance, suggesting participants were well matched on verbal cognitive control ability prior to the pressure manipulation. Differences between pressured and control participants on ambiguous sentences emerged in second-pass reading times: ‘pressured’ participants spent significantly more time than ‘non-pressured’ participants re-reading the disambiguating region (spit up) (p<.05). Additionally, pressured participants were marginally more likely to regress into the disambiguating region (p<.10). Importantly, no group-differences emerged elsewhere. Moreover, no group-differences emerged for unambiguous sentences in any region. Thus, anxious participants behaved differently from others but only in terms of greater trouble recovering from incompatible analyses. These results extend research integrating cognitive control and parsing: real-time sentence processing is adversely affected under increased cognitive control demands, particularly when control is initiated to recover from misinterpretation. This function is mediated by performance pressure, which can burden verbal cognitive control processes [8].

A. While Anna dressed the baby that was cute and cuddly spit up on the bed. (Ambiguous).
B. The baby that was cute and cuddly spit up on the bed while Anna dressed. (Unambiguous).

It is well known that individual differences in verbal working memory capacity (VWM) can predict one's performance in several aspects of sentence processing (e.g., [1]). This suggests that general cognitive abilities are recruited during sentence processing. In fact, several recent studies have suggested that inhibition function, which is a general cognitive ability to suppress potent responses that are active but irrelevant to current demands, plays a role of suppressing representation(s) which has been activated but is incompatible with the current input word during online sentence comprehension (e.g., [2]-[4]). However, it is unclear whether inhibition function plays a role at the very time a garden-path recovery becomes necessary. Furthermore, they did not take the potential influence of other cognitive abilities to garden-path recovery into consideration. This study, therefore, investigated (i) whether performance on garden-path recovery can be predicted by performance in a task that taps inhibition function and (ii) whether the contribution of inhibition function to garden-path recovery is independent from lexical knowledge or VWM. To address these issues, we conducted a self-paced reading task, a color-word Stroop task, a Kanji-word reading test named “Hyakurakan” that taps lexical knowledge, and a Japanese reading span test that taps VWM. In addition, we conducted another inhibition task called Attention Network Test (AST) to examine a possible difference between a verbal (Stroop) and a non-verbal inhibition task (ANT) with respect to prediction power for one’s performance on garden-path recovery. First, we found that the mean reading time for disambiguating words in garden-path sentences (e.g., (1a)) was significantly longer than that in control sentences (e.g., (1b)). We also found that the mean response time for incongruent trials was significantly longer than that for congruent trials in the Stroop task as well as in the ANT. Multiple regression analysis including the garden-path effect (= the mean reading time for disambiguating words in garden-path sentences – that for their counterparts in control sentences) as a dependent variable and the interference effect (= mean reaction time for incongruent trials – that for congruent trials) in the Stroop task and that in the ANT, Hyakurakan score, and reading span score as independent variables revealed that the interference effect in the Stroop task and Hyakurakan score significantly predicted performance on garden-path recovery (R2(adj)=.246, F(4,27)=3.53, p<.05; regression coefficient for the Stroop task=.433, p<.05; regression coefficient for Hyakurakan=-.427, p<.05). Furthermore, in a hierarchical regression analysis, the Stroop task made significant contribution when it was entered after RST and Hyakurakan (R2(change)=.159, p<.05), suggesting that the contribution of the Stroop task to performance on garden-path recovery was independent from lexical knowledge and VWM. In sum, we revealed that performance on garden-path recovery reflected by garden-path effect can be predicted by performance in a task that taps inhibition function (i.e., Stroop task) even when effects of lexical knowledge and VWM were controlled, suggesting that inhibition function is recruited immediately when a garden-path recovery becomes necessary. Finally, we showed that a verbal inhibition task is better at predicting performance on garden-path recovery than a non-verbal inhibition task.

(1) a. Keikan-ga Hannin-o tsukamaeta seinen-ni ore-o itta. policeman-Nom criminal-Acc caught young man-Dat thanked
“A policeman thanked a young man who caught a criminal.”
b. Hannin-o tukamaeta seinen-ni keikan-ga ore-o itta criminal-Acc caught youngman-Dat policeman-Nom thanked
“A policeman thanked a young man who caught a criminal.”

RETRIEVING AND PROCESSING THE SYNTAX AND SEMANTICS OF THE MASS/COUNT DISTINCTION

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The linguistic mass/count distinction has a conceptual basis: count nouns (CN) usually denote discrete individuals (chair), while mass nouns (MN) generally denote homogeneous, non-atomic units (oil). This semantic distinction has lead to proposals that mass nouns have more complex lexical semantic representations than count terms (Link 1983), and lexical decision experiments found that MN are recognized more slowly than CN (Gillon et al 1999). However there are mismatches between concepts and mass/count grammar: i.e. individual-denoting MN (furniture), nouns that can be either (stone), cross-linguistic variation (spinach is a MN in English, CN in French) and languages like Chinese in which all nouns are grammatically MN. This mismatch suggests that the distinction is morpho-syntactic, not semantic and that CN involve additional grammatical structure (Bale & Barner, 2007). This is consistent with Steinhauer et al (2001) who find that implausible CN evoke greater LAN ERPs than implausible MN in a sentence reading experiment. Less is known, however, about nouns that can be either mass or count. Barner & Snedeker (2006) show that determiners and number morphology are used by adults and young children to interpret dual nouns (DN) as either mass or count, but the lexical semantics and processing of these nouns remains unclear.

Experiment 1 compared MN, CN and DN in a single word lexical decision experiment. We find that unambiguous MN (judged by raters as incompatible with count syntax) were responded to significantly slower than unambiguous CN and DN (F1=5.34,p<.02).This contrast is consistent with Barner and Snedeker (2006)'s proposal that lexically MN roots are individual-denoting while CN and DN noun roots denote true mass and require syntax for count denotations.

Experiment 2 collected word-by-word self-paced reading data on DN in sentential context. We manipulated the determiner and number morphology (1-4), controlling for noun lemma frequency. On the noun, we found a main effect of plurality (F1=7.632,p<.01) and determiner (F1=72.350,p<.001) and no interaction (F1=.159,p=.692), suggesting the cost of processing plurality and the determiner are independent. On the noun+1 region, we found a main effect of determiner (F1=27.091,p<.001) and a weak plurality-determiner interaction (F1=3.599,p=.063) driven by a fast recovery of the bare plural compared to the bare singular. Nouns which are embedded in count syntax were read quickly, but nouns embedded in mass syntax were read significantly more slowly. Interestingly, bare plurals are morpho-syntactically count, but semantically very similar to mass nouns (Link, 1983), and we find reading times that seem to reflect this semantic property rather than the syntactic factors.

In summary, we find that DN are associated with the same lexical retrieval costs as CN, not MN, suggesting that DN have the same lexical semantics as CN. Moreover, mass syntactic environments cause them to be read more slowly than count environments, suggesting that processing mass semantics is computationally challenging whether the source of the interpretation is lexical or syntactic.

(1) The country vineyard supplied wine for the auction. (bare singular)
(2) The country vineyard supplied wines for the auction. (bare plural)
(3) The country vineyard supplied the wine for the auction. (definite singular)
(4) The country vineyard supplied the wines for the auction. (definite plural)
LEXICAL TELICITY?: PROCESSING EVIDENCE FOR AND AGAINST VERBAL TELICITY.

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Linguistic events vary between telic (inherent end point) and atelic interpretation. For certain verbs linguistic (Verkuyl 1972) and psycholinguistic (Todorova et al. 2000) evidence shows that DPs without determiners (–bounded 1a) do not license telic events while DPs with determiners (+bounded 1b) do. Other verbs appear to determine event telicity independent of direct objects (D.O.). Regardless of D.O. telic verbs license telic events (2ab) while atelic verbs never license telic events (3ab). Thus two factors arguably interact to determine event telicity: verb telicity specification and D.O. boundedness. However while linguistic theory argues for telic verbs (Mittwoch 1991 Borer 2005) the status of atelic verbs is contentious (Kiparsky 1998 Schein 2002 Borer 2005). In these studies we focus on verbal telicity’s role and predicted interaction with boundedness in online event interpretation.

Previous research finds evidence for incremental event interpretation. Telic verbs are harder to process than atelic verbs when modified by durative temporal modifiers (Piñango et al. 1999 Brennan Pylkkänen 2008) and ease garden-path reanalysis (O’Bryan 2003). Our research examines the processing of telicity without temporal modifiers/garden-paths by directly manipulating VP content to test for verb–D.O. interactions. Since telicity minimally requires the verb and D.O. (Verkuyl 1972) the parser may only commit to event interpretation after processing the minimal VP (verb+D.O.).

Using word-by-word self-paced reading experiment 1 manipulated verbal telicity (telic/unspecified) and D.O. (boundedness) (4). Verb length and frequency were controlled. At the noun region we found effects of boundedness (F1=19.167 p<.001). Nouns in –bounded DPs were read slower than +bounded DP nouns perhaps reflecting difficulty recovering covert determiners. At the noun+1 region we found a main effect of boundedness (F1=10.262 p<.01) and the predicted verb–D.O. interaction (F1=4.579 p<.05). Importantly atelic events (unspecified verb –bounded D.O.) were read slower than telic events whose telicity results from telic verbs (telic verb –bounded D.O.) confirming that telic verbs have +telic features distinguishing them from unspecified verbs and affecting online event interpretation.

In experiment 2 we examined the parsing of atelic verbs by manipulating verbal telicity (atelic/unspecified) and D.O. (boundedness) (5). At the noun region we replicate effects of boundedness (F1=9.194 p<.005). However at the noun+1 region we found a main effect of boundedness (F1=4.122 p<.05) but no predicted verb–D.O. interaction (F1=.330 p=.568). Surprisingly atelic events whose atelicity results from atelic verbs (atelic verb +bounded D.O.) were not read more slowly than telic events (unspecified verb +bounded D.O.) suggesting that atelic verbs have no –telic feature distinguishing them from unspecified verbs and affecting online event interpretation.

Taken together these two studies provide processing evidence for lexically telic verbs and against lexically atelic verbs. In experiment 1 the parser used verbal telicity and boundedness to make immediate commitments to event telicity upon parsing the initial VP as revealed by the interaction. However experiment 2 did not find this interaction suggesting that verbal telicity is parsed as a privative feature. This result supports recent linguistic theory which argues for the existence of telic verbs and casts doubt on the existence of atelic verbs.

<table>
<thead>
<tr>
<th>Verb</th>
<th>D.O.</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) a. unspecified</td>
<td>–bounded</td>
<td>telic inspected gardens #in an hour</td>
</tr>
<tr>
<td>b. unspecified</td>
<td>+bounded</td>
<td>telic inspected the gardens in an hour</td>
</tr>
<tr>
<td>(2) a. telic</td>
<td>–bounded</td>
<td>telic completed gardens in an hour</td>
</tr>
<tr>
<td>b. telic</td>
<td>+bounded</td>
<td>telic completed gardens in an hour</td>
</tr>
<tr>
<td>(3) a. atelic</td>
<td>–bounded</td>
<td>atelic roamed gardens #in an hour</td>
</tr>
<tr>
<td>b. atelic</td>
<td>+bounded</td>
<td>atelic roamed the gardens #in an hour</td>
</tr>
<tr>
<td>(4) The local horticulturist [completed/inspected Ø/the gardens] in the neighborhood last week.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) The local horticulturist [roamed/inspected Ø/the gardens] in the neighborhood last week.</td>
<td></td>
<td></td>
</tr>
</tbody>
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PLURAL SETS CAN SATURATE RECIPROCAL THEMATIC ROLES

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Patson and Ferreira (2009) showed that the standard garden path effect in sentences with structures like (1) (i.e., increased processing time on the disambiguating region, cried) is reduced or eliminated when the subject of the initial clause is a complex reference object and the initial verb is reciprocal (1a), as compared to minimally different sentences with either another kind of plural subject (e.g. a plural definite description like the lovers or the two lovers) or an optionally transitive verb (1b). They argued that this reduction of the garden path effect occurred because the two individuals in the complex reference object saturated the thematic roles of the reciprocal verb, leaving no unfilled expectation for an object/patient NP.

The current study probed deeper into what kinds of plurals can saturate a reciprocal verb’s theta roles. Patson and Ferreira’s findings suggested that only plurals that have ‘visible’ individuals, or individuals accessible via pointers, can fill a reciprocal verb’s roles. But there remain many unanswered questions about what kinds of properties the individuals must have, and the readings that must be available for the reciprocal. For example, simply having two pointers to different sets might allow those sets to fill the open thematic roles. However, given that Patson and Ferreira only tested conjoined singular NPs, it could also be necessary that the two pointers each pick out individuals. Their evidence also does not rule out the possibility that the verb may need to be interpreted in a strongly reciprocal (Dalrymple, Kanazawa, Kim, McHombo, & Peters, 1998) way in order for its theta roles to be satisfied.

The current self-paced reading study investigated whether complex reference objects made up of plural sets saturate the thematic roles of reciprocal verbs. The experiment had a 2x2 design, manipulating verb type (reciprocal (1a, 2a) vs. optionally transitive (1b, 2b) and subject type (conjoined singular NPs (1a,b) vs. conjoined plural NPs (2a,b)). Results indicated a main effect of verb type such that reading times on the disambiguating region were longer in the optionally transitive verb conditions (M= 552 ms) than in the reciprocal verb conditions (M= 482 ms, F1(1,47) = 4.78, MSe= 50430.18, p < .05; F2(1,27) = 5.72, MSe= 5888.82, p < .05). There was no interaction, indicating that conjoined plural noun phrases also block the garden path when presented with a reciprocal verb. These findings suggest that all that is required to saturate the thematic roles of reciprocal verbs is a subject that establishes two pointers to different sets. The fact that these sets were plural definite descriptions and did not force a strongly reciprocal interpretation suggests that even weakly reciprocal interpretations of a verb are enough to saturate the thematic roles of the verb, thus eliminating the expectation for an upcoming argument.

1a. While the man and the woman kissed the baby cried in the crib.
1b. While the man and the woman cleaned the baby cried in the crib.
2a. While the men and the women kissed the baby cried in the crib.
2b. While the men and the women cleaned the baby cried in the crib.
ON HALLUCINATED GARDEN PATHS
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The garden path sentence—one of the central phenomena in human syntactic comprehension—is classically understood to be a sentence whose preferred analysis does not match the preferred analysis of one of its prefixes. The recent work of Tabor et al. (2004) and Konieczny (2005), however, has brought this characterization of garden-pathing into question by demonstrating that syntactic analyses of contiguous non-prefix strings can interfere with online comprehension, as with "the player tossed" in (1). Here we present two self-paced reading studies and a computational model demonstrating a new class of garden-paths: those involving discontiguous substrings of the input prefix.

In (2a), the combination of (i) the verb "crackled" being final in the sentence-initial subordinate clause, together with (ii) locative inversion in the main clause, induces considerable processing difficulty in comparison with (2b) and (3). Although it is well-established that in reading, commas serve as strong disambiguating syntactic cues and are effectively used by comprehenders to avoid potential garden paths, as in (4) below (Christianson et al., 2001; Steinhauer & Friederici, 2001; Hill & Murray, 2000), we observe a significant interaction between subordinate verb clause-finality and main-clause locative inversion, with question-answering accuracy lowest and reading times at the main-clause verb "soared" highest in (2a).

A second study crossing locative inversion with length of ambiguous region (2 and 5) corroborates these results, with a main effect of inversion on reading times and question-answering accuracy lowest in the inverted-long condition (5a; see the digging-in effects of Ferreira & Henderson, 1991, and Tabor & Hutchins, 2004).

These results indicate that comprehenders can be garden-pathed by a non-existent analysis of the substring "the clouds crackled, above the glider" in which "above the glider" is a dependent of "crackled". This conclusion lends support to the uncertain-input model of Levy (2008b), in which perceptual evidence (the physical string of words being read) is treated as inherently uncertain and is combined with top-down grammatical and semantic knowledge through noisy-channel Bayesian inference to determine posterior beliefs about sentence form and structure. In this model, both present and past surface input can be overridden when they are strongly in conflict with top-down expectations. In (2--5a), main-clause locative inversion (copresent with a fronted subordinate clause) makes the true input prefix up to "glider" far less probable than the comma-free variant "While the clouds crackled above the glider" would be. As a result, comprehenders commit substantial resources to this "hallucinated" garden path. In a novel extension of Levy's uncertain-input model, we show that the surprisal (Hale, 2001; Levy, 2008a) of the main verb "soared" is correspondingly much higher in (2--5a) than in other conditions, even without a grammatical rule allowing a PP to combine with an immediately preceding verb across a comma.

Our results can be interpreted as the first empirical evidence that comprehenders' inferences reflect deletion-overriding, where inferences may be made about utterance form and structure as if some part of the surface input were absent. This in turn raises questions of whether comprehenders' inferences may also involve other types of input overriding, such as insertions and/or word swaps.

(1) The coach smiled at the player tossed the frisbee.
(2a) While the clouds crackled, above the glider soared a magnificent eagle.
(b) While the clouds crackled, the glider soared above a magnificent eagle.
(3a) While the clouds crackled in the distance, above the glider soared a magnificent eagle.
(b) While the clouds crackled in the distance, the glider soared above a magnificent eagle.
(4a) While Mary washed the baby spat up in the bed.
(b) While Mary washed, the baby spat up in the bed.
(5a) While the clouds crackled, above the glider flying low in the sky soared a magnificent eagle.
(b) While the clouds crackled, the glider flying low in the sky soared above a magnificent eagle.
THE EFFECT OF DISCOURSE INFERENCES ON SYNTACTIC AMBIGUITY RESOLUTION

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Studies investigating the interaction between referential context and syntactic ambiguity resolution in reading often find differing degrees of interaction: some show modifier-supporting contexts can prevent garden pathing (Spivey and Tanenhaus, 1998 JEP) while others show weak or delayed effects of context (Binder et al, 2001 JML). Here, we investigate two issues: (a) the time-course of the interaction between context and ambiguity, and (b) the influence exerted by the difficulty of the contextual inference on this interaction. We investigate (a) by comparing early and late eye-tracking measures in reading, and (b) by using (across experiments) different degrees of lexical overlap between context and target.

We present three experiments using a reduced relative ambiguity. The reduced relative reading is supported by a relative-supporting (RS) context involving two entities, one of which is the antecedent for the target noun (“the witness who was accused”) and a second entity which contrasts with the first (i.e. a witness who was not accused). In Experiment 1, both the noun (“witness”) and verb (“accused”) are repeated between the RS context (1a) and the target (1c). A non-relative supporting (Non-RS) context condition (1b) contained no possible antecedents and hence had no lexical repetition. An unreduced relative target sentence served as a baseline. In Experiment 2, the lexical repetition between the RS context (2) and the target sentence (1c) was removed: a bridging reference was necessary to determine contextual support between the non-repeated RS (RS/NR) context and the target (e.g. “the witness” refers to a person being cross-examined). Experiment 3 took advantage of the fact that a context without a contrasting discourse entity does not support a restrictive relative clause. Unlike Experiments 1 and 2, the Non-RS context in Experiment 3 (3b, Non-RS-M) always had one possible antecedent, and differed only minimally from the RS context (3a, RS/NR-M).

Reduced relative conditions were compared with unreduced baselines. All experiments showed a main effect of garden path (GP) cost on the critical region “carried by”, in first-pass measures. However, only in Experiment 1 was there a reliable reduction in GP cost in reduced relative conditions, and then only in later measures (e.g. 2nd pass). Interestingly, though, both Experiments 1 and 2 showed an early main effect of facilitation for RS contexts. In the case of Experiment 2, one possible explanation is that subjects were making the bridging inference fairly early, but were not able to use this information to facilitate syntactic processing. However, Experiment 3 only showed a main effect of GP cost, with no main effect for context and no interaction. This suggests that the main effect of context observed in first fixation in Experiments 1 and 2 was driven by other factors, such as the cost of accommodating a discourse-new entity in the neutral Non-RS conditions. Overall, these findings suggest that contextual information has a delayed effect on syntactic ambiguity resolution, and, when difficult inferences are required to make use of context, it may not be used by the sentence processor at all.

(1) a. RS context: The lawyer went easy on the first few witnesses, but accused the last witness of lying under oath.

b. Non-RS context: After days and days of tedious testimony, there finally was quite a bit of drama in the courtroom earlier today.

c. Target sentence: The witness [who was] accused by the lawyer was trying to cover for his wife.

(2) RS/NR context: The lawyer went easy on the first few people, but suggested that it was the last one who was lying under oath.

(3) a. RS/NR-M context: The lawyer was cross-examining two people in the courtroom that day. He reproached the one of them for lying under oath in the courtroom, but went easy on the other.

b. Non-RS-M context: The lawyer was cross-examining one person in the courtroom today, and keeping an eye on a juror. The lawyer reproached the person being cross-examined for lying under oath and watched the juror’s reaction.
THE CANONICAL WORD ORDER MYTH: INVESTIGATING A PROCESSING-TYPOLOGICAL PUZZLE
IN THE CANTONESE DOUBLE OBJECT CONSTRUCTION

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The frequency of canonicity (frequent, structurally basic and/or pragmatically neutral) word orders is often associated with easier processing, while syntactic alternatives usually incur complexity and processing difficulty (Hawkins, 2004; Ellis, 2002; Cook et al., 2009). In this paper we show that the canonical double-object construction (DOC, a) in Cantonese (VO with head-final NPs) is difficult to process in that incremental increases in the complexity of the direct object (DO) increase reading time (RT) and reduce recall accuracy relative to syntactic alternatives, and induce greater avoidance of the DOC in elicited production. We hypothesize that this is because the canonical word order involves processing-demanding center-embedding (Hawkins, 2004).

While the psycholinguistic literature has looked at various structures (RCs: Reali & Christiansen, 2006; passive: Gennari & MacDonald, 2009; Heavy NP Shift: Staub et al., 2006) in different languages (cf. Bornkessel et al., 2002; Yamashita & Chang, 2001), often canonical word orders are the most efficient. Cantonese allows us to test whether canonical (frequent and neutral) word orders are processing-efficient, since the DOC is highly frequent, basic and neutral but has center-embedding while alternatives are efficient but infrequent. We hypothesize that despite DOC’s high frequency, center-embedding will cause avoidance of DOC (Expt. 1), comprehension difficulty (slower average word RT, Expt. 2) and recall difficulty in production (lower accuracy, Expt. 2).

In Expt. 1 (untimed elicited production), participants read full DOC (a) sentences and reported the agent’s actions when prompted. As the syntactic weight of the DO increases (3 levels: bare N, Adjective-N, RC-N), the use of syntactic alternatives increased ((b) double-give-construction, (c) serial-verb construction, (d) BA-construction, (e) object topicalization) while the use of the DOC decreases, F1(2,40)=55.97, p<.001, F2(2,33)=17.01, p<.001.

Expt. 2 used a dual-task paradigm to investigate the effects of weight (3 levels) and construction type (DOC (a) and BA-construction (d)) in both language comprehension and production. Immediately after reading a sentence word-by-word (one-word window), participants tried to recall the sentence faithfully upon seeing “REPEAT”. Both DO complexity and construction type were significant, and participants’ performance is consistently better for the BA-construction than for the DOC in both comprehension (average word RT, F1(1,17)=4.933, p=.040, F2(2,33)=1.235, p=.301) and production (accuracy of construction used, F1(1,17)=11.86, p=.003, F2(1,23)=0.419, p=.524).

The results suggest that the frequent and structurally basic word order are not necessarily easier to process. We also find that the non-canonical BA-construction is processed faster than the DOC (cf. faster RTs for topicalization in Matthews & Yeung, 2001), contradicting the assumption that non-canonical structures incur a processing penalty. We propose that participants performed better on the BA-construction because BA immediately precedes the DO, making possible early prediction and assignment of correct syntactic relations (Maximize On-line Processing, Hawkins, 2004). Speakers may still frequently use the potentially inefficient canonical word order - when the DO modifier is relatively short, working memory allows Chinese speakers to tolerate center-embedding without apparent difficulty.

a) ngo (1sg) bei (give) di (CL) cin (money) nei (2sg) [Double object construction]
b) ngo (1sg) bei (give) di (CL) cin (money) bei (give) nei (2sg) [Double-give construction]
c) ngo (1sg) lo (take) di (CL) cin (money) bei (give) nei (2sg) [Serial verb construction]
d) ngo (1sg) zoeng (BA) di (CL) cin (money) bei (give) nei (2sg) [BA construction]
e) di (CL) cin (money) ngo (1sg) bei (give) nei (2sg) [Object topicalization]

All: “I give you some money”

Please find the data summary and the full appendix at http://www2.hawaii.edu/~antonio1/

Selected References
DISTINGUISHING EFFECTS OF EXPECTATION AND INTEGRATION IN NON-LOCAL DEPENDENCIES

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Representations of preceding and upcoming linguistic input have both been claimed to modulate on-line comprehension processes. Comparisons between local and non-local dependency processing provide some evidence for each. Resolving non-local dependencies can be relatively slow (locality effects), suggesting that distance may degrade representations of recent input (e.g., Grodner & Gibson 2005). Conversely, resolving non-local dependencies can be relatively fast (anti-locality effects) when contextual cues inform probabilistic expectations about the identity of upcoming input (e.g., Konieczny, 2001).

A self-paced reading study directly compared expectation effects and distance effects and tested for interactions between them, providing an empirical basis for a processing model that subsumes both. We tested a simple model based on two assumptions: (i) expectation effects are facilitations of lexical processing (consistent with models in which probabilistic expectations are formed about upcoming lexical input; Levy, 2008); and (ii) distance effects are slowdowns in dependency resolution caused by slower retrievals of one or more dependency elements (consistent with retrieval models of parsing; e.g. Lewis & Vasishth, 2005).

The empirical design afforded independent tests of distance and expectation effects at a critical, embedded verb. Expectation strength was varied by manipulating the strength of forward association (validated by a norming study) from the matrix subject (car or tractor) to the embedded verb (drove), while maintaining equivalent plausibility levels. Distance was varied by separating the subject and embedded verb by 0, 1 or 2 PPs. Tests of distance effects controlled for the semantic context provided by PPs by fronting them in some conditions, since semantic context may affect expectation-based processing.

We focus on four predictions made by the simple model outlined above: (1) Stronger lexical expectations (car vs. tractor) should lead to faster processing of the embedded verb. (2) Increasing subject-verb distance from 1-2 PPs should create slowdowns at the embedded verb when controlling for semantic context prior to the verb. (3) This distance effect should not interact with the expectation effect, consistent with their loci in separable stages. (4) Finally, the amount of semantic context (1 or 2 PPs) should not interact with the expectation manipulation if there is a common locus of semantic context on lexical expectation.

This experiment is the first direct empirical test of the interplay between dependency integration processes and semantically informed expectations. The results advance theories of sentence comprehension by discriminating between (a) models that posit a common processing mechanism underlying locality and anti-locality effects, and (b) other models, like the one outlined above, that do not.

The (car / tractor) that the husband always drove was parked in the driveway.
The (car / tractor) that the husband down the street always drove....
Down the street the (car / tractor) that the husband always drove...
The (car / tractor) that the husband down the street near the factory always drove...
Down the street the (car / tractor) that the husband near the factory always drove...

HOW FIXED ARE FIXED EXPRESSIONS? ACTIVATION OF IDIOMATIC MEANING IN IDIOMATIC PHRASES WITH NOUN OR VERB SUBSTITUTIONS

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Figurative language is assumed to differ from literal language in two important aspects, 'syntactic anomaly' and 'semantic fixedness' (e.g., Gibbs & Nayak, 1989). Hence, the meaning of figurative expressions like idioms cannot be constructed from the meaning of the single words. Psycholinguistic models differ on the question of whether the meaning of an idiomatic phrase is stored separately from the meaning of its constituents, and how the idiomatic meaning is assembled.

In the present study, three sentence priming experiments were conducted to investigate the process of literal and figurative meaning assembly in idiom comprehension. As established in a previously conducted sentence completion test, the last word (=verb) of all idiomatic phrases was highly predictable (80-100%). Experiment 1 examined whether the literal meaning of the verb is activated in addition to the figurative meaning of the idiom. Idiomatic phrases like (1) were presented visually, word-by-word (500 ms SOA), and participants made lexical decisions about nouns that were associated with either the figurative meaning, 'Erleichterung' (relief), or the verb's literal meaning, 'Leiter' (ladder), or were matched unassociated nouns. Experiment 2 examined whether the idiomatic meaning is activated when the verb is substituted by a synonym, as in sentence (2), and Experiment 3 examined whether the idiomatic meaning is activated when the noun is substituted by a synonym or semantic associate as in sentence (3). In the latter two experiments, lexical decisions to figurative meaning associations were compared with those to unassociated nouns.

Results showed that in idiomatic sentences like (1), not only the figurative meaning of the idiom but also the literal meaning of the verb is activated relative to unassociated controls. Furthermore, even when verb or noun constituents are substituted, as in (2) or (3), the figurative meaning of the idiom is activated to some degree. These findings indicate that the literal meaning of single word constituents is accessed during figurative processing. Most importantly, 'semantic fixedness' is not completely 'fixed', not even in noncompositional idioms. We present a model of idiom comprehension that allows more flexibility regarding the 'fixedness' of idiomatic expressions.

(1) "Mir ist ein Stein vom Herzen gefallen."
   word-for-word (W): ‘to me is a stone from heart fallen’
   literal (L): A stone fell off my heart.
   figurative (F): "It took a load off my mind."
(2) "Mir ist ein Stein vom Herzen gepurzelt."
   L: A stone tumbled down my heart.
(3) "Mir ist ein Stein vom Magen gefallen."
   L: A stone fell off my stomach.
PROCESSING POSTNOMINAL RELATIVE CLAUSES IN BASQUE: AN INQUIRY INTO THE DEPENDENCY LOCALITY THEORY

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A processing advantage for subject relative clauses (SR) over object relative clauses (OR) has been typically reported in languages with postnominal relative clauses (e.g., [1]). Some accounts claim that this is a universal processing preference ([2]), while others argue that the distance between the filler and the gap determines the asymmetry. The Dependency Locality Theory ([3]) appeals to linear distance as the crucial factor, indicating that processing complexity increases as a function of the number of intervening words between filler and gap. Accordingly, while postnominal relatives are predicted to show SR advantage, prenominal relatives are predicted to show the opposite pattern, with ORs being processed easier than SRs.

Recent evidence from Basque testing prenominal relative clauses has revealed an OR advantage ([4]), confirming the prediction derived from the DLT, since the number of intervening words between filler and gap is bigger in Basque prenominal SRs like (1a) than in ORs like (1b).

Critically, Basque also uses postnominal RCs, and thus provides a unique opportunity to test the predictions derived from the linear distance account within the same language. We conducted an online self-paced reading experiment to explore the processing of postnominal SRs (2a) versus ORs (2b). Following similar procedures ([4]), ambiguous sentences where the ambiguity was not resolved until the penultimate word were used. Results indicated that postnominal SRs show a processing advantage over ORs, as revealed by shorter reading times at the critical disambiguating region as well as at the subsequent region. These results clearly confirm the DLT’s predictions, showing that within the same grammar an OR advantage is found in prenominal clauses, while a SR preference is found for postnominal clauses.

References
GARDEN PATHS IN COMPARATIVES
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The experiment presented here shows a simplicity-based processing effect in comparative structures not previously analyzed in the sentence processing literature. It has been claimed that all constituents headed by 'than' are underlingly clausal (Lechner 2001). Examples like (1a) are problematic for this type of account. I will claim, following others (Keenan 1987, Ivorski 1995) that comparatives like (1a), so-called phrasal subcomparatives, have a different syntax and semantics than clausal comparatives like (1b). On this assumption, (1a) and (1b) are ambiguous between a phrasal than-phrase ((than NP)) and a clausal one ((than CP)) through the word teachers. The present hypothesis is that the parser initially assigns the smaller, phrasal than-phrase, resulting in a garden path in sentences like (1b).

An eye movement study was conducted to test this hypothesis. 32 subjects read 24 sentences like those in (2, brackets indicate analysis regions). The study exploited the fact that definites are generally illicit as NP complements to than, and therefore disambiguate toward a clausal than-phrase interpretation. The NP/DP following 'than' was either a bare plural (2a) or a definite DP (2b). Further, the comparatives were compared to corresponding relative clauses (2c–d). We predicted that in condition (a), the embedded verb (Region 3) would be misanalysed as a main verb, causing difficulty at the true main verb (Region 4). The definite NP in condition (b) was expected to disambiguate toward a clausal than-phrase, and therefore difficulty was expected to occur earlier in the sentence, on Regions 2 and 3, and perhaps be resolved before the main verb. No major differences were expected between relative clause conditions, except some difficulty associated with having a bare plural subject of an embedded clause. A linear mixed-effects model analysis showed a significant interaction in go-past times (the sum of fixation durations from first fixating a region until leaving it to the right; Staub & Rayner 2007) on Region 3 (p<.001). This interaction was such that the comparative/definite condition was longer than the comparative/bare plural condition (424ms in condition (b) vs. 374ms in (a)), while the reverse pattern obtained for the definite/bare plural relative clauses (377ms in (d) vs. 469ms in (c)). On Region 4, go-past times were longer for comparatives than relative clauses (513ms (a) and 538ms (b) vs. 406ms (c) and 389ms (d), p=.01). Increased sentence-final go-past times and regression rates in comparatives (68 and 72% in (a) and (b) vs. 42 and 47% in (c) and (d)) also indicate difficulty. However, the prediction that condition (a) would be slower than condition (b) in Region 4 was not borne out. This could indicate that the difficulty associated with constructing a clausal than-phrase persists through subsequent regions, or that definite DPs did not adequately disambiguate toward the clausal interpretation. A second experiment is underway testing whether another DP type, proper names, better disambiguate the structures.

While the pattern of reanalysis in clausal comparatives remains to be fully understood, we take these results as evidence that readers do adopt the phrasal than-phrase structure first. This result has implications for our understanding of both the structure and processing of comparatives.

1. a. More students [than teachers] signed the petition. (Keenan 1987)
   b. More students [than teachers encouraged] signed the petition.
   d. The students that 1] the teachers 2] scolded 3] improved 4] their work habits. 5]

Integrating a word w into the current partial phrase marker (CPPM) is often the harder the greater the distance is between w and information within the CPPM necessary for integrating w, as captured by the distance locality theory (DLT) (Gibson, 2000). This theory is challenged by findings of so-called antilocality effects (Konieczny, 2000): sometimes increasing the distance between w and its attachment site eases the integration of w. It is still a matter of dispute under which circumstances distance increases or decreases sentence complexity. To address this issue, we investigated German wh-main-clause questions. Sentences were presented auditorily; participants had to judge the grammaticality at the end of each sentence as fast as possible. All sentences began with a wh-phrase and ended with a second NP as in (1).

(1) Wh-phrase … Verb … (adverbial) … NP2

Sentences occurred either with subject-object (SO) or object-subject (OS) order. Locally ambiguous sentences shared the clause-initial wh-phrase; disambiguation was achieved by means of case morphology on the sentence-final second NP. The distance between the ambiguous wh-phrase and the disambiguating clause-final phrase was either short or long. In the short condition, a short wh-phrase is separated from the clause-final NP only by the verb in verb-second position. In the long condition, a long wh-phrase is separated from the clause-final NP by the verb and an additional adverbial. The experiment also contained unambiguous grammatical and ungrammatical sentences which were created by replacing the ambiguous wh-phrase with a wh-phrase unambiguously marked for case.

The experiment yielded the following results. All main effects (Order, Status and Length) are significant. In addition we find two interactions involving the factor Status: Order-by-Status and Length-by-Status. Performance was best for grammatical sentences independent of order and length. Ambiguous sentences show an OS penalty. Compared to grammatical sentences, this produces a garden-path effect. Ungrammatical sentences were judged worst (ranging from 42% to 79% correct), with more judgment errors in SO-sentences. For short sentences, our results extend earlier findings by Meng (1998) to the auditive modality. In addition, we find effects of length. Significant effects of length were found for locally ambiguous OS sentences – long OS sentences produced a stronger garden-path effect than short sentences – and for ungrammatical sentences – long ungrammatical sentences received more judgment errors than short ungrammatical sentences.

In summary, our results show that sentence parsing is sometimes subject to locality effects, as predicted by the DLT. This holds for syntactic ambiguity resolution (see also Van Dyke and Lewis, 2003) and for the detection of case violations. We propose that our results are best explained by assuming that the activation of syntactic features decays with time. Reaccessing features gets more difficult when more material intervenes between the initial activation and the later point of retrieval. In long sentences, garden-path recovery is thus more difficult and the detection of case violations more error-prone. We will discuss how our findings relate to reports of anti-locality effects.

References:
ON-LINE INTERACTION OF MATHEMATICAL AND SYNTACTIC DEMAND: FAILURE TO REPLICATE

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We attempted to replicate Fedoreno et al’s (2007) finding of a math X syntax complexity interaction in a self-paced task in which participants read object and subject relative clauses phrase-by-phrase while concurrently doing mathematical problems whose elements were presented one-by-one simultaneously with the sentence segments. The authors interpreted these results as evidence for a shared resource system for mathematics and parsing.

In experiment 1, 12 subjects were tested on materials comparable to those used in the original study and 12 on materials used in the original study. In experiment 2, 32 participants were tested on materials used in the original study and eye fixations were obtained using head-mounted eye tracking. The eye fixation data were gathered to explore the possibility that the interaction in Fedorenko et al was due uploading linguistic and mathematical processors, which might be more demanding when more complex operations were required. If this were the case, and if operations were uploaded upon initial encounter with a stimulus type, the interaction would be expected to appear in the initial fixations of the stimuli at the point of greatest load and not in subsequent fixations at that point.

The results of two studies, including a sub-analysis of the participants in experiment 1 who saw the original materials, failed to show math X syntax interaction in self-paced reading/computation times. The eye fixation data were nonetheless examined to obtain information about the point(s) at which the operations needed for a particular type of processing were made available.

Preliminary analyses have focused on the relative clause segments, the point of greatest load. First run fixations (fixation on a stimulus type) on sentential material at the relative clause segment were longer following fixations on mathematical material than following fixations on sentential material on the previous segment, and total fixations on sentential material showed the opposite pattern. Fixations on sentential material at the relative clause segment that followed fixations of the same type of stimulus showed effects of sentence type (longer fixation duration for object than subject extracted sentences) while fixations on sentential material at that point that followed fixations of the opposite type of stimulus (the mathematical stimuli) did not. This is consistent with the hypothesis that uploading an algorithm for language or mathematical processing occurs upon initial encounter with a stimulus type and that processing occurs during subsequent fixations upon that type of stimulus. Interactions of sentence complexity and mathematical complexity were not seen in fixations following fixations of either the same or different stimulus types, indicating that the non-replication of Fedorenko et al. is found for both measures of operation upload and the working memory systems that apply those operations.

The reasons for the differences in results require further study, but these data weaken the claims for a shared working memory system underlying syntactic and mathematical processing based upon dual task results.

THE DIFFERENTIAL EFFECTS OF PERSON AND GENDER FEATURES ON PRONOUN RESOLUTION

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Pronoun resolution is an integral part of sentence comprehension. Previous research has shown that the parser uses various sources of information to accomplish this task (see Garnham, 2001). The present study focuses on the role of morphosyntactic information, more precisely on person, gender and number agreement. With regard to gender, prior studies demonstrated mismatch effects for both anaphoric pronouns and cataphoric pronouns (e.g., Kazanina et al., 2007; Kennison, 2003; Kennison et al., 2009; van Gompel & Liversedge, 2003).

The present study examines the processing of cataphoric pronouns by means of a self-paced reading procedure. In contrast to prior studies in which the pronoun was the first NP and thus could only be interpreted as a cataphor, the pronoun is preceded by another NP in a licit antecedent position. However, the actual antecedent follows the pronoun. As schematized in (1), the cataphoric pronoun is contained in a fronted temporal adjunct clause while its antecedent (NP2) is part of the following main clause. This is the structural configuration which was shown to be especially suited for the use of cataphoric pronouns (Gordon & Hendrick, 1997). The temporal adjunct clause is complex itself, consisting of a matrix clause containing the apparent antecedent (NP1) followed by an embedded complement clause containing the pronoun. The experiment employed 30 sentences following the schema in (1) each in 6 versions varying two factors. NP1 was either the first-person pronoun “ich” (‘I’), a masculine proper name or a feminine proper name. The pronoun was either a masculine (“er” ‘he’) or a feminine (“sie” ‘she’) third-person singular pronoun. Importantly, the third-person singular pronoun “sie” is homophone with the plural third-person pronoun (‘they’). This number ambiguity is resolved via subject–verb agreement on the corresponding verb.

Reading times show the following pattern:

1. On the pronoun and thereafter in the embedded clause, reading times are prolonged when pronoun and NP1 differ in gender. The effect is more pronounced in case of masculine pronouns. Sentences with a first-person pronoun in NP1 position are read as fast as sentences in which pronoun and NP1 match in gender.

2. Reading times on the complement-clause verb (V2 in (1)) are also enhanced in sentences with a gender mismatch between NP1 and pronoun, but this time more so in sentences with a feminine pronoun.

3. After encountering NP2, reading times are longer when the three NPs (NP1, pronoun, NP2) match in gender while reading times are fastest in sentences with a first-person pronoun as NP1.

In sum, reading times indicate a strong tendency to establish an antecedent for a pronoun as soon as a potential candidate is available, where candidates are defined in terms of person features. A first-person pronoun as NP1 is not considered as a potential antecedent for the following third-person pronoun. When NP1 is a proper name, the parser immediately associates the pronoun with NP1 even if this leads to a gender mismatch, as revealed by the prolonged reading times. With a number ambiguous pronoun, the gender conflict can be circumvented by constructing a plural antecedent. This strategy runs into problems on encountering the disambiguating verb which rules out the plural reading of the ambiguous pronoun.

Example (schematic)

(1) [[when NP1 V1 [that PRONOUN-i ... V2]] Aux NP2-i ... V3]

References
We present experimental results suggesting that anaphora resolution is grounded in internalized deictic gesture. More specifically, we provide first evidence for the view that interpretation involves locating discourse objects in a mental virtual space, keeping track of the imaginary spatial relations between the various referents. Consider sentence (1). By our hypothesis, hearers and readers will interpret the nominals in such examples by constructing a mental space and locating the referents of the subject and object NP in this imaginary space. One plausible assumption is that first mentioned (or subject) referents are placed to the left of later referents.

Moreover, we hypothesized that resolving a pronoun (e.g., she in the above example) referring to a previously mentioned entity is grounded in an internalized pointing gesture in the mental virtual space. Assuming that hearers (readers) adopt the perspective of an outside observer on the scene, reference to a sentence-initial subject (1) involves a mental pointing gesture to the left, while anaphoric reference to the object (2) involves an internalized pointing gesture to the right.

To test this prediction, we conducted an experiment modeled after studies investigating the action-sentence-compatibility effect (Glenberg & Kaschak, 2002).

Participants seated in front of a screen were asked to read and evaluate sentences in terms of their plausibility, using a keyboard that consisted of three buttons located in a line, however with a distance of about 15 cm to its left or right neighbor. Sentences were displayed word by word by keeping the center button pressed. The stimuli used were analogous to the previously mentioned example in that they consisted of main and following subordinate clause; the main clause contained two noun phrases, the subordinate clause contained an anaphoric pronoun. Half of the target sentences involved pronouns which clearly referred back to the subject; the remaining target sentences contained pronouns that clearly referred back to the object. Plausibility was evaluated by pressing the left or right button, respectively (with button assignments reversed after half of the trials). We predicted that compatible responses are performed faster, i.e. that interpreting a pronoun which refers back to the subject (1) will be facilitated if evaluating the sentence requires pressing the left button, while interpreting a pronoun referring to the object (2) will be facilitated if evaluating the sentence requires the participants to press the button on the right. Because there is a strong preference in German for resolving ambiguous pronouns as referring to the Subject of the matrix clause (Hemforth et al, 2009), we also predicted faster responses to sentences, where the pronoun is resolved accordingly.

We fitted a linear mixed-effects model with participants and items as random factors. As predicted, the results show two independent main effects for the fixed factors pointing compatibility and Subject-reference: While responses to Subject-resolutions were generally faster, we found shorter hand movement times when the forced response direction was compatible with the canonical location of the discourse referent in the mental virtual space (subject/first-mentioned:left and object/second-mentioned:right).

We will discuss the implications for an embodied view of language comprehension, and for grounding of anaphora in deixis and pointing gestures in particular.

(1) Die Opernsängerin sah den Straßenfeger, als sie die schwierige Arie sang.
The opera singer saw the scavenger, when she performed the difficult aria.

(2) Der Straßenfeger sah die Opernsängerin, als sie die schwierige Arie sang.
The scavenger saw the opera singer, when she performed the difficult aria.


EXPECTING COREFERENCE: THE ROLE OF ALTERNATIVE CONSTRUCTIONS

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We present a questionnaire and a self-paced reading study in Portuguese, showing that distributional properties and expectations about alternative constructions play a crucial role in anaphora resolution.

In a questionnaire, we obtained different coreference patterns for sentences with a (semantically similar) subordinating or coordinating temporal conjunction: in the case of coordination (depois: 'after that', 1a) there is a preference for the pronoun to co-refer with the subject of the preceding clause, while for the subordinating conjunction (antes que: 'before', 1b) we observed a strong object preference for the pronoun.

To explain that, we propose that comprehenders use a Gricean or expectation-based strategy: in Portuguese, for sentences like (1b) there is a highly frequent alternative infinitive construction (antes de abrir: 'before opening'), which only allows coreference with the subject of the preceding clause. Upon seeing the subordinate construction, comprehenders may assume that the speaker intended coreference with an antecedent other than the subject.

To further examine if this effect shows up in on-line processing, and to exclude an explanation in terms of coordination and subordination, we conducted a self-paced reading experiment, where we only used subordinate constructions and varied the kind of conjunction, one having an alternative construction (antes que: 'before', 2a+b), the other one not (quando: 'when', 2c+d).

Participants read sentences like (2a-d), in which the subordinate clause contained a pronoun referring unambiguously to the subject (2a+c) or object (2b+d) of the preceding main clause.

On both the pronoun and the spill-over region, we found a reliable interaction, in a way that for the subordinate clause with an alternative infinitive construction there is a clear decrease in reading times in the object coreference condition (2a) whereas this differences was not found in the cases with no alternative construction (2c+d).

Our results suggest that the effects found in both the questionnaire and the on-line reading study can be attributed to comprehenders’ using a Gricean or expectation-based strategy in anaphora resolution. We will discuss whether these strategies are at work in on-line processing or whether they reflect the comprehenders’ experience with referentially ambiguous and unambiguous constructions.

(1a) O polícia encontrou o espion. Depois ele abriu a janela.
'The policeman met the spy. After that he opened the window'

(1b) O polícia encontrou o espion, antes que ele abrisse a janela.
'The policeman met the spy, before he opened the window'

(2a/b) O polícia encontrou a actriz, antes que ele/ela abrisse a janela.
'The policeman met the actress, before he/she opened the window'

(2c/d) O polícia encontrou a actriz, quando ele/ela abriu a janela.
'The policeman met the actress, when he/she opened the window'
THE INTERACTION OF TOPICALITY AND SENTENTIAL POSITION DURING CHINESE DISCOURSE PROCESSING

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In light of ample investigations of potential discourse influences on language comprehension, it is generally agreed that contextual cues can modulate language processing effort. However, while most of the studies focused on the impact of contextual information on the processing of plausibility, ambiguity and anaphoric resolution, little is known with respect to topicality (i.e. what the utterance is about) (but see ref.3). To shed light on possible influences of discourse topicality on sentence comprehension, we conducted an ERP study in Chinese, a language where topicality plays a key role.

We presented different context questions (Topic Questions [1/2] vs. Neutral Questions [3]) followed by target sentences in two word order configurations (Topicalized (OSV) vs. Non-Topicalized (SVO) [a/b]). In Chinese a definite noun-phrase (NP) in sentence initial position is characterized as a topic and is expected to carry given information. This manipulation thus enabled us to examine how topic (enforced by the context question) affects the processing of an upcoming entity at the topic position compared to sentence-internal non-topic position.

At the topic position, we were able to detect the processing costs of NPs following different contextual environments, namely TOPIC-CONTINUITY [1a/2b], TOPIC-SHIFT [1b/2a] and NOVEL-TOPIC [3a/b]. ERP data first revealed that NPs that can draw an identity relation with previously mentioned information (i.e. TOPIC-CONTINUITY) elicited the most reduced N400 compared to other contextual environments (i.e. TOPIC-SHIFT & NOVEL-TOPIC), thereby confirming previous findings from referential processing (ref.1). Second, context questions generate specific contextual predictions. In contrast to a neutral context question [3], a topic question [1/2] opens a slot at the sentence-initial position expected to be filled with given information due to the topic principle in Chinese (ref.2). Accordingly, extra processing costs, reflected in significantly larger N400 mean amplitude, emerged for TOPIC-SHIFT (i.e. a mismatch between expected and encountered topic) compared to NOVEL-TOPIC. Consequently, TOPIC-SHIFT revealed the most processing demands in establishing a discourse dependency.

In addition, in the 500–700ms time window, an enhanced positivity was obtained for TOPIC-SHIFT compared to TOPIC-CONTINUITY and NOVEL-TOPIC. This converges with the proposal that this positivity reflects discourse updating costs (ref.1): the TOPIC-SHIFT condition [1b/2a] is the only construction where two distinct arguments (NPs) are already encountered, suggesting that the extra integration demands and the topic-driven reorganization of the discourse model enhance discourse complexity.

Critically, at the non-topic positions, a general new/given information distinction was found without any impact of topicality, reflected in a biphasic N400–LatePositivity pattern for new information [1a/2b/3a/3b].

These data converge with a neurocognitive model of discourse processing that distinguishes two stages of discourse integration: dependency formation/linking (N400) and discourse updating (LatePositivity). The present study further showed that topicality interacts with NP-position, by differentially influencing online discourse processing at the topic position. Strikingly, TOPIC-SHIFT exerts most costs and impedes both processing in the early dependency formation stage and the late discourse updating phrase.

Examples:

   (Topic Question)                                       (Topic Question)                           (Neutral Question)
b. Lisi / beat / Zhangsan.                           b. Lisi / beat / Zhangsan.              b. Lisi / beat / Zhangsan.

EFFECTS OF PERSPECTIVE-TAKING ON SENTENCE PRODUCTION: WHAT BURGLARS AND VICTIMS CAN TELL US ABOUT LANGUAGE PRODUCTION

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INTRODUCTION--There is often more than one way to describe an event. For example, a picture of a dog chasing a policeman could be described as: (a) a dog is chasing a policeman (active: agent-initial), (b) a policeman is being chased by a dog (passive), or (c) a policeman is fleeing from a dog (active:patient-initial). These sentences do not differ in core meaning but they differ in syntactic structure (active/passive) and subject-choice (agent-initial/patient-initial). In fact, the choice of sentence frames is known to be influenced by semantic([2]), syntactic([3]) and perceptual priming([4]).

However, choice of sentence frames also reflects different perspectives, i.e., whether the event is described in terms of the dog (a) or the policeman (b)-(c). Existing research has shown that the way in which we perceive and interpret a stimulus greatly depends on what perspective we take on a situation. E.g., [1] found that the encoding or understanding of written material is greatly influenced by the reader’s perspective. However, effects of perspective-taking on sentence production have not yet been directly tested. The current study uses a priming paradigm to investigate the existence and generality of perspective effects on language production.

EXPERIMENT--During the priming phase (about 10 min), participants (n=20) wrote about a home invasion incident from the standpoint of either the burglar/aggressor or the victim. During the test phase (about 20 min), participants described visual scenes (unrelated to home invasion). To investigate whether "aggressor" and "victim" perspectives generalize to broader "agent" and "patient" perspectives, the visual scenes included both (i) negative events like home invasion (e.g. biting) and (ii) positive events where the consequences of the agent action were favorable to the patient (e.g. kissing).

RESULTS--For NEGATIVE events, participants primed with the victim perspective were more likely to produce passives (17% vs. 6%) and start sentences with patients (26% vs. 8%) than participants primed with the aggressor perspective (p<.05). For POSITIVE events, victim-perspective participants did not produce more passive sentences than aggressor-perspective participants. However, victim-perspective participants did produce more patient-initial active sentences (11% vs. 2%, p<.05). There was also an interaction of event polarity and sentence form for victim-perspective (p<.05): Victim-perspective participants were more likely to produce passives and start utterances with patients when describing negative than positive events. (Further analyses indicate that these effects cannot be reduced to syntactic priming; frequencies of passives and patient-initial sentences in participants' home-invasion descriptions do not correlate with those in participants' spoken picture descriptions.)

CONCLUSION--Our results indicate that perspective-taking has a significant influence on sentence production. Also, the finding that victim-perspective participants were more likely to start their utterances with the patients even in positive events suggests that the 'victim' perspective activates a more general 'patient' perspective. However, the fact that when describing negative scenes, victim-perspective participants were much more likely to produce passives and start utterances with patients suggests that adversity plays an important role in the use of passives or patient-initial active sentences.

THE NATURE OF PHRASAL PLANNING IN ONLINE SENTENCE PRODUCTION

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Several studies have reported evidence for a phrasal scope of planning in sentence production (Smith & Wheeldon, 1999; Martin, Miller, & Vu, 2004; Allum & Wheeldon, 2009), finding longer onset latencies for complex-simple sentences (e.g., “The cat and the apple are above the chair”) than simple-complex sentences (e.g., “The cat is above the apple and the chair”), suggesting that subjects plan both lexical items within a phrase before speaking. Although these researchers have argued that phrasal planning involves lexical retrieval, studies manipulating lexical variables have failed to find evidence of lexical planning beyond the first item (Griffin, 2001; Costa, Navarrete, & Alario, 2006; Crowther & Martin, 2009). The purpose of the current study was to assess what representations are planned in phrasal planning.

Experiment 1: Allum and Wheeldon (2009) found evidence for lexical planning when subjects were presented with a preview of one of the pictures they would subsequently produce in a sentence context, finding priming only for items in the first phrase. However, it could be that the priming they observed was semantic priming, as subjects did not name the prime pictures. In the current experiment, subjects were presented with a single picture to name, followed by three pictures to produce in a sentence. The three prime types were the first picture, the second picture, and an unrelated picture. Prime type was crossed with phrasal complexity. Similar priming was found for the first item in both sentence types, but in contrast to Allum and Wheeldon’s findings, there was negative priming for the second item in the complex-simple sentences, suggesting that planning of both lexical items interfered with production.

Experiment 2: Smith and Wheeldon (1999) found that a preview of three pictures to be produced in a sentence largely eliminated the phrasal complexity effect, arguing that this preview allowed subjects to retrieve the lexical items corresponding to the pictures. In current experiment, subjects were given a preview of the pictures to be named, the structure to be produced, or a preview of both the pictures and structure. In contrast to the Smith and Wheeldon (1999) results, it was found that a picture preview did not significantly reduce the phrasal complexity effect, but the preview of the structure and both the pictures and the structure did. The difference in results across the two experiments is likely due to the fact that the configurations of the pictures in the preview and naming conditions were more dissimilar in the current study. This indicates that retrieving information about picture identity alone is not enough to eliminate the phrasal complexity effect.

The results of the current study support the notion that phrasal planning does not involve the retrieval of lexical items within a phrase. Instead, phrasal planning appears to involve semantic or relational processing. It may further be the case that phrasal planning found in experiments using the visual world paradigm may reflect processes involving scene apprehension, rather than linguistic planning.

References

THE ROLE OF INHIBITION IN THE PRODUCTION OF DISFLUENCIES

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Models of language production often assume the existence of a speech monitor [1] which checks the appropriateness of utterances prior to articulation. According to [2], when a problem is detected the system will produce a collateral signal (uh or um), which conveys information about the difficulty to a listener. One unexplored issue is the extent to which inhibition is required to prevent incorrect speech plans from being articulated. Therefore, we examined disfluency production in participants with attention-deficit/hyperactivity disorder (ADHD), which has been linked to deficits in inhibitory function and response suppression [3]. If inhibition plays a role in monitoring and correcting errors, we expect ADHD participants to produce more repetition and repair disfluencies. They may also be less likely to produce filled pauses, which typically occur in sentence initial positions, and have therefore been associated with planning difficulty.

In this study, 195 community-recruited participants completed 36 trials in which they were presented with two pictures (one animate and one inanimate) and a verb, and their task was to produce a sentence. The design was 3x2x2 (diagnostic group x picture order x verb type). Diagnostic group (control, ADHD-primarily inattentive, and ADHD-combined) was between-subjects. The primarily-inattentive subtype shows elevated symptoms of inattention, and the combined subtype shows elevated symptoms in both inattention and hyperactivity/impulsivity. Picture order and verb type were within-subjects variables. Picture order indicates which picture, animate or inanimate, was presented first. The animate-first order biases towards actives (The man moved the chair.), and the inanimate-first order biases towards passives (The chair was moved by the man). Verb type was either participle (ridden) or ambiguous, meaning that the past tense and past participle forms were identical (dropped). Participle verbs bias towards passives, and have fewer syntactic options compared to ambiguous verbs. Participants also completed assessments of IQ and working memory.

We were interested in the proportion of sentences with a disfluency. We examined filled pauses (uh, er, um), repetitions, and repairs. All three showed a main effect of verb type, with more disfluencies for participle verbs. For both repetitions and repairs, there was a main effect of picture type. The inanimate-first order resulted in more disfluencies compared to the animate-first order. Repairs also showed a main effect of group, which was driven by the ADHD-combined subtype. In the inanimate-first/ambiguous verb condition, the ADHD-combined group was significantly worse than the other two. In the animate-first/participle verb condition, the ADHD-combined was marginally worse than ADHD-primarily inattentive and significantly worse than controls. These results show that the ADHD-combined group experiences difficulty when picture order and verb biases conflict. Differences between the ADHD groups suggest that deficits are likely due to the hyperactive-impulsive symptom domain or some combination of the two symptom clusters. We were also able to rule out IQ and working memory differences as explanations of this finding. These results suggest that inhibition plays an important role in detecting and correcting repair disfluencies in language production.

THE FUNCTIONS AND FORMS OF MINIMAL RESPONSE TOKENS IN A TASK-ORIENTED DIALOGUE

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Spoken interaction often consists of short non-topical utterances, such as okay, alright, yeah, uh huh, right, etc., which Gardner (2001) referred to as minimal response tokens. Recent investigations of these tokens highlight their importance for facilitating cooperative interaction by performing various pragmatic/discourse functions (e.g., Bangerter & Clark, 2003; Gardner, 2001). We report the results of an analysis of minimal responses in a recently constructed corpus of task-oriented dialogue between six adult American English speaking dyads. The dyads communicated remotely via telephone while collaboratively performing a task that required a Searcher to look for target objects (colored boxes) in a search environment consisting of connected rooms. The Director had a map of the environment, which showed the locations of some of the target objects. All communication was verbal, resulting in 29% of the 1,239 turns at talk consisting of minimal response tokens.

The transcribed corpus is coded for the turns’ dialogue move (communicative intention) following Carletta et al. (1997). The coding distinguishes minimal responses that serve as general acknowledgements from ones that are affirmative replies to questions. Drawing from the Conversationalist Analysis framework, the minimal responses coded as acknowledgements were further classified according to five functions shown in the Table. The classification criteria consisted of (1) the previous turn’s move (e.g., instruction, description, reply, etc.) and whether it expressed uncertainty, (2) the previous turn’s terminal intonation (continuative rising or flat intonation vs. falling intonation), and (3) the response token’s position in a discourse segment (beginning, middle, or end).

Table. Number of minimal response tokens performing different functions.

<table>
<thead>
<tr>
<th>Function:</th>
<th>okay</th>
<th>alright</th>
<th>uhhuh</th>
<th>yeah</th>
<th>right</th>
<th>other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree: I agree with you</td>
<td>90</td>
<td>8</td>
<td>15</td>
<td>7</td>
<td>0</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Continue: please continue</td>
<td>51</td>
<td>2</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Confirm: you are correct</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>7</td>
<td>2</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Open discourse segment:</td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Close discourse segment:</td>
<td>84</td>
<td>11</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>141</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>237</td>
<td>26</td>
<td>50</td>
<td>18</td>
<td>16</td>
<td>355</td>
<td></td>
</tr>
</tbody>
</table>

Note: "other" includes phrases such as got it, gotcha.

The Table shows that okay was overwhelmingly the most frequent minimal response token in our corpus, and this was true for all dyads. In addition, okay, its variants (kay, mkay), and alright never performed the Confirm function, whereas uh huh, yes, yeah, and right rarely performed the Open or Close function. The frequent use of okay to perform the Continue function contrasts with previous studies. The criteria for this function were that the preceding utterance was an installment in a complex description ending with continuative intonation. We found that the Continue okays were distinguished from the okays performing other functions by possessing continuative-like intonation on the 2nd syllable, which was reflected in this syllable having a significantly longer duration relative to the other functions. The importance of the different functions to the structure of collaborative dialogue will be discussed.

References
LOCALITY EFFECTS IN RESOLVING NUMBER AMBIGUITIES

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Recent research into the relationship between working memory and human parsing has become increasingly interested in „anti-locality“ effects which were first reported for verb-final clauses in German [3] but have meanwhile also been found for English. Anti-locality effects challenge classical theories of sentence complexity [2] because they show that increasing the distance between two dependent elements can ease the parsing process. We present two experiments showing that garden-path recovery in German verb-final clauses exhibit classical locality effects.

Both experiments investigate the processing of number-ambiguous nouns. As shown in [1], when the parser encounters a number ambiguous noun phrase like „Peters Techniker“ (either 'Peter's technician' or 'Peter's technicians') in subject function, it assigns number based on the frequency with which the head noun occurs as singular or plural in language use. This results in a garden-path effect when the clause-final verb does not agree with the noun's most frequent number value. Experiment 1 varied the distance between the number ambiguous noun and the clause final verb by either including an adverbial phrase of six words or not (see (1)).

The method used was a speeded-grammaticality judgment task with word-by-word presentation; participants gave their judgments immediately after the clause-final disambiguating verb. Measuring garden-path effects in this way was shown in [1] to yield results that closely correspond to results obtained with self-paced reading. In unambiguous control sentences, a determiner replaced the possessive proper name, thereby making the whole NP number unambiguous. Control sentences were either unambiguously grammatical or unambiguously ungrammatical. The results show a garden-path effect for ambiguous sentences with and without adverbial phrase in comparison to unambiguous control sentences. The magnitude of the garden-path effect was larger when the adverbial was included.

Experiment 2 also used a speeded grammaticality judgments with wordwise presentation and manipulated the presentation rate by which words were displayed on the computer screen (fast versus slow presentation rate). With a slow presentation rate, the amount of time that elapses between the number-ambiguous noun and the disambiguating clause-final verb is greater than with a fast presentation. If memory traces become less accessible with time, it should be more difficult to retrieve the number ambiguous noun under the slow presentation rate, thereby making it more difficult to change the number feature in case of a mismatch between the noun’s preferred number assignment and the number specification of the clause-final verb. The experimental results confirm this prediction: a significantly larger garden-path effect was observed with slow word presentation than with fast word presentation.

Taken together, our experiments show the existence of locality effects when processing verb-final clauses. Increasing the distance between ambiguous noun and disambiguating verb - either in terms of additional material or of time elapsing between noun and verb - makes garden-path recovery more difficult (see [5] for related findings from English). We show how our findings can be reconciled with the findings of anti-locality effects as reported in [3] by presenting a computer simulation along the lines of [4].

Example:

(1) Ich glaube, dass Peters Techniker (gerade noch vor Beginn der Pause) den Fehler beseitigt hat.
   'I believe that P.’s technician(s) just yet before start of-the break the bug removed has'

References
TO NAME OR NOT TO NAME: THE ROLE OF SHARED EXPERIENCE IN SPEAKERS’ CHOICE OF REFERRING EXPRESSIONS

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An optimal referring expression should minimize the speaker’s effort, while containing sufficient information for the addressee to identify the intended referent. But do speakers track their addressee’s knowledge and, when they can access it, take into account whether information is shared or privileged to them? Or alternatively do speakers use general heuristics, without consulting event or entity-specific knowledge?

Speakers’ use of names versus descriptions is a useful domain for addressing these issues because a speaker must access her memory representation to retrieve a name. If, as Horton and Gerrig (2005) suggest, memory representations include shared experience, then whether or not a name is shared might be easily available to the speaker. The question of interest, then, is whether speakers take this information into account when generating a referential expression.

In a recent study, modeled on Wu and Keysar (2007), two naïve participants learned names for unrelated novel shapes together. The participant randomly selected to be the speaker then learned some additional names alone. In the test phase, a referential communication task, the speaker was shown a shape on her screen and instructed the matcher, who had three shapes on his screen, to click on the target shape. Like Wu and Keysar, we found that speakers used more names for privileged objects when most names were learned together (high overlap). However, the form of the utterance (including the prosodic form of the name), clearly marked whether the speaker believed the name was shared.

The current study examines whether speakers use the status of individual pieces of information when the information is structured such that the speaker and addressee have overlapping knowledge in a particular conceptual domain, but not others, as is often the case in natural conversation. The two interlocutors learned the names for most, but not all, members of one semantic category (monsters), but only the speaker learned the names for members of another semantic category (robots). This allowed us to test whether speakers rely on the amount of overlap within a semantic category; if so, then speakers should have higher name usage for privileged monsters than privileged robots, since 2/3 of the monsters are shared.

Pairs of naive participants were taught the names for 24 novel items using flashcards. Half of these names (all monsters) were learned together. The speaker learned the remaining half of the names (half monsters, half robots) alone. Training was followed by a referential communication task. The speakers’ utterances were transcribed and coded for whether and how they used the names they had learned.

Speakers used names for shared monsters 65% of the time, but only used names for the privileged monsters 15% of the time. Names used for privileged items had the form name-then-description, which marks this information as privileged. Most strikingly, there was no difference in name usage between privileged monsters and robots. Therefore, shared experience is a powerful cue for whether or not to use a name, even when a categorical heuristic could have been employed.
**USING DISFLUENCY TO UNDERSTAND, UM, SENTENCES . . . WITH PP-ATTACHMENT AMBIGUITIES**

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Listeners can use prosodic cues to help disambiguate sentences. E.g., in “Doggy yelled at the bear with the funnel”, lengthening “bear” and pausing after it promotes the interpretation of “funnel” as an instrument, as opposed to a modifier of “bear” (Snedeker & Trueswell, 2003). However, lengthening and pausing are ambiguous cues, and might instead reflect speaker difficulty, as in “Doggy sang to thee uh beeeear [pause]...” (Ferreira, 2007). How do listeners know how to interpret pausing and lengthening? We test the hypothesis that disfluency leads listeners to attribute them to speech difficulty, rather than syntactic structure – even in the absence of syntactic complexity (cf. Clifton et al., 2006). If so, we would expect pauses to lead to fewer instrument interpretations in disfluent than fluent utterances.

We examined the effect of pausing on PP-attachment ambiguities like “yell...with the funnel”, in both disfluent and fluent utterances. In order to control for known verb biases, we used 16 verb-instrument pairs from Snedeker & Trueswell (2004), and created sentences with animal agents. Sentences were recorded, crossing pausing and disfluency to produce four versions. The pause following the direct object sounded like a typical syntactic break, and co-occurred with lengthening of the direct object noun. Cross-splicing ensured that initial segments were identical across the two fluent (“...yelled at the”), and disfluent (“...yelled at thee uh”) conditions, and the second segment was identical for both pause conditions, and both no-pause conditions. We constructed pictures depicting each interpretation. E.g., the instrument version pictured a dog yelling through a funnel at a single bear. The modifier picture included a contrast set, e.g. two bears, and a dog yelling with his mouth at the one with a funnel. 32 subjects listened to the sentences, and chose which picture better illustrated it (version location counterbalanced). Since this was a meta-linguistic task, no fillers were used. One item was excluded due to cross-splicing problems.

In fluent conditions, listeners chose the instrument interpretation more often in the pause than no-pause condition, consistent with previous evidence that pauses following direct objects signal verb attachment. By contrast, in disfluent conditions there was no pause effect (see Table 1). We assessed the significance of disfluency and pausing effects with a multilevel logistic regression, with both subjects and items as random effects. This revealed a significant disfluency x pause interaction, as well as a main effect of pause. Separate analyses of disfluent and fluent conditions confirmed that the pause had a significant effect only in the fluent condition; the effect of the pause on parsing disappeared in the disfluent condition.

Listeners thus interpreted pauses differently following disfluency. This could reflect sensitivity to the probability of disfluency co-occurring with lengthened surrounding words and pausing (Bell et al., 2003). Alternatively, the disfluency may lead listeners to infer speaker difficulty, which in turn accounts for the presence of the pause. Either way, these results suggest that the informativeness of particular speech cues, like duration and pausing, is modulated by attributions about the source of the cue.

Table 1. Stimulus characteristics for the four conditions (durations given in average msec and SE) and average results, given in % of instrument interpretations chosen

<table>
<thead>
<tr>
<th>Condition</th>
<th>The/thee uh dur.</th>
<th>Object dur.</th>
<th>Pause dur.</th>
<th>%Inst. Chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluent / no pause</td>
<td>127 (10)</td>
<td>384 (38)</td>
<td>29 (5)</td>
<td>68%</td>
</tr>
<tr>
<td>Fluent / pause</td>
<td>130 (10)</td>
<td>493 (38)</td>
<td>212 (15)</td>
<td>79%</td>
</tr>
<tr>
<td>Disfluent / no pause</td>
<td>1379 (67)</td>
<td>381 (39)</td>
<td>35 (6)</td>
<td>66%</td>
</tr>
<tr>
<td>Disfluent / pause</td>
<td>1357 (64)</td>
<td>499 (38)</td>
<td>205 (15)</td>
<td>63%</td>
</tr>
</tbody>
</table>

References
Bell et al. (2003). Effects of disfluencies, predictability, and utterance position on word form.... JASA, 113, 1001-1024.
Snedeker, J., & Trueswell, J. C. (2003). Using prosody to avoid ... Journal of Memory and Language, 48, 103-130
HIDDEN UNACCUSATIVE VERBS AND LICENSING OF STRANDED NUMERAL QUANTIFIERS IN JAPANESE: A SENTENCE ACCEPTABILITY JUDGMENT STUDY

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Data & Hypothesis: Japanese has a group of two-place verbs whose complement can be marked with either accusative case (the acc structure) or an oblique marker (the obl structure) (1a and 1b). Previous studies have shown that these verbs express durative events with the acc structure and instantaneous events with the obl structure (Kuno 1973). They also impose different selectional restrictions on their subjects as subjects must be animate only when these verbs are in the acc structure (Teramura 1982).

We hypothesize that these syntactic and semantic differences obtain because these verbs alternate between transitive and unaccusative verbs. When they are transitive verbs, these verbs express durative events and their subjects are agents. The same verbs express instantaneous events with theme arguments when they are unaccusative verbs. Under the syntactic unaccusativity hypothesis (Burzio 1986), this means that subjects of the alternating verbs are external arguments with the acc structure while they are internal arguments with the obl structure. This analysis makes predictions about distribution of ‘stranded’ numeral classifiers (NCs) associated with subjects under the assumption that NCs and their host NPs must be in a local relation at one point of derivation (Miyagawa 1989).

When the alternating verbs are transitive verbs, their subjects would not license a NC in a post-complement position because they are external arguments (2a). When they are unaccusative verbs, their subjects would license a NC in a post–complement position because they are originally internal arguments (2b).

Experiment: A two-part sentence acceptability judgment experiment (the magnitude estimation) was conducted with 53 university students in Osaka, Japan. The first sub-experiment (Sub-Ex1) examined whether naive native Japanese speakers distinguish unaccusative and unergative verbs with licensing of NCs. Three putative unaccusative (come, arrive and die) and unergative verbs (laugh, dance and swim) were presented in two conditions: (i) non-stranded NC condition with NCs adjacent to subjects and (ii) stranded NC condition with an adverb intervening between NCs and subjects. The second sub-experiment (Sub-Ex2) examines licensing of stranded NCs by subjects of the alternating verbs. Four alternating verbs (touch, ascend, come out and separate) were presented in the same two conditions. These sentences were presented with 40 fillers.

Results: In Sub-Ex1, the difference between the two conditions was not significant with the unaccusative verbs (p =.66) while it was nearly significant with the unergative verbs (p = .07). In Sub-Ex2, the difference between the two conditions with the alternating verbs in the acc structure was significant (p =.003) while it was not significant (p =.16) with the same verbs in the obl structure.

Conclusions: Our results show that (i) native Japanese speakers are sensitive to the interaction between the unaccusative/unergative distinction and licensing of ‘stranded’ NCs and (ii) it is significantly more difficult to associate a stranded NC with subjects of alternating verbs in the accusative structure than the same verbs in the oblique structure. As such, our results provide a strong piece of evidence for the ‘hidden unaccusative’ analysis of the alternating verbs.

(1) a. Kodomo-ga kabin-o/ni sawar -ta
   child-NOM vase-ACC/GOAL touch -PST
   ‘The child touched the vase.’

b. Neko-ga heya-o/kara de -ta
   cat-NOM room-ACC/SOURCE come_out -PST
   ‘The cat left the room.’

(2) a. Accusative Structure:
   [*SUBj-NOM [COMP-ACC NQi Verb]]

b. Oblique Structure:
   [SUBj-NOM [COMP-OBL [ ti NQi Verb]]]

The present study investigated the comprehension of cross-linguistic homographs, or words with two competing meanings exhibiting an orthographic overlap between languages (e.g., TALLER as in “height,” or as in “shop” in Spanish), and cognate words whose meaning and orthographical representation is shared/overlapped between languages (e.g., ACTOR being the same across English and Spanish). In Experiments 1-2, participants made lexical decisions to interlingual homographs (e.g., TALLER) and their English/Spanish controls (e.g., BUSIER/ABUELO), and to cognates (e.g., ACTOR) and their controls (e.g., BREAD/PELO). Participants in Experiment 1 were instructed to make lexical decisions to English words, and in Experiment 2, to respond to Spanish words. Fillers in Experiment 2 were all in Spanish so as to induce participants into the “Spanish language mode.” Overall, results for Experiments 1 and 2 were identical. Cross-linguistic cognates (e.g., ACTOR) were significantly faster than their controls, thus exhibiting a cognate facilitation effect. However, inter-lingual homographs were no faster than their controls, in both Experiments. Experiment 3 utilized a modified visual moving window. Bilinguals in this experiment read sentences, one word at a time, under conditions in which the preceding context biased the meaning of the interlingual homograph (e.g., ...longer legs does not make him TALLER...) or the cognate (e.g., ...Hollywood movie, the ACTOR...), or where the context was unbiased with regard to the meaning of the homograph (e.g., Sometimes being TALLER...) and the cognate (e.g., We all noticed when the ACTOR...). Contextual conditions for the control sentences were identical to those of the homograph/cognate sentences, except that the critical target (e.g., TALLER/ACTOR) was replaced by its control (e.g., BUSIER/BREAD). Among the most critical findings was a significant two-way interaction between Context (Biased vs. Unbiased) and Word Type (Homograph vs. Cognate). Homographs were read faster under unbiased- than biased contextual conditions, thus suggesting exhaustive multiple language activation. However, cognates were faster under biased contextual conditions. More important was the significant three-way interaction of Word Type X Context X Experimental Condition (Control Target vs. Experimental Target). This interaction showed cognates to be faster than their controls, but only in the unbiased context condition, suggesting that this cognate facilitation was possibly due to multiple language activation. In the biased context condition, no cognate facilitation was observed, suggesting that the biased contextual information prevented exhaustive multiple language activation. These results replicate previous research findings reported in the bilingual literature (e.g., Schwartz & Kroll, 2006). The homographs showed a similar contextual effect, with unbiased context producing a negative effect, where homographs took longer to read than their controls. However, this effect was not significant. Results are discussed in terms of task demands, language dominance, current psycholinguistic bilingual language processing and general multiple activation models of human language performance.
UNDERSTANDING ACCEPTABILITY JUDGMENTS: DISTINGUISHING EFFECTS OF GRAMMAR AND PROCESSING

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When building linguistic theories, linguists rely on acceptability judgments as the main source of evidence about the grammatical status of utterances. Substantial evidence, however, demonstrates that these judgments also reflect processing difficulty. Acceptability data thus require further interpretation in theories that explicitly distinguish grammar (formal constraints) from processing (functional constraints). How can theorists decide whether an acceptability contrast stems from formal or functional constraints?

Our research examines whether formal and functional constraints have dissociable effects on acceptability judgments. In a series of acceptability experiments, we consider two factors that might distinguish these constraints: (1) how constraints combine and interact with one another, and (2) the working memory (WM) capacity of participants. If functional constraints tax a finite set of resources, then we should observe super-additive effects on acceptability when some threshold is exceeded. In contrast, if formal constraints reduce acceptability via some other mechanism (i.e. not by creating processing difficulty), they should not yield super-additive effects. Similarly, the combination of formal and functional constraints should not yield super-additive effects, if they tax different cognitive resources. Lastly, when acceptability decrements are due to processing difficulty, subjects with higher WM scores should experience less difficulty and thus find sentences more acceptable.

In Experiment I, we varied two sources of processing difficulty: the distance between two arguments and their syntactic head ([1]). Results indicate main effects of both manipulations, as greater argument-head distance lowered judgments, and a significant interaction: combining two long-distance dependencies produces a super-additive decrement in judgments. Additionally, higher WM scores significantly predict higher judgments of acceptability. In Experiment II, we varied the grammaticality of two parts of the sentence: the tense morphology on a verb and the case-marking on a pronoun ([2]). Each manipulation produced a significant main effect without an interaction, i.e. the constraints did not combine super-additively. In contrast to the results of Experiment I, WM scores did not affect judgments. Experiment III combines grammaticality (tense morphology) and processing manipulations (wh-dependency length), as in [3]. The results reveal a main effect of grammaticality and a significant interaction: processing difficulty lowered judgments only in grammatical conditions -- the constraints combined sub-additively. As predicted, higher WM scores were associated with significantly higher judgments in grammatical conditions, but not ungrammatical conditions.

In sum, phenomena in which judgments improve with increasing WM scores may be due to functional constraints (although other data indicate this relationship disappears in sentences with extreme processing difficulty), and multiple sources of processing difficulty may produce super-additive effects, unlike multiple grammatical violations. Consequently, super-additivity and variation due to subject differences in working memory offer a means to differentiate grammatical and processing effects.

[1a/b] The nurse (who was) from the clinic supervised the administrator who scolded the medic.
[1c/d] The administrator who the nurse (who was) from the clinic supervised scolded the medic.
[2] The friend who (visited / visit) Sue asked (her / she) whether the value of the house had dropped since the recession began.
[3a] They couldn’t remember which lawyer that the reporter interviewed had (defended / defending) the elderly man at the courthouse.
[3b] They couldn’t remember which lawyer had (defended/defending) the elderly man that the reporter interviewed at the courthouse.
GRAMMATICAL AND PRAGMATIC BIASES IN JAPANESE PRONOUN INTERPRETATION

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ueno@ling.ucsd.edu

Background: Previous work (Stevenson et al. 1994; Arnold 2001; Rohde et al. 2006) has shown that pronoun interpretation in English is driven by the interaction of grammatical and pragmatic biases. For instance, Rohde et al.’s passage completion study utilized transfer-of-possession verb frames with pronoun prompts (1), varying verb aspect between perfective (1a) and imperfective (1b). Significantly more interpretations of pronouns to the Source thematic role (the subject referent) occurred in the imperfective condition, correlated with a greater number of Source-biased coherence relations. Rohde et al. (2008) further ran passages with pronoun prompts against those with ‘free’ prompts (2) and showed that pronouns overlay a grammatical subject bias on top of pragmatic biases.

This study: The interpretation of Japanese null pronouns has been claimed to be analogous to the interpretation of overt pronouns in languages without a null form (e.g., Kuroda 1965; Kameyama 1985), although few experimental studies have been performed. Walker et al. (1994) reported an influence of grammatical/information-structural factors, including higher salience to topic- versus nominative/subject-marked referents. We examined whether null and overt Japanese pronouns are influenced by the same types of biases that have been found for English.

Method: Twenty native speakers of Japanese took part in a passage completion experiment with a 2x2x3 design (60 stimuli plus 40 fillers), varying aspect (perfective/imperfective), topic/nominative-marking (-wa/ga) of the previous subject, and prompt type (null pronoun/overt pronoun/free) (3). Two judges (blind to the hypothesis) annotated the referents (Source/Goal/Other) of the matrix subjects and coherence relations (e.g., Source-biased: Elaboration/Explanation vs. Goal-biased: Occasion/Result) in the completed passages.

Results: Overt pronouns led to significantly more subject mentions of the Source than free prompts. Further, aspect significantly influenced pronoun interpretation and coherence relations both in the overt pronoun and free prompt conditions (imperfective yielding more Source referents and Source-biased relations). Both results mirror those of Rohde et al. for English pronouns. However, in the null pronoun conditions, aspect had no effect on interpretation or coherence relations, which was most strongly and uniformly Source-biased. Further, across prompt types, there was no influence of topic-marking on interpretation, but a reliable influence on coherence relations, with topics favoring Source-biased relations (an effect found even in the null pronoun continuations).

Discussion: The results therefore suggest that Japanese null pronoun interpretation is not analogous to English overt pronoun interpretation, being driven predominantly by grammatical position without sensitivity to pragmatic factors. Instead, overt Japanese pronouns patterned with English in demonstrating such sensitivity. The results do not show that topic-marked referents are more salient than nominative-marked ones; however, as with the event-structuring function of aspect, the information-structural function of topic marking appears to influence the manner in which such discourses are coherently continued. The overall data suggest distinctive patterns of interactions between grammatical and pragmatic factors in the interpretation of null and overt pronouns, possibly reflecting a greater degree of grammaticization in null pronouns.

(1)  a. Perfective John (SOURCE) handed a book to Bob (GOAL). He ______________________
b. Imperfective John was handing a book to Bob. He ______________________

(2) Free prompt John handed/was handing a book to Bob.

(3) 太郎が／は 次郎に本を 渡した／渡しているところだった。主語省略／彼は／自由_________________
     Taro-wa/ga Jiro-ni hon-o watashita/watashi-te-iru tokoro-datta. shugo-shoryaku/kare-wa/jiyu
     Taro-TOP/NOM Jiro-to book-ACC handed/hand-INF-ASP scene-was subject-omission/he-TOP/free
     ‘Taro-TOP/NOM handed/was handing a book to Jiro.’ ‘Subject-omission/He-TOP/Free’
Atypical prosodic production is a core feature of autism and is often observed even in high-functioning children with no syntactic or lexical impairments. Many researchers have suggested that autism is characterized by a broad deficit in prosodic processing that affects both production and comprehension. A global prosodic deficit, however, would be expected to have wide-ranging effects. Psycholinguistic research demonstrates the prosody constrains diverse linguistic processes ranging from word segmentation to inferences about communicative intentions. Research supporting a global deficit in prosodic comprehension is sparse: most studies have focused on high-level pragmatic inferences and have employed offline metalinguistic judgment tasks (Paul et al., 2005).

The clearest evidence for a prosodic deficit at a lower level of language processing comes from Diehl and colleagues (2008) who found that adolescents with high-functioning autism (HFA) were less able to use prosody to interpret PP-attachment ambiguities than typically-developing controls (1). These conclusions were limited by: the absence of online measures, the presence of strong bias toward VP-attachment and stimuli which, in the critical condition, required revision of this analysis. The ability to revise has been linked to prefrontal functions (such as cognitive control) which are known to be impaired in HFA (Novick et al., 2005).

We addressed these concerns in a visual-world study (based on Snedeker & Yuan, 2008) using lexically- unbiased, globally-ambiguous utterances. Children with HFA (n=22, 9-15 years) were matched to typically-developing controls (n=22) on age, IQ, and receptive language abilities. The critical utterances contained an ambiguous prepositional phrase which could be attached to the noun as a modifier or to the verb to indicate the instrument used in the action. Prosody was manipulated by placing an intonational phrase boundary either before the first noun phrase (2) or before the prepositional phrase (3). Prosody was blocked such that participants received four utterances with one prosodic structure, then four with the other, with order counterbalanced across participants. The first block provided an index of participants’ ability to use prosody as a constraint on parsing. Comparison of the first and second block assessed their tendency to perseverate in their responses.

We find that children with HFA show no impairment in detecting prosodic cues or employing them during online processing, but they have a strong tendency to perseverate. On the first block, the two groups performed similarly on the offline task (73% correct for both HFA and TD). In both groups, the effect of prosody emerged in the first 500ms after the critical ambiguous word (Table 1). Thus, when the need to revise/inhibit prior responses is minimized, children with HFA showed no impairment in their ability to spontaneously process prosodic information. However, like preschoolers and unlike age-matched controls, HFA children performed more poorly on the second block, suggesting that they are less able to shift their interpretation (HFA 64%, TD 77%). The difference between Block-1 and Block-2 was correlated with age in HFA (r=.44) but not controls (r=.09). Thus while the use of prosody in syntactic analysis is robust in HFA, the ability to switch between interpretations is more fragile and may depend on inhibitory/control processes that develop more slowly in this population.

1. Put the dog...in the basket on the star//Put the dog in the basket...on the star
2. Modifier Prosody: You can feel...the frog with the feather
3. Instrument Prosody: You can feel the frog...with the feather

Table 1: % Looking to Instrument in Block 1

<table>
<thead>
<tr>
<th>Time Window</th>
<th>ASD</th>
<th>TD</th>
<th>Prosody Group x Pros</th>
<th>Group x Pros</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late PP-Object</td>
<td>I Pros</td>
<td>M Pros</td>
<td>I Pros</td>
<td>M Pros</td>
</tr>
<tr>
<td>(700-1200ms)</td>
<td>25.6%</td>
<td>15.6%</td>
<td>26.0%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Early PP-Object</td>
<td>49.3%</td>
<td>22.2%</td>
<td>43.4%</td>
<td>9.6%</td>
</tr>
</tbody>
</table>

References:
Snedeker & Yuan (2008). JML.
REFERENTS WALK AWAY, WHAT DO CHILDREN DO?

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Earlier literature suggests that children’s attentional resources may be limited in combining multiple cues in language comprehension. Even though children are able to use both structural and semantic cues, they may fail to fully interpret visual referential constraints (Snedeker & Trueswell, 2004; Trueswell et al., 1999). We investigated whether the visual presence/absence of the referents would affect children’s comprehension when they resolve ambiguous pronouns. We asked whether visual presence/absence would (similarly) affect linguistically more/less prominent entities (subjects/objects), or, whether linguistic prominence, and, thus, the memory representation of the characters, would suffice to explain preferences in reference resolution (Foraker & McElree, 2007).

In two visual world eye-tracking experiments 4-year-old German children watched short videos depicting a location and two animals while listening to stories. During the second sentence (SVO/OVS), the characters approached each other, participated in the action, and walked away. In Exp.1 both characters remained on the screen; in Exp.2 one character left (counterbalanced: subject/object). Thus, while in Exp.1 both characters were present when children heard the ambiguous pronoun (er ‘he’), in Exp.2 one of them was absent. Following the last sentence, both characters appeared on the screen and children were asked to determine who carried out the action mentioned in the last sentence.

Children’s final interpretations showed a significant subject preference in both experiments, regardless of word order. In Exp.1 a significantly stronger subject preference was observed with SVO than OVS sentences revealed by an interaction between grammatical role and word order. Importantly, in Exp.2, object antecedents were selected significantly less often when they had left the screen, whereas the presence/absence affected subject antecedents significantly less. Children’s eye movement behavior in Exp.1 reflected their offline preferences: There were more looks to the subjects than objects independent of word order. However, of the characters that remained on the screen in Exp.2, children looked more to the object in SVO and OVS early on; and more to the subject in SVO later. Even though they seldom looked to where the characters had left, these looks showed the same pattern, but with a clearer late preference for the subject in SVO.

The study showed that children are not insensitive to visual-referential context in language comprehension. Instead, the inspected co-speech actions affected their comprehension processes and their final interpretation. In addition, the study showed that visual presence importantly contributes to the availability of the referents in four-year-old children’s mental representation. Importantly, while children had a strong memory representation of the referents introduced as subjects, followed by a subject preference unaffected by visual presence; the referents introduced as objects were clearly more amenable to visual presence/absence. This suggests that in the absence of sufficiently clear linguistic cues, children are able to divide their attention between linguistic and visual information.

Da sind der Hase und der Fuchs. Der/Den Hase streichelt den/der Fuchs in der Nähe von dem Fluss. Er...
‘There is the bear and the fox. The bear (SUBJ/OBJ) strokes the fox (OBJ/SUBJ) near the river. He...’
USE OF MORPHOSYNTACTIC CUES IN VERB LEARNING BY JAPANESE 16-MONTH-OLD CHILDREN

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Recent habituation studies have shown that, by 20 months of age, monolingual French, English, and Japanese children can rapidly map novel words onto actions without relying on social-pragmatic cues when the words are presented in a verb sentence frame (Kobayashi & Oshima-Takane, 2009; Oshima-Takane, Satin & Tint, 2008), suggesting that children’s morphosyntactic representations are abstract enough to guide early verb learning. One question that remains to be resolved is whether the representations of morphosyntactic information in immature word learners before the onset of vocabulary spurt are abstract enough to guide their verb learning. The present study addresses this question by investigating whether Japanese-learning 14- and 16-month-olds can use morphosyntactic cues to map novel verbs onto actions rather than agents when both agent and action interpretations are possible.

Using a habituation paradigm with a switch design (e.g., Werker et al., 1998), forty Japanese 14- and 16-month-olds watched two habituation events in which an agent (an animal and a vehicle) engaged in an intransitive action (jumping and bouncing). Each event was paired with a novel word (moke/seta) embedded in a verb sentence frame with a null subject (“moke/seta-shi-te(i)ru-yo”, i.e., “[it] is moke/seta-ing”). After being habituated to the event-sentence pairings, children were given a baseline trial (one of the habituation events) and three switch test trials (agent switch, action switch, and word switch). In the switch test trials, the agent, the action or both elements of the habituation events were switched to evaluate which association they formed with the novel word.

One-way repeated measures ANOVA with test type (baseline, word switch, agent switch, and action switch) for each age group revealed a significant main effect for the 14-month-olds, $F (3, 45) = 4.670, p = .006$, and for the 16-month-olds, $F (3, 69) = 13.599, p < .001$. Further analyses with Bonferroni correction revealed that the 16-month-olds looked significantly longer at the word switch ($M = 17.1s; p < .001$) and the action switch ($M = 12.1s; p = .015$) trial than the baseline ($M = 7.1s$) whereas they did not look significantly longer at the agent switch ($M = 10.6s; p = .176$) than the baseline, indicating that the 16-month-olds were able to map the novel verbs onto the actions rather than the agents. By contrast, the 14-month-olds looked significantly longer at the word switch ($M = 11.9s; p = .004$) than the baseline ($M = 6.7s$) while they did not look significantly longer at the agent switch ($M = 10.7s; p = .098$) and the action switch ($M = 9.7s; p = .409$) trial than the baseline, indicating that the 14-month-olds failed to map the novel verbs onto the actions although they learned the original event-sentence pairings.

The present findings demonstrate that Japanese 16-month-olds but not 14-month-olds can rapidly map novel verbs onto actions. An additional finding that 16-month-olds in the no-word condition noticed the agent change, but not the action change, indicated that the agent switches were perceptually more salient than the action switches in this word-mapping task. These findings together provide strong evidence that children’s representations of morphosyntactic information are abstract enough to guide early verb learning even before the vocabulary spurt.

Reference


SPEAKERS EMPLOY FINE-GRAINED PROBABILISTIC KNOWLEDGE

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Corpus studies of spontaneous speech suggest that grammaticality is gradient (Wasow to appear), contra a widespread assumption. In experiments with the English dative, Bresnan (2007) compared a corpus-derived predictive model to one built from subject trial data, showing that the same probabilistic factors that influence production also influence judgment and are thus arguably part of competence. These models are, however, largely predicated on categorical predictors. In contrast, predictive models of English complement clause (CC) and non-subject-extracted relative clause (RC) ‘that’-optionalitiy (Jaeger 2006) have as their most significant factors the predictability of an embedded clause, given the verb (CC) or head noun (RC) lemma—factors that are themselves highly gradient. Establishing that these factors are similarly involved in judgments could provide evidence that fine-grained probabilistic knowledge is part of linguistic competence.

We undertook eight such judgment experiments, employing both existing methods and experiments run via Amazon’s online ‘Mechanical Turk’ platform, providing access to a large pool of participants.

Experiment 1 (26 participants, 30 items) began with the models of RC-reduction developed in Jaeger (2006). Corpus tokens were then binned by relative model-predicted probability of ‘that’-omission. Six tokens were extracted at random from each of five bins (0≤p<20% likelihood of ‘that’-inclusion; 20≤p<40%; and so on.) In a gradient scoring paradigm—distributing 100 points between available options (Bresnan 2007)—participants rated how likely each choice—with or without ‘that’—was as the continuation of a segment of discourse. As hypothesized, mean participant ratings significantly correlate with corpus model predictions (r=0.614, p=0.0003).

To address concerns that subjects might be ‘over-thinking’ the process, Experiment 2 (29 participants) replicated Experiment 1 using a timed forced-choice paradigm where participants had from 5 to 24 seconds (varied as a linear function of token length) to choose between the reduced/unreduced RC stimuli. These results correlate even more closely with predictions (p=0.838, p<0.0001).

Seeking both to generalize across populations and to explore a methodology of potential to psycholinguistics, Experiments 3 and 4 replicated RC Experiments 1 and 2 on Amazon’s Mechanical Turk (1600 hits each, across 89 and 66 unique participants, respectively). While Turk measures can be expected show lower correlation due to unbalanced data sets, the results remain significant in both trials (r=0.562, p=0.0009; r=0.364, p=0.0285), offering evidence of the robustness of the alignment between production and judgment models.

Next, Experiments 5-8 employed the same paradigms (100-point and timed forced-choice, lab-based survey and via Turk) to investigate ‘that’-mentioning in CCs, where predictability of embedding is an even stronger factor in the corpus model. As with RCs, each of these trials produced significant correlations (r=0.433 to 0.500, p=0.0107 to 0.0034). Finally, mixed-effect logit models were fitted to the judgment data. Exactly as in the corpus-derived models, predictability of embedding remains the most significant factor in all experimental models (excluding individual subject variation).

In conclusion, these results suggest that speakers consider the same factors in judgment as in production, offering evidence that competence grammar includes access to probability distributions.

3.6 Poster Session III

GRICEAN PRINCIPLES AND FREQUENCY IN ANAPHOR RESOLUTION

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Beyond factors such as information structure and coherence relations, grammatical roles are assumed to be central to anaphor resolution in most languages. Generally, subjects seem to play a prominent role in a sentence and this fact makes them highly accessible or even immediately available as antecedents for pronominal anaphors.

In our research, we compare pronominal anaphor resolution in three different languages: French, English, and German, comparing within sentence with between sentence pronoun resolution with two different connectives « before » and « when » (compared to "then", 1a,b,c to 3a,b,c). In a series of off-line paper and pencil experiments as well as in visual world experiments, we established the following pattern:

- All three languages show a clear subject preference for between sentence anaphor resolution in sentences like (1b), (2b), and (3b).
- German and English, both show a subject preference for within sentence anaphor resolution for both kinds of connectives (2a,c,3a,c).
- French shows are clear object preference for within sentence anaphor resolution for both kinds of connectives. (1a,c)

An explanation of the differences between German and French before-sentences could be based on the Gricean principle of manner (avoid ambiguity). In French, the temporal clause can be unambiguously related to the subject of the matrix clause using an infinitival construction such as (1d). In German, no such alternative construction exists. French listeners or readers might thus apply a Gricean logic taking the object of the matrix clause as the antecedent of the the full pronoun in (1a).

A Gricean account is however hard to reconcile with the English data: For English, an alternative construction relating the temporal clause to the subject is available as well (2d). Still, the full pronoun in (2a) consistently shows a clear preference for the subject across experiments. An experience based account is fully compatible with the results of the sentences with « before » . In a small scale corpus analyses (100 sentences per language) we established the following distribution: 77% subject antecedents for German (Frankfurter Rundschau), 64 % subject antecedents for English (Wall Street Journal) and 100 % (Le Monde) or 85% (Google News groups) object antecedents for French. A reason why French speakers prefer producing an infinitival construction for subject antecedents may be the increased complexity of temporal clauses with « avant que ». They demand the subjunctive form of the verb in French, which can be highly irregular and thus harder to access than the infinitival form. The results so far would thus be fully compatible with an approach linking production preferences to comprehension preferences (Gennari & MacDonalds, 2009).

Within anaphor resolution for sentences with « quand », however, poses a problem here: « Quand » does not require the subjunctive form and the subject related alternative (1e) requires a fairly complex and rare participial form. Moreover, corpus counts show a slight advantage for subject antecedents (55%). Nevertheless, we consistently found an object preference in comprehension for French sentences with « quand ». A possible explanation would be a connective independent generalized preference based on the fairly high number of constructions allowing for a less complex infinitival alternative.

(1) a. Le facteur a rencontré le balayeur avant qu’il rentre à la maison. / b. Le facteur a rencontré le balayeur. Puis il est rentré à la maison. / c. Le facteur a rencontré le balayeur quand il était en train de rentrer à la maison. Obj/ d. Le facteur a rencontré le balayeur avant de rentrer à la maison. /e. Le facteur a rencontré le balayeur étant en train de rentrer à la maison.
(2) a. The postman met the street sweeper before he went home. / b. The postman met the street sweeper. Then he went home. / c. The postman met the street sweeper when he was going home. / d. The postman met the street sweeper before going home.
This study investigated the influence of grammatical role and word order on resolution of ambiguous null pronouns (pro) in Korean. Previous work has shown that the preferred antecedent of an ambiguous pronoun is the grammatical subject and/or the topicalized entity as encoded by word order (Gernsbacher & Hargreaves, 1988; Gordon et al., 1993). However, in a rather strict word-order language like English, with syntactic subjects occupying the sentence-initial position most of the time, it is often difficult to tease apart syntactic function and word order. In two self-paced reading studies, we took advantage of the relatively free word-order of Korean NP arguments to determine the contribution of grammatical role and word order in the resolution of ambiguous pro.

In Experiment 1, participants (N=40) read a Korean transitive sentence introducing two characters in the canonical SOV or scrambled OSV order, followed by a sentence containing an ambiguous pro and disambiguation towards either the subject or the object in the previous sentence. A probe question asking the referent of the pro was then presented. The results from on-line reading times at the disambiguation region revealed faster reading times when the identity of pro turned out to be the subject, irrespective of word order. The question accuracy data, analyzed with logit mixed models (Jaeger, 2008), however, yielded an interaction between grammatical role and word order as a significant predictor, with accuracy lowest when participants read a disambiguation towards the subject after the OSV order.

To explore whether the delayed effects of word order was due to the violation of the discourse demands of scrambled sentences (Kaiser & Trueswell, 2004), in Experiment 2, the SOV and OSV antecedent sentences were presented embedded in a supporting discourse. In addition, because there is a cost associated with using a repeated name co-referentially for the grammatical subject of a sentence in a local discourse (Gordon et al., 1993), we varied the continuation type (pro vs. repeated name) to see whether the same cost is observed in Korean for the subject or possibly for the scrambled object presented in a supporting discourse context. The results from both on- and off-line data replicated the findings of Experiment 1: even when the scrambled OSV sentences were read embedded in a supporting discourse context, there was an overall subject preference, but word order affected the final interpretation in conjunction with grammatical role as was in Experiment 1. Interestingly, the repeated name penalty was not observable in Korean.

We interpret the asymmetry in on- and off-line data in terms of the early effect of grammatical cue vs. later heuristics-based interpretation processes. The lack of repeated name penalty in Korean suggests that the expectation for explicit reference to be associated with less accessible entities (Ariel, 1973) might not be directly applicable in Korean.

<table>
<thead>
<tr>
<th>Table 1. Residual reading times at disambiguation (ms)</th>
<th>Table 2. Question response accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXP. 1 pro=S</td>
<td>184.4</td>
</tr>
<tr>
<td>pro=O</td>
<td>691.4</td>
</tr>
<tr>
<td>EXP. 2 pro=S</td>
<td>293.9</td>
</tr>
<tr>
<td>pro=O</td>
<td>631.7</td>
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</tbody>
</table>

AN ACTOR-PREFERENCE IN A SPLIT-ERGATIVE LANGUAGE: ELECTROPHYSIOLOGICAL EVIDENCE FROM HINDI

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The "subject-preference", which assigns the subject function to an initial ambiguous NP, is a highly robust strategy of ambiguity resolution during language comprehension. It has been observed in several languages including Dutch, German, Italian, Spanish, Turkish and Chinese (see [1] for a recent overview) and thus appears to be a good candidate for a universal of language processing.

However, from a cross-linguistic perspective, the category "subject" is ill-defined. In ergative languages, for example, the sole argument of an intransitive verb (S) shows similar morphosyntactic properties (e.g. case, agreement) to the more patient-like argument (O) of a transitive verb rather than – as in nominative/accusative languages – to the more agent-like argument (A) of a transitive verb (i.e. in ergative languages, "Peter" bears the same case/agreement in "Peter slept" and in "John hit Peter"). Hence, in ergative languages, grammatical subject properties (e.g. nominative case, agreement with the verb) diverge from interpretive correlations with the subject function (i.e. subject as cause of the event described).

In view of these considerations, the present ERP study examined the preferred interpretation for an initial ambiguous NP in an ergative language, Hindi. Hindi is of particular interest for this question because it is "split-ergative", i.e. it shows an ergative case pattern in the perfective aspect and a nominative/accusative case pattern elsewhere. This allowed us to examine both the basic preference for an initial NP and whether processing would be affected by the ergative/non-ergative alignment of the current construction.

Thirty native speakers of Hindi read sentences of the type in (1-4) as well as a range of controls and fillers (including sentences in which an initial argument was disambiguated towards an S or A reading). The initial NP was either non-case-marked (1/3) and therefore ambiguous between an S, A and O reading, or case-marked as an O argument (2/4). This manipulation is possible because Hindi has differential object marking, i.e. inanimate O-arguments are only case marked when they are definite/specific. Animate arguments, by contrast, must always be marked, and were therefore not suitable for inclusion in the present study. (For reports of a subject-preference for inanimate arguments in other languages, see [1-2]). The disambiguating verb was either in the imperfective (1/2) or perfective aspect (3/4).

ERPs at the position of the verb showed an N400 for the disambiguation towards an O-reading in both the imperfective (1 vs. 2) and perfective aspect (3 vs. 4). (Note that N400s are not unprecedented in the domain of word order disambiguation, see [1,3].)

These results provide evidence for an S/A-over-O preference in Hindi, the revision of which is costly irrespective of the ergative vs. non-ergative status of the construction and of whether the O argument agrees with the verb (3) or not (1). We derive this possibly universal "Actor"-preference from the endeavour to minimise semantic dependencies within generalised semantic role assignments [4].

References:
MOTION AFFECTS SPEAKERS’ MESSAGE CONSTRUCTION

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Great strides have been made in understanding production mechanisms, such as proposing how speakers transfer the meaning of an intended message into linguistic components. However, it has been difficult to investigate the factors that influence meaning construction. Comprehension research has argued for the importance of embodiment/simulation in sentence interpretation, e.g. showing interactions between motor activities and the comprehension of sentences that describe movement. To explore both message construction and the role of embodiment/simulation in production, we examined whether motor activities influence event descriptions in language production.

Experiment 1 (Japanese) examined whether prior physical activity affects the direction of events chosen for messages. Thirty-six participants were first cued to make toward-, away-, right-, or left-motions with a computer mouse. The screen then displayed the sentence fragment “Watashi-wa (I am)…” followed by two successive pictures (300 ms each) in the canonical word order of Japanese: a location (a basket) and then a target object (an apple). Speakers completed the fragment by describing an action involving the two pictured objects. The speech was otherwise unconstrained. End-of-experiment interviews confirmed that no participant noticed any relationship between the mouse movement and the pictures/speech production.

We predicted that when participants formulated their messages, previous motion would activate embodied knowledge associated with linguistic knowledge. As a result, engaging in toward-movement would increase the proportion of sentences denoting toward-movement (e.g. taking an apple from the basket) while away-movement would facilitate the activation of away-language (e.g., putting an apple into the basket).

Both participant and item analyses showed significant effects of the action for both toward and away responses (all p’s<.005). Further, there was a significant relationship between event language and word order: away-language sentences were more likely to have scrambled word order than canonical word order, while toward-language sentences were expressed more in canonical order. This suggests a bias for linguistic orders that align with the spatial and temporal order of the events described in the stimuli (4): in away sentences, attention centers first on the direct object and then on a location that would typically be further away from the agent, while in toward sentences, the typically distal locations are mentioned before the direct objects.

Experiments 2 (Japanese,N=40) and 3 (English,N=19) were identical to Experiment 1, except that the physical activity was performed after perceiving two pictures, i.e., while constructing the message. Results for each language showed that motion again influenced toward/away predicate choice (all p’s<.05), although the word order effect diminished.

The results indicate that direction-oriented activities feed directional information to the subsequent (Experiment 1) or concurrent (Experiments 2, 3) process of meaning construction, which in turn is used to configure event descriptions. They support the claim that speakers access event representations in chronological order by running simulations while producing language. Since the motions used here are typical motions that can co-occur with everyday speech, this provides groundwork for future investigations of how motions might influence message generation in fully spontaneous speech.
SCALAR IMPLICATURES ARE SENSITIVE TO THE SPEAKER’S EPISTEMIC STATE

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Perceivers can generate a scalar implicature (SIs) when a speaker uses an expression that is less informative than a salient alternative. For example, (2a) is often interpreted as conveying that not all of the Chardonnay was missing, because the speaker chose the less informative “some,” rather than the more informative “all.” The not-all implicature arises because the perceiver infers that the speaker was not in a position to use the stronger quantifier [1,2]. This requires social reasoning. The perceiver recovers the speaker’s intentions by taking her perspective and imagining what she could have said from that perspective. This potentially involves consideration of the speaker’s epistemic state.

There has been disagreement in the linguistics literature about how sensitive SIs are to speaker knowledge. If \( w \) is the sentence uttered by the speaker and \( s \) is a salient alternative that is more informative than \( w \), there are a number of possibilities. One possibility is that uttering \( w \) implies the negation of \( s \) \((\neg s)[2] \) or that the speaker knows \( s \) is false \((K\neg s)[3] \). Both of these accounts yield a strong implicature—that the more informative statement is actually false. They are also insensitive to the speaker’s knowledge. An alternative is that uttering \( w \) merely implicates that the speaker doesn’t know \( s \) is true \((\neg Ks)[4] \). This is a weaker implicature than positing \( s \) is false. It also predicts that the strong implicature arises in a context where the speaker is assumed to know whether \( s \) is true \((\neg Ks \& (K\neg s \lor Ks)=K\neg s)) \).

This present study investigates how speaker knowledge influences SI generation. Using a self-paced presentation, participants read sentences like (2a) in contexts where the speaker should know whether “all” was true (1a), or where she merely might know (1b). Expectations about speaker knowledge were confirmed via an offline survey. A final sentence either affirmed the strong SI (3a) by referring back to the complement set conjured by the strong SI (e.g., some bottles that are not missing for (2a)), or cancelled both the weak and strong SI by announcing \( Ks \) (3b). If the default SI is strong, then speaker knowledge shouldn’t matter. If instead the SI is weak then participants should compute the strong SI only when the speaker has full-knowledge.

Knowledge had reliable and immediate effects on RTs. The scalar quantifier and subsequent two words were processed more slowly in the full-knowledge conditions. This is likely because the strong SI invoked a complement set thereby increasing the complexity of the discourse. In contrast, full-knowledge led to faster RTs for Affirmations, presumably because the complement set was more available for reference when the strong SI was generated. When the complement set was introduced literally(2b), there were no effects of speaker knowledge. Finally, Cancelation was equally difficult for both full and partial knowledge. This suggests that it is equally difficult to rescind the strong SI and the weak SI. This work demonstrates that knowledge affects SI generation and that SIs are generated immediately upon encountering a scalar expression.

Context Sentence Conveying Speaker Knowledge:
(1a) Full: After my house was burglarized, I carefully inventoried my wine collection.
(1b) Partial: After my house was burglarized, I briefly checked the basement.

Critical Sentence:
(2a) Scalar: Some of the bottles of Chardonnay were missing
(2b) Literal: Only some of the bottles of Chardonnay were missing

Final Sentence:
(3a) Affirmation: The rest were safe, but I was still extremely upset.
(3b) Cancelation: In fact, they all were even though I had secured them.

PROCESSING PITCH ACCENTS IN CONTEXT: AN ERP STUDY

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In Germanic languages, pitch accents are used to mark focus constituents which represent the most informative part of an utterance. Similarly, the lack of prosodic prominence is linguistically meaningful as a signal for less important background information. Recent ERP studies attribute prosody processing to contradicting neural correlates. Some studies report an N400 for missing accents on focus constituents only [1], while others claim that all incongruous prosodic patterns elicit different components (P300, N400), depending on their sentence position [2]. In addition, the processing of prosodic mismatches has been related to a so-called 'P800' component [3]. The different languages and tasks used in these studies further complicate the interpretation of the results.

The present study investigated how listeners process contextually incongruous prosody on focus and background elements. Twenty-nine Dutch participants listened to short dialogues (occasionally answering a comprehension question), while their ERPs were recorded. Each dialogue sequence consisted of a question and an answer. The question set up a context with a choice to be made between contrasted elements either in medial (1) or in final (2) sentence position. In the answer, the contextual expectation for an upcoming focus constituent and its accentuation was either met (a) or violated (b). We analyzed targets in medial position that represented the focus (1a, 1b) or the background (2a, 2b) and were respectively incongruously deaccented (1b) or incongruously accented (2b). ERPs were time-locked to the onset of each stimulus relative to a 200 ms pre-stimulus baseline. ANOVAs performed on nine ROIs showed a significant interaction between Accent x Congruity (p<.01) for incongruously accented elements on right regions in a time window between 300-500 ms post stimulus onset. That is, superfluous accents on background elements triggered a right lateralized N400. In a late time window between 800-1100 ms, there was an effect of Congruity (p<.05) on occipital regions for both incongruously accented and incongruously unaccented medial elements. Hence, both superfluous and missing accents elicited late positivities on occipital regions that can be interpreted as an instance of a P800. Alternatively, this positivity may represent a P300 that belongs to the processing of the second prosodic violation in final position (player in 1b, 2b).

The current experiment provides evidence that contextually incongruous prosody is processed on-line even when listeners do not actively attend to accentuation. In contrast to [1] and similar to [2], our results suggest that listeners process prosodic mismatches on both focus and background elements and do not ignore the accentuation of the latter. Unlike the P300 reported for missing and superfluous accents in medial position [2], we found that prosody processing depends on the type of prosodic mismatch: Superfluous accents elicited an N400 effect whereas missing accents did not. Moreover, all prosodic mismatches elicited late positivities. Along with this qualitative difference, listeners processed incongruously accented words faster than incongruously unaccented ones, as revealed by the N400 and P800 respectively. Hence, the presence of prosodic prominence not only facilitates speech comprehension but also contributes to a faster detection of incongruity.

1. Did the club give a bonus or a fine to the player?
   (1a) congruous accent on focus They gave a BONUS to the player.
   (1b) incongruous missing accent on focus They gave a bonus to the PLAYER.
2. Did the club give a bonus to the player or to the trainer?
   (2a) congruous missing accent on background They gave a bonus to the PLAYER.
   (2b) incongruous accent on background They gave a BONUS to the player.

A MARKER OF AUTOMATIC SYNTACTIC PROCESSING OR A CONTEXT-RELATED EFFECT? THE ELAN REVISITED.

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A considerable number of influential studies using a phrase structure (PS) violation paradigm in spoken German (and Italian) sentences have consistently reported early left anterior negativities (ELANs) between 100 and 300 ms (Hahne & Friederici, 1999, Friederici, 2002, Rossi et al., 2006). The ELAN’s short onset latency was taken as an important marker of very early automatic parsing processes and has been contrasted with subsequent morpho-syntactic parsing stages reflected by later LANs (300-500 ms). More recent research has cast doubt on this interpretation and discussed alternative accounts for the ELAN, including baseline problems due to systematic lexical and prosodic differences between violation and control conditions (Van den Brink & Hagoort, 2004). The long duration of some ELAN effects (e.g., more than 1400 ms in Rossi et al., 2006) also seems incompatible with an early automatic process. To better understand the etiology and functional significance of ELAN- and LAN-like ERP components, we created a novel, fully balanced PS violation paradigm in English avoiding previous confounds: Averages across (i) violation conditions (C+D) and (ii) control conditions (A+B) share identical baselines and identical target words.

A) The man hoped to enjoy the meal with friends.
B) The man cooked the meal to enjoy with friends.
C) The man hoped to meal the enjoy with friends.
D) The man cooked the enjoy to meal with friends.

(Note: * indicates the PS violation; target words are underlined.)

A previous reading study using these sentences found LAN-like negativities after 300 ms and subsequent P600s, but no ELANs (Steinhauer et al., 2006).

Methods. Here we replicated the study with 40 spoken sentences per condition, in both young (n=20) and older adults (65-85 years; n=12). EEG was recorded continuously from 19 electrodes (10-20 system, SynAmps2 DC, 500 Hz/24 bit sampling), and data were analyzed using EEProbe software.

Results. In young adults, PS violations elicited a biphasic pattern consisting of a right-lateralized negativity (400-750 ms) followed by a P600-like positivity (750-1700 ms), as well as a sustained left-frontal negativity after 300 ms. A somewhat earlier and more frontal negativity for PS violations was observed in comparisons of conditions A and D that are similar to the German PS violation paradigm previously found to elicit ELANs (Hahne & Friederici, 1999). However, although the target verb was kept constant in this contrast, these conditions still differed in terms of prior context. In fact, contrasting B and C results in the inverse pattern, suggesting a context rather than a violation effect. Older subjects generally elicited reliable P600 components but reduced negativities.

Discussion. The present study adds important new data to advance our understanding of ERP correlates for PS violations. First, early ELAN-like components may be partly due to contextual differences between violation and control conditions rather than the violation per se. Second, negativities preceding the P600 in PS violations seem to vary in scalp distribution and are affected by age. Third, sustained frontal negativities appear to be independent of early LAN-like effects and may reflect working memory load.
THE IMMEDIATE COST OF EMBODIED PROCESSING IN ASPECTUAL COERCION: EVIDENCE FROM EVENT-RELATED POTENTIALS

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Introduction: Punctive verbs, such as kick, describe bounded events which occur within short periods of time (e.g. After several minutes the boy kicked the ball). Nonetheless, when placed within durative contexts, comprehenders readily understand such verbs to mean that multiple events have occurred (e.g. For several minutes the boy kicked the ball. describes several kicks). This process is termed aspectual coercion [1]. Previous studies have yielded mixed results as to whether aspectual coercion occurs online during language processing, some reporting immediate behavioral [2,3] and neural [3] cost while others have not [4]. In the current experiment we used Event Related Potentials (ERPs) to examine the time course of aspectual coercion. Unlike previous studies we measured processing on the verb itself, contrasting punctive with durative verbs (e.g. run) and contrasting aspectual coercion with explicit iterativity (e.g. Several times the boy kicked the ball.) to determine the extent to which aspectual coercion costs reflect abstract semantic combinatorial operations [5] and/or the cost of embodying multiple (versus single) individual events [6]. Methods: Event-related potentials (ERPs) were measured as participants read sentences, presented word-by-word (450ms, 100ms ISI), that contained critical punctive verbs in one of three contexts: 1) punctive (non-coerced, single iteration), 2) explicitly iterative (non-coerced, multiple iterations), or 3) durative (coerced, multiple iterations); see example. Durative (non-coerceive) verbs were likewise presented in each of the three contexts. Choice of punctive and durative verbs were based on a separate rating study and all verbs could plausibly appear in all three contexts. Participants answered yes/no comprehension questions interspersed throughout the experiment. Results: When punctive verbs appeared in durative contexts, they evoked a larger frontally-distributed negativity between 400-600msec than when they appeared in punctive contexts, consistent with recent MEG findings [3]. The same effect was seen to punctive verbs in explicitly iterative (versus punctive) contexts. Punctive verbs in durative contexts (relative to both other types of context) additionally evoked a sustained negativity effect between 800-1000msec. Processing of durative verbs was unaffected by context in any time window. Discussion: Our findings suggest that aspectual interpretation is computed online as soon as it becomes licensed [2,3]. The continued processing penalty may reflect the consequences of abstract semantic operations involved in aspectual computation [5]. However, the initial cost of this computation appears to reflect processes related to iterating a single, short-lived punctive event. Such an interpretation is consistent with embodied models of language processing [6].

Introductory Sentence: Tom and Rita went to the park to play with a ball.
Punctive context/ Explicitly iterative context/ Durative context:
After several minutes… / Over and over… / For several minutes…
Remainder of sentence, punctive verb: … Rita kicked the ball.
Remainder of sentence, durative verb: … Rita ran with the ball.

OVER-SPECIFIED REFERENTIAL EXPRESSIONS IMPAIR COMPREHENSION: AN ERP STUDY

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The Gricean Maxim of Quantity states that speakers should not include more information than is necessary for an object to be identified [1]. Several studies, however, have shown that speakers will often include unnecessary modifiers when producing referential expressions [2]. There is currently a great deal of debate about the comprehension of referential expressions with unnecessary modifiers, called over-descriptions. Some argue that over-descriptions are detrimental to comprehension [3], and others argue they are beneficial [4]. In this study, we used a Posner-type attentional cuing paradigm to examine more precisely the processing costs associated with over-descriptions.

Ten participants were presented with two side-by-side objects on a computer screen. Objects were either of the same type (two squares) or different (a square and a circle). After two seconds, a fixation cross appeared in the center. Participants were required to fixate the cross. Following an interval of 500ms, participants heard an utterance that referred to one of the objects (e.g. “look to the large square”). Participants made a left or right button press corresponding to the side of the display the target was on. RTs and ERPs were the dependent variables, and were time locked to adjective onset. The design was 2x2 (modifier type x display type). Modifier type was either size or color, and display type was contrast present (two objects of the same type) or contrast absent (two different objects).

For RTs, both main effects were significant. RTs for over-described instructions (contrast-absent displays) were slower than for contrast-present displays, and color modifiers were responded to faster than size modifiers. The significant interaction was driven by larger differences for size modifiers (~140ms) compared to color modifiers (~75ms). Preliminary ERP results revealed that size over-descriptions produced a centro-parietal negativity in a 450-800ms time window compared to when size was not over-described. Color over-descriptions initially generated a centro-frontal positivity in a 300-500ms time window, which was followed by a sustained negativity in a 650-900ms time window. This sustained frontal negativity has a similar distribution as the Nref component [5], which occurs in response to ambiguous (or under-specified) referential expressions.

Based on these results, we conclude that subjects generate expectations about linguistic input because with both contrast-absent (over-described) and contrast-present displays, the target is uniquely identifiable at the modifier. When the display does not necessitate a modifier, participants expect an unmodified NP, and when this expectation is violated with an over-description, it results in a slowdown in RT. ERP results indicate that referential processing with size and color involves qualitatively and quantitatively different mechanisms. Color related components showed an earlier (positive) onset with a frontal distribution, similar to the P3a component, which suggests stronger attention allocation and faster RTs. This positivity was followed by a sustained negativity, similar to the Nref. Size related negativity in centro-parietal regions occurred earlier than the color related negativities. Based on these data, we conclude that over-specified referential expressions impair comprehension.

WHAT IT TAKES TO BE A GOOD ACTOR: A MULTILEVEL-REGRESSION ANALYSIS OF ERP DATA
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It has been proposed by Bornkessel-Schlesewsky and Schlesewsky (2009) that it is a cross-linguistically valid goal of language comprehension to unambiguously identify the participant that is primarily responsible for a linguistically expressed event (actor). Further participants are defined in opposition to the actor and competition for the actor role is costly. An important feature for actor identification is animacy. Accordingly, an N400 is evoked if the subject analysis is contradicted by animacy (e.g. inanimate subject) across different languages such as German (e.g. Frisch & Schlesewsky, 2001), Mandarin Chinese (Philipp et al., 2008), English (Weckerly & Kutas, 1999) and Tamil (Muralikrishnan, R. et al., 2008).

But is it really animacy per se or do other prototypical actor features such as causation, sentience, volition or autonomous movement (cf., for example, Dowty, 1991) determine the goodness of an actor? In order to answer this question, we constructed a structural equation model and conducted a questionnaire study, based on our previous knowledge about linguistically relevant actor features as well as findings by Corrigan (2002). The model consists of a measurement model with 12 7-point Likert scales (e.g. with / without consciousness) and a structural model with agency as a latent variable. A total of 215 students participated in the online study and rated 180 nouns.

In a subsequent ERP study, we used 168 of those nouns and their corresponding factor value ranging from -4.5 (poor agent) to 3.4 (good agent) in order to test the impact on online sentence processing. Our sentence material consisted of 336 German verb-final subordinate clauses, which allow to investigate argument processing before a verb is encountered. Each noun was presented with a definite determiner and preceded by an unambiguously case marked wh-pronoun for nominative (SO) and accusative (OS). 40 German native speakers between 19 and 32 years of age participated in the study. ERPs were time-locked to the second noun phrase (good agent: der / den Richter; poor agent: der / den Bettler).

If further participants are defined in opposition to the actor role, we expect decreasing agency values to make sentences in the OS condition more costly, as reflected in a negativity between 300-500ms. As we used agency as a continuous variable, we analysed the data using multilevel regression analysis. The regression analysis revealed an interaction between the predictors agency and word order in this time window, thus confirming our hypothesis. Interestingly, we find this effect even if we analyze human nouns separately suggesting that animacy per se is not the decisive factor. These results imply that, in addition to the mere animate-inanimate dichotomy, more fine-grained differences might determine actor identification during online language comprehension.

WHEN PROSODY CUES SYNTACTIC STRUCTURE, ONLY TO BE IGNORED: AN ERP STUDY OF THE COMPOUND/PHRASAL STRESS DISTINCTION IN ENGLISH

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Previous research using picture/word matching tasks has demonstrated a tendency to incorrectly interpret phrasally stressed strings as compounds [1,2]. We used ERPs to investigate whether this pattern stems from poor perceptual sensitivity to the compound/phrasal stress distinction, or from post-perceptual bias in behavioral response selection (e.g., due to frequency or a preference for analyzing strings as lexical items).

Twenty adults participated. Test items were 44 pairs of segmentally identical phrases and compounds. In experimental trials, an image (e.g., a green-colored house) established context and was followed by a sentence featuring the test item with either the congruent (green house) or incongruent (greenhouse) stress pattern, for a 2 (stress) x 2 (congruency) within-subjects design. Subjects indicated whether the item depicted was named correctly. With EEG time-locked to test-item onset, ERPs were calculated separately for each stress pattern as the difference between congruent and incongruent trials.

Behavioral results replicated previous findings of significantly greater accuracy for compound stress (89% for congruent compounds, 72% for congruent phrases). In incongruent trials, there was a tendency to indicate (incorrectly) that the test item matched the image; subjects responded correctly to only 32% of incongruent compounds and 13% of incongruent phrases. A modified signal detection theory (SDT) analysis of these results showed a bias towards the compound interpretation of test items; criterion was significantly lower when compound-congruent images set the context \([t(19)=-3.23, p<0.01]\). However, no significant difference in sensitivity was indicated, (i.e., the two discriminability indexes did not differ significantly \([t(19)=-1.61, p>0.10]\)).

A right-anterior positivity (RAP) was observed for both stress patterns when incongruent with the image. A LAN was observed for incongruent compound stress, whereas incongruent phrasal stress elicited a biphasic LAN-P600 response. ANOVAs confirmed significant main effects of congruency in the 400-600ms time window for the RAP \([F(1,19)=5.75, p<0.05]\) and LAN \([F(1,19)=5.92, p<0.05]\), with no effects of stress or stress/congruency interactions. Analysis of the P600 yielded a significant stress/congruency interaction during the 850–1000ms window \([F(1,19)=4.78, p<0.05]\), as only incongruent phrasal stress elicited a P600. The RAP response reappeared in conjunction with the P600, with a significant main effect of congruency \([F(1,19)=4.51, p<0.05]\) during the 800-1000ms time window.

We interpret the RAP as a response to prosodic expectancy violation [3], and the LAN-P600 as reflecting the computation of unanticipated syntactic structure (a phrase when a single word is expected). These results complement the SDT analysis of the behavioral data, demonstrating sensitivity to both stress patterns. This suggests post-perceptual bias as the source of previous findings of a preference for compounds [1,2]. Our findings also complement previous evidence for an early syntax/prosody interaction, in which the right hemisphere contributes prosodic information to the initial structure building process [4]. Moreover, our results suggest that the same right-hemispheric resources actively modulate later parsing stages, as reflected by a second RAP co-occurring with the P600. This study is the first to demonstrate that prosodic expectancy violations over well-formed noun-phrases can elicit a LAN-P600 response.

THE PROCESSING OF PRONOUNS WITH NUMBER MISMATCH BY NATIVE AND NONNATIVE SPEAKERS OF ENGLISH: EVIDENCE FROM EYETRACKING

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In English the plural pronoun “they” can be used to refer to singular antecedents (I saw someone, and asked them for directions). Models of pronoun resolution (e.g. Sanford, 1985) often assume that pronoun resolution occurs through a conceptual search for a referent that matches features marked on the pronoun (i.e., gender and number). Assuming that “they” is treated as a purely plural entity this predicts a processing cost where “they” is used to refer to a singular referent. A recent eye-tracking study by Sanford & Filik (2007) confirmed that native English speakers experience a processing cost of number mismatch for both plural and singular pronouns, although this occurs later, and is overcome more easily, for singular-plural pronoun-antecedent pairs (someone-them) than plural-singular pairs (some people-her). The current research further investigates this previous finding and extends it to highly proficient nonnative speakers of English. Because the use of plural pronouns as gender-unspecified singular pronouns is unique to English, an interesting question is whether native and nonnative speakers are differentially sensitive to mismatching plural pronouns.

Native and nonnative participants read short texts (from Sanford & Filik, 2007) while their eye movements were monitored. As illustrated below, sentences had a singular or plural referent referred to by a pronoun (him/her/them) that was either matching or mismatching with the referent in number. Different but matched groups of native and non-native speakers rated the same set of sentences for grammaticality. In the offline study non-native speakers rated mismatching-them as less natural than native speakers. In the first of two on-line reading tasks, native speakers did not experience any processing cost for mismatching-them. A second experiment that differed only in terms of filler sentences, making participants more likely to identify the experimental items, did find some evidence of a processing cost for mismatching-them in total reading times only. Crucially, the nonnative speakers do NOT show an apparent on-line processing cost for mismatching-them. However, both groups did demonstrate a cost of number mismatch for singular pronouns although this effect occurred later for non-native than native speakers. These results challenge the findings of Sanford & Filik (2007) and suggest that, when processing plural pronouns, we are more tolerant of violations in feature mapping rules, consistent with a constraint-based approach to pronoun resolution (Arnold, 1998, Arnold, 2000). Finally, these results also contribute to a growing literature that suggests that, during sentence processing, non-native speakers show different, more native-like performance in online than offline tests (e.g. Roberts, et al. 2008, van Hell, in press).

Example: Mr Jones was looking for the station. He saw [antecedent] someone/some people on the other side of the road so he crossed over and [pronoun] asked them/ her [adverb] politely [final] where the station was. It was in a different part of town.
CAN YOU GET A FISH OUT OF A SWIMSUIT? SEMANTIC ACTIVATION OF EMBEDDED VERBS IN COMPOUND NOUNS.

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Recent visual-world eye-tracking studies have shown that as listeners hear a noun unfold, they partially activate semantically-related concepts. For instance, hearing the word “piano” leads listeners to look briefly at depicted semantic associates (e.g., a trumpet, Huettig & Altmann, 2005). Similarly, Myung, Blumstein, and Sedivy (2006) report that objects (e.g., a typewriter) sharing action-relevant affordances with target concepts (e.g., “piano”) receive referential consideration. Yee and Sedivy (2006) found that even phonological competitors of target words activate associated concepts (e.g., hearing “log” increases fixations to a depicted key – a semantic associate to the phonological competitor “lock”).

Studies to-date on this topic have focused exclusively on whether semantically-related noun concepts are activated upon hearing a partial or complete spoken noun. Here, we consider whether an "embedded verb" occurring within a noun can trigger partial activation of related noun concepts and whether this activation reflects syntactic in addition to semantic factors.

Eye movements were monitored as listeners viewed computer displays containing four objects and clicked on the object corresponding to an isolated spoken word (e.g., "popcorn", or "swimsuit"). On critical trials, names of target objects were verb-noun compounds. In addition to the target, each critical display included a competitor that was either a semantic associate (SA) of the embedded verb in the target name (e.g., a balloon, for “_pop_corn”), or a semantically-unrelated control that was visually similar to the SA (e.g., a hand mirror). Importantly, SAs reflected strong associations only with embedded verbs and not the full target nouns. Additionally, we included two types of SA’s to examine whether activation depends on the embedded verb’s argument structure frame. In the “Both” condition, the depicted SA could commonly occur as either the subject or object of the embedded verb (e.g., balloon, for "popcorn"). In the “Subject Only” condition, the SA typically occurred with the embedded verb only as a sentential subject (e.g., fish, for "_swim_suit").

Results showed listeners made significantly more transient fixations to SAs than to control objects, reflecting partial activation of noun concepts via the verb embedded within the unfolding noun. However, this was observed only when the competitor could occur in either subject or object position within the embedded verb’s syntactic frame, and not when it could occur solely in subject position. LSA measures confirmed the difference was not an artifact of overall stronger associations between embedded verbs and SAs in the former condition. We suspect that significant activation of the SA in the “Both” condition is critically tied to its potential to occur as a post-verbal argument, and that the pattern is best explained in terms of verb-based anticipatory effects (cf. Altmann & Kamide, 1999) combined with "merely local" syntactic processing (cf. Tabor et al., 2004) whereby local combinatory possibilities (even when globally impossible) are computed as language unfolds.

An ongoing experiment tests a strong version of this hypothesis, examining whether embedded verbs' activation of "post-verbal" noun concepts still occurs when using sentence frames that underscore the noun status of the target word ("_Click on the_ popcorn").
ARE LANGUAGE-MEDIATED SHIFTS IN VISUAL ATTENTION AUTOMATIC OR UNDER VOLITIONAL CONTROL?

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Research on situated language processing has identified tight connections between language processing and visual attention. While language can guide gaze in a co-present scene, visual information in turn can influence comprehension processes (e.g., Tanenhaus et al. 1995, Altman & Kamide 1999, Knoeferle & Crocker 2006). Eye movements have been utilized in the study of a variety of linguistic phenomena in the visual world paradigm. Underlying these studies is the assumption that eye movements can be linked to linguistic processes such as lexical activation, anticipation of upcoming verb arguments, and syntactic disambiguation. A challenge to this linking hypothesis is that predicted eye movements are not observed in every instance or in every participant. Since eye movements can be subject to volitional control, it is possible that participants in visual world studies may simply choose to look at a particular object at a particular time. To find out to what extent language mediates involuntary shifts of visual attention we tested its effect on covert visual attention. Saccadic eye movements are always preceded by a shift of covert attention to the eye movement target (Henderson 1992). These shifts, in contrast to eye movements, can be tested for being voluntary or automatic.

We conducted a study investigating the influence of language on covert visual attention using Posner’s spatial cuing paradigm (Posner 1980). Participants first saw displays consisting of two object photographs, then heard a word referring to one of those two objects, and subsequently had to detect the appearance of a visual target while fixating on a centrally presented cross. The target could appear in the same location as the named object (valid cue) or in the location of the unnamed object (invalid cue). Additionally, we manipulated between participants whether the spoken word was predictive of the location in which the target would appear: in the predictive condition, 75% of trials were valid, whereas in the unpredictable condition the cue was as likely to be valid or invalid (50% valid). While in the predictive case participants were expected to direct their attention voluntarily towards the location of the named object, this was not the case for the unpredictable condition, where participants were encouraged to ignore the word on the whole. Reaction times were significantly faster if the cue was valid (p<.001) indicating an attentional shift towards the location of the named object before the target appeared. In the predictive condition, participants were on average 26 ms faster on valid cue trials. Crucially, participants were also faster on valid cue trials in the unpredictable condition, where they were not expected to orient their attention voluntarily. The difference of 8 ms was confirmed to be significant by a follow-up anova (p<.005). These results show that the link between language and visual attention is not dependent on volitional control, which verifies the close link between attention, and language that is presupposed in visual world studies.

SIZE MATTERS, FOR A WHILE…

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Models of semantic representation differ in terms of the nature of the representations they posit, but in one aspect their assumptions are similar: given a set of concepts one can express their semantic similarity in terms of overlap either in feature space (e.g. McRae et al. 1997, Vigliocco et al. 2004), or in a multidimensional vector space derived from word co-occurrences (e.g. LSA, Landauer & Dumais, 1997). Importantly, these approaches implicitly assume a static semantic representation. However, it has been shown that meaning can be dynamically modulated by context: participants are faster to recognize “thorns” after hearing “The girl was pricked by a rose” than “The girl smelled the rose” (Tabossi, 1988). The dynamic activation of individual features of concepts may in turn influence their similarity to other concepts in upcoming discourse: a cactus may be perceived as more similar to a rose after the first than after the second sentence.

We explored contextual effects on semantic similarity using the visual world paradigm. In Experiment 1 participants saw a picture of a trumpet held by a boy riding a bus. After 3 seconds, a word was presented auditorily. Participants’ task was to look at the picture while listening to the word. We manipulated both context-dependent and context-independent semantic similarity. In the context of the picture with the trumpet, context-independence would predict increased looks to the trumpet after hearing “violin” and “piano” (relative to “envelope”) and no difference between the two. Context-dependence would predict more looks after “violin” than after “piano” (violins are more compatible with carrying on buses). The stimuli were equated for semantic similarity (McRae norms and LSA), frequency, familiarity and length.

At word offset, we found more looks to the trumpet after “violin” (proportion of fixations: .38) than after “piano” (.28) or envelope (.27). At 200 ms post-offset, a difference began to emerge between all three (.39, .31, .17, respectively).

To confirm that the “piano”/”violin” difference was driven by the visual context, we presented in Experiment 2 the trumpet with three unrelated objects (i.e. no boy/bus scene). At word offset there were no more looks to the trumpet after “violin” (.26) than after “piano” (.24); both engendered more looks than did “envelope” (.14). A difference emerged between all three around 400ms post-offset (.44, .33, .17, respectively). In both studies, these later differences were reflected in gaze durations, with longer gazes following “violin” than “piano” than “envelope”.

Unlike in Tabossi’s demonstration, we have shown here that the bus context did suppress looks that would have been engendered through conceptual similarity of pianos and trumpets, but only early on (at word offset). Although this modulatory effect of context persisted post-offset, the conceptual similarity of pianos and trumpets did manifest, albeit later, with more looks towards the trumpet after “piano” than after “envelope” (but more looks still after “violin”). These dynamically changing influences of context and conceptual similarity will be discussed within a dynamical framework of the processing of meaning (e.g. Elman, 2004).

WHEN CONTRAST IS SALIENT, PRAGMATIC 'SOME' PRECEDES LOGICAL 'SOME'

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A fundamental issue in experimental pragmatics is the time course of scalar implicatures. Some studies focusing on the <all,some> scale find that the upper-bound interpretation for 'some', (some but not all) is arrived at more slowly than both its stronger alternative all and number terms such as 'two' or 'three' (Huang & Snedeker (2009) - HS). In contrast, other studies find no delay in the computation of the upper-bounded meaning of 'some' as compared to literal controls (Grodner et al).

One difference between the HS and the Grodner study is that the former included trials on which sets of objects were referred to either by 'some' or by number terms. The absence of number terms in the Grodner study may have led to learning that the target subset would be referred to with some, leading to the fast responses. In addition, neither study contained a literal 'some' condition, in which 'some' was used to refer to a full set of objects.

We examine the interpretation of 'some' in a modified version of the visual-world paradigm. On each trial, subjects saw a prize machine with an upper chamber filled with 5/6 gumballs and 5/6 rings and an empty lower chamber. After 2.5 seconds a “ka-ching” was followed by a new display in which either 0, 2/3, or all of the objects in each set had moved to the lower chamber. Participants then heard a statement of the form You got X of the gumballs/rings and responded by clicking in the lower chamber on the set of objects mentioned. We used the quantifiers 'some', 'all', 'two', and 'three'. The displays on target trials were such that there was either a contrast between a proper subset of one class and the full set of another class having moved, or no contrast (two subsets or full sets moved). On some contrast trials the some-NP referred to the full subset, constituting a literal some condition. In addition, there were trials with false statements about the scene. Participants were instructed to click on a button in the middle of the machine if they thought the statement was not about the scene. Responses and eye movements were measured.

We highlight the most important results. In line with Grodner et al.’s results, participants were fast to converge on the target in the contrast conditions for both 'some' and 'all' (within 300ms of quantifier onset, as compared to after noun onset in the no-contrast conditions). In addition, participants initially looked to the subset rather than to the full set in the literal 'some' condition before switching to the target, reflecting a robust initial pragmatic interpretation of 'some'. 50% of responses in the literal 'some' condition were pragmatic responses (i.e. clicks on the button in the center of the machine).

We conclude that, given the right context (in this case a salient contrast set), pragmatic 'some' is not delayed relative to literal 'some', even when pre-coding is implausible.

Some theories claim that developmental dyslexics are less able to store and retrieve correspondences between spoken and printed words, ultimately leading to inaccurate word identification. Others propose that slow word naming speed (assumed to disrupt general reading fluency) might provide a second explanation of the disability. Given these accounts, the distinction between deficits in speed (i.e. how quickly dyslexic readers gain access to stored word representations) versus accuracy (i.e. whether words are sufficiently well represented to be recognised by dyslexic readers) appears to be of central importance.

Traditional reaction time paradigms (e.g. lexical decision) are not entirely conclusive in this respect because participants often trade off speed for accuracy in such tasks (e.g. Wickelgren, 1976). The present study employed a novel eye-tracking paradigm which does not suffer from such shortcomings. In each trial, participants first looked at a fixation dot in the centre of a screen. The dot was then replaced with a 3000ms display containing an actual English word and a non-word distractor, each appearing about 1.5 degrees above or below the previously shown fixation dot. Participants simply had to look at the word and ignore the non-word, and their eye-movements were monitored. The latter allowed for a continuous analysis of how accuracy improved over time.

We tested ten independently diagnosed dyslexic readers and twelve normal controls (four males per group). The two groups were from the same age-range, and a pre-screening confirmed a between-group difference in dyslexia scores (p < .001), but not in general intelligence or working memory (ps > .1). Within participants, two factors were manipulated (61 trials per cell). The target word (T) was either consistent (1-3) or inconsistent (4-6) in spelling and pronunciation (cf. Glushko, 1979; Ziegler et al., 1997). The non-word distractor (D) was either unpronounceable (1,4), pronounceable (2,5), or a pseudo-homophone (3,6). Distractors were matched in length and bigram frequency with their targets, and the targets were matched in length, lexical frequency, and bigram frequency across conditions.

Cumulative-average probabilities of fixations over time indicated an initial uncertainty period (with little discrimination between targets and distractors) until probabilities of incorrect fixations on the distractor reached a peak. After this point, looks to the distractor gradually declined in favour of more looks to the target (homing-in period). We fitted a 4-parameter (amplitude, location, width, symmetry) log-normal function to the distractor-curves per cell and participant (mean adjusted Rsq = .985). After examining systematic parameter variation in those fits, we found that dyslexic readers were generally slower (both in overcoming initial uncertainty and in homing-in on the target) than normal readers. Interestingly, there was also a reliable Group × Target interaction in amplitude: Even with sufficient time, dyslexic readers were more likely to incorrectly fixate the distractor when the target was inconsistent (4-6) rather than consistent (1-3); control participants did not show this effect. We conclude that, apart from a general speed deficit, dyslexic readers are less accurate in recognizing words with inconsistent spelling and pronunciation, the latter suggesting a representational deficit for such words in dyslexic readers.

(1) T: fridge D: necltb
(2) T: spring D: stoint
(3) T: bunch D: lepht
(4) T: glove D: dparp
(5) T: tomb D: mibe
(6) T: ghoul D: proab
THE ROLE OF STRUCTURAL PARALLELISM ON ANAPHORIC ANTECEDENT RESOLUTION

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Anaphors (Arnold & al. 2000) and ellipsis constructions (Shapiro & al. 2003) cause reactivation of their antecedents, similar to that in the initial mention of the referent (Huettig & Altmann 2005). However, different types of anaphora and ellipsis constructions predict different types of parallelism with their antecedent. VP ellipsis (1) requires syntactic parallelism with the antecedent structure (Arregui & al. 2006, Merchant 2009), so reactivation of the antecedent nominal is expected. Similarly, pronominal anaphors like (3) require a referent nominal in the antecedent. On the other hand, VP (so-called “do-it”) anaphors (2) only require a similar event in their antecedent (Tanenhaus & Carlson 1990), so the nominal referents involved should be activated less. Assuming a linking hypothesis between “activation … and likelihood of fixation” (Tanenhaus & Brown-Schmidt 2008), we test these predictions in a visual world eye tracking experiment.

We monitored participants’ eye movements (21 subjects, 24 items) as they listened to one of four ellipsis, anaphora (do-it and pronoun), or control sentences (see examples) while four pictures appeared on screen (from Yee & Sedivy 2006). One picture (the Target) was the object of the antecedent clause, one was semantically related (the Related) to the target, and the other two were distractors. After the antecedent clause, participants clicked on a fixation cross on a blank screen before hearing the second clause.

The region of interest for the analysis was a 300ms window starting 200ms after the offset of the verb. Only NEW looks were analyzed (where the current and previous look regions differed), using weighted mixed-model regression of the empirical log-odds. Effects of the intercept (predictive eye movements at the beginning of the analysis region) and the slope of eye movements (effects after the ellipsis or anaphor) were analyzed, as well as their interaction with the conditions. Eye movements to Target and Related after hearing the antecedent object replicated previous results from the literature (Huettig & Altmann 05, Yee & Sedivy 06).

In the second clause, the most predictive eye movements to the Target and the Related were in the ellipsis condition (T p<.001; R p<.001), followed by the do-it anaphor (T p<.05; R p<.001), all significantly greater than the intransitive control. There were significantly increasing looks to the Target over time (slopes) only in the pronoun (p<.001) condition, suggesting that most effects of condition were based on predictions made upon recognizing the construction. There were also decreasing looks to the Related in the do-it condition (p<.001).

We find that antecedent nominals and their semantic neighbors are reactivated in ellipsis and anaphora constructions, but that event anaphors (do-it) actually cause more activations than pronominals, contrary to the predictions. However, the particular pattern of activation of Related in “do-it” anaphora is consistent with it reactivating the whole event. Overall, antecedents seem to be increasingly reactivated proportional to the degree of structural parallelism required by their construction. Further work will test this by manipulating structural parallelism with respect to event structure and amount of surface form.

The security guard opened the lock, (Antecedent) and the night watchman …

(1) did, too. (Ellipsis)
(2) did it, too. (Do-it)
(3) dropped it. (Pronoun)
(4) slept. (Intransitive control)
**WORD RECOGNITION DURING READING: THE INTERACTION BETWEEN LEXICAL REPETITION AND WORD FREQUENCY**

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Efforts to understand how word repetition facilitates lexical processing have been prominent in the development of general cognitive models both of word recognition and memory. These efforts have shown that the effect of word frequency on the magnitude of repetition priming differs between word recognition tasks and memory tasks. Word recognition studies that use barely visible masked primes typically show that the magnitude of repetition priming does not differ as a function of word frequency and that priming does not persist if visible words intervene between the masked prime and the target word (e.g., Forster & Davis, 1984; Holcomb & Grainger, 2007). In contrast, list memory studies, which use clearly visible primes, typically show a greater degree of repetition priming for low frequency words than for high frequency words, an effect that persists over intervening words (e.g., Scarborough et al., 1977; Young & Rugg, 1992).

When repeated words are read as part of a text they are (usually) clearly visible and other words almost always intervene between the prime and the target (e.g., Raney & Rayner, 1995; Traxler et al., 2000). This makes the priming situation during reading more similar to the one used in studies of memory than the one used in masked-prime studies of word recognition; it suggests that repetition priming should interact with frequency on measures of reading. However, word recognition is a major determinant of first-pass reading; on that basis first-pass reading times should show patterns similar to those found in masked-priming studies of word recognition. Here we report two eye-tracking experiments designed to determine whether the effect of lexical repetition on word recognition during reading depends on the frequency of the repeated word.

The first experiment manipulated whether or not a target word (e.g., president) repeated a preceding word (e.g., president or commander) (see Example 1). Word frequency was manipulated by using the same sentence frames with low frequency words that matched the higher frequency words in length (e.g., bicyclist and navigator). The second experiment manipulated the same factors using proper names (see Example 2). For both experiments, recognition of the target word was assessed using first-pass reading time (sum of all first-pass fixations on a region before the eyes leave that region). For the first experiment this region consisted of the target name and preceding article while for the second experiment it consisted of the target name only. Both experiments suggest that repetition priming (new target minus repeated target) is greater for low frequency words than for high frequency words.

Our findings show that lexical repetition priming during reading follows a pattern similar to that observed in memory studies: it persists across intervening words and it interacts with frequency. This pattern is found on measures of word-recognition that occur much more rapidly after fixation of the word than do the lexical decision responses that are commonly used in masked-priming studies of word recognition.

Example 1: On the news, the president’s/commander’s sister boldly said the president was responsible …

Example 2: After lunch Herman/Robert and Amanda moved the cabinet so that Herman could …


WHEN CHOCOLATE CAKES ARE "GOOD-ENOUGH" PIES: ADJUSTING MANNER OF PROCESSING TO NON-NATIVE SPEAKERS

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Non-native speech is less reliable in conveying the speaker’s intention than native speech. Expectations can influence the way speech is interpreted (Niedzielski, 1999) or attended to (Magnuson & Nusbaum, 2007). Therefore, listeners may adjust their manner of processing when listening to non-native speakers (NNS) by increasing reliance on contextual information and “good-enough” processing (Ferreira et al., 2002). Yet ability to control attention depends on working memory (WM). Therefore, people with High WM might be better at adjusting their manner of processing to the speaker. This project tests whether people adjust their processing manner when listening to NNS and whether the ability to adjust depends on WM capacity.

Experiment 1:

Native English speakers (NS) performed a WM task and then followed instructions by either a NS or a NNS to click on pictures with a common theme, such as a round cookie, a tortilla, and a round block of cheese. These pictures implied the theme of “food”, leading participants to expect a chocolate cake as the next target. Yet the critical instruction was to click on the "pahy". The target was π, which relates to the previous pictures via a less dominant theme (circle). Reliance on the dominant context of “food” should lead to greater consideration of the distractor (cake). “Good-enough” processing might eliminate looks to the Target (π). We evaluated this with eye-gaze and object selection.

As predicted, participants selected the target less often when the speaker was a NNS (64%) than when she was a NS (75%). Eye-tracking data revealed that participants with High and Low WM reached their decision in differently. High WM participants relied on context more with the NNS: They were more likely to look at the distractor already at word onset when listening to the NNS. They also showed "good-enough" processing with NNS: They were less likely to look at the Target at all with a NNS than a NS when they selected the distractor. This suggests that they were less likely to notice the discrepancy between the label and the referent with a non-native speaker. Participants with Low WM showed neither of these adjustments. These results indicate that participants with High WM did not simply correct their interpretation with the knowledge that NNS have lower proficiency, but used a different manner of processing from the outset.

Experiment 2:

Experiment 2 provides converging evidence that listeners have “good-enough” representations of non-native speech via a different methodology – Change Detection. Participants listened to a story by either a NS or a NNS, and then received a modified written version of the story. Their task was to detect the word changes (e.g., scream to panic). Participant detected fewer changes when the speaker was a NNS, suggesting that representations of non-natives’ speech are less detailed. The difference disappeared when participants attempted to remember instead of comprehend the text. Therefore, the effect is due to manner of processing, not to the difficulty of understanding non-natives.

Discussion:

These experiments show that listeners adjust their manner of language processing when listening to NNS by increasing their reliance on the context and using "good-enough" representations, but this adjustment depends on listeners’ WM. Such differences in processing have social implications as they affect memory for non-native speech and might affect the inferences listeners draw from it.
SOME INFERENCES STILL TAKE TIME: PROSODY, PREDICTABILITY, AND THE SPEED OF SCALAR IMPLICATURES

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Pragmatic inferences can be rapid and robust.1-2 But are language-dependent inferences like scalar implicature (SI) preceded by semantic analysis? Many studies find an initial period of semantic interpretation (e.g., some interpreted as "some-and-possibly-all").3-4 In contrast, Grodner and colleagues (2008), based on Huang and Snedeker (2009), found that SIs were rapidly calculated when the quantifier was phonologically-reduced, providing a cue to the partitive construction (summa instead of some-of), see also Breheny (2009).5-6 However, Grodner and colleagues (2008) differed from Huang and Snedeker (2009) in several ways. In particular, each set type was predominantly labeled with a single quantifier, creating a consistent mapping between quantities and verbal labels. Thus evidence of a rapid SI in this study could reflect spontaneous verbal encoding initiated prior to quantifier onset.

The present studies explore the role of prosody and prediction in the generation of SIs. In Experiment 1 (N = 40), we used phonologically-reduced forms in a design where sets were labeled with both quantifiers and numbers. This allows us to explore two alternate explanations for the rapid SI effects: 1) if SIs are automatic for phonologically-reduced quantifiers, then we should replicate evidence of rapid inferencing and 2) if rapid SIs depend on the predictability of the verbal label, then we should fail to see immediate inferencing when the subset is associated with multiple labels.

Participants were asked to “Point to the girl that has summa the socks” while their eye-movements were measured to displays contrasting a girl with 2 of 4 socks with either a girl with 3 of 3 soccer balls (2-referent trials) or one with 0 of 3 soccer balls (1-referent trials). In 2-referent trials, the semantics of the quantifier is initially compatible with both girls but this ambiguity may be immediately resolved via a SI which restricts reference to the subset. In contrast, in 1-referent trials, the referent of the quantifier can be resolved by semantics alone. Control trials asked for the contrasting set (alla/nunna). Critically, to decrease the predictability of the quantity-to-quantifier mapping, we included filler trials referring to the same sets using number words (two/three). In 1-referent trials, fixation to the subset rapidly shifted 200ms after the onset of summa, demonstrating early disambiguation based on semantics (p < .01). However, in 2-referent trials, looks to both girls were initially equal with no preference for the target emerging until the 1000ms window (p < .01).

In Experiment 2 (N = 80), we factorially manipulated prosody (some-of vs. summa) and predictability (two/three vs. some/all fillers) in a between-subjects design. Following quantifier onset, looks to the subset were initially at chance and did not differ across the four conditions. However, during the 600ms window, shifts to the target were greater in conditions with scalar fillers compared to number fillers (p < .05). There was no effect of prosody or interaction (p’s > .60). These results suggest that comprehension involves a dynamic interplay between (1) bottom-up processes which operate over logically-ordered linguistic representations and (2) top-down processes which encode events for communication. The rapidity and spontaneity of these latter procedures suggest that they are a fundamental aspect of language comprehension rather than an experimental strategy.

TOWARDS A BROAD COVERAGE MODEL OF PREDICTION IN HUMAN PARSING: UNIFYING LOCALITY AND SURPRISAL EFFECTS

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There is strong evidence that human sentence processing is incremental, i.e., that structures are built word by word [5,6]. Recent experiments show that the processor also predicts upcoming linguistic material on the basis of previous input [4,6]. However, current theories of sentence processing do not model prediction explicitly (with the possible exception of [8]). We address this shortcoming by proposing a computational model that incorporates an explicit prediction process, and show that this model can also account for other sentence processing phenomena, such as locality and surprisal effects.

We assume incrementality in the strictest sense, requiring all input words to be connected under one syntactic category. Our model generates predictions when additional syntactic structure is needed to connect a new input word (e.g., when two arguments of a head have been seen, the head category is predicted), or through a word’s subcategorization frames (e.g., when a transitive verb is encountered, an NP argument is predicted). We model this process using the PLTAG formalism, an incremental version of Tree Adjoining Grammar. PLTAG [3] supports a lexicon of predicted structures and augments standard TAG operations (substitution and adjunction) with the new operations of prediction and verification. The latter checks previous predictions against new input.

The model includes a linking function that translates word-by-word parser states into processing difficulty. We assume that processing difficulty is proportional to the surprisal over the incremental structures plus a verification cost which occurs when predicted structure is matched against new input. The verification cost is determined by the predicted structure’s probability, combined with a decay in memory. The longer ago a structure was predicted, the harder it is to verify, thus incurring greater processing difficulty. This verification mechanism captures Gibsonian locality effects [1].

The computational implementation of our model is based on a probabilistic, strictly incremental predictive parser, trained on the Penn Treebank. We tested the model on subject/object relative clauses [1] and on “either ... or” constructions [6]. Our model captures the locality effects found in subject/object relative clauses (longer reading times at the ORC verb compared to the SRC verb in items such as “the reporter that attacked the senator/that the senator attacked ...”). It also replicates the facilitatory effects of “either” in “either... or” constructions, which has been attributed to prediction (on the experimental items in [4]).

The model therefore provides a unified account of locality and surprisal effects, which standard models such as Dependency Locality Theory [1] or surprisal [2] are unable to do. We have implemented a broad-coverage version of the model, whose parsing accuracy has been evaluated on the Penn Treebank. Being broad coverage, the model can also be tested on the Dundee corpus, for which both locality and surprisal effect have been reported previously [7]. Work is also underway to evaluate the model on a range of data sets from the sentence processing literature, including garden path effects, complexity effects, and prediction results.

References:
MODELLING THE EFFECT OF DISCOURSE ON SYNTACTIC AMBIGUITY RESOLUTION USING MARKOV LOGIC

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It has been argued probabilistic models of sentence comprehension are beneficial because a single model can represent several levels of linguistic processing, including lexical, syntactic and semantic processing (Jurafsky, 1996). However, accounting for discourse in a probabilistic model is challenging as models of discourse often require first-order inference (Kamp and Reyle, 1993, interalia). Moreover, it has been observed that discourse information can influence the behaviour of the human sentence processor (Altmann and Steedman, 1988; Spivey and Tannenhaus, 1998; interalia). For example, Experiment 2 of Spivey and Tannenhaus involves a short contextual discourse (1A or 1B) followed by a syntactically ambiguous or unambiguous target sentence (2). They found that the critical region (underlined) in ambiguous targets were read faster with a supportive discourse (1B) than with a non-supportive discourse (1A). Spivey and Tannenhaus presented a constraint-based model which simulated the experimental results, but the model was small-scale in that its predictions were limited to their own experiment.

In the present work, we present a broad-coverage probabilistic model of sentence comprehension which can account for contextual effects by adding an additional layer of representation which models the first order ‘truth-conditional semantics’ of a sentence. Crucially, though, the model does not use a strict logical interpretation, but rather applies a probabilistic interpretation to the first order language using Markov Logic (Richardson and Domingos, 2006).

We derive predictions from the model using the notion of reanalysis (Crocker and Brants, 2000): when the most likely interpretation changes (either due to syntactic or discourse constraints), we predict that a reanalysis occurs, which causes processing difficulty. Computationally, the discourse constraints are implemented using a corpus-based model of NP anaphora and by modeling discourse coherence constraints in the first-order language of Markov Logic. One such constraint states that an NP with a restrictive modifier (e.g. “the actress selected”) is more coherent in a discourse when there is a contrasting NP available.

The model successfully predicts the outcome of the Spivey and Tannenhaus experiment, but the benefit of using a general probabilistic model means that the model simulates a broad range of phenomena, including numerous forms of syntactic garden path sentences (Brants and Crocker, interalia). While the model is limited by a sparsity of corpus resources amenable for probabilistic logic, it nonetheless gives surprisingly reliable predictions for discourse phenomena related to those in the above experiment. For example, the logical framework necessary to model a context with one or two antecedents (e.g. 1A or 1B above) naturally allows the model to successfully simulate some effects of plural reference noted by Moxey et al. (2004).

(1A) An actress and the producer’s niece were auditioning for a play. The director selected the actress but not the niece.
(1B) Two actresses were auditioning for a play. The director selected one actress but not the other.
(2) The actress [who was] selected by the director believed that her performance was perfect.

ASSESSING THE DIRECTIONALITY OF N400 AND P600 EFFECTS WITH MEG

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Introduction: Functional interpretations of ERP effects require understanding the directionality of the effects, i.e., which experimental condition is associated with more intense brain activity. For example, it only makes sense to hypothesize that the P600 is related to reanalysis if the ill-formed condition is indeed what elicits an increase in activation. However, since traditional language-related ERP components such as the N400 and P600 are defined as difference waves, it is unclear whether these effects are driven by increased activation in the ill-formed or the well-formed condition. In fact, an fMRI study by Kuperberg et al. (2003) found a decrease in left temporal and inferior frontal activity for the P600 ill-formed condition. FMRI, however, lacks the temporal resolution for assessing the direct relationship of these findings to the P600 effect.

To examine what brain activity is affected—and in what way—by classic N400 and P600 manipulations, we used the P600 materials of Osterhout and Holcomb (1992) and the N400 materials of Johnson & Hamm (1999) during a simultaneous EEG+MEG recording, the latter allowing relatively detailed source reconstruction.

Methods: Nine subjects were presented with 80 ‘N400’ sentences (1–2) and 60 ‘P600’ sentences (3–4) during a simultaneous EEG+MEG recording. As in Johnson & Hamm (1999), N400 stimuli were not formally matched on any variable other than length.

(1) Well-formed: The kitten played with a ball of yarn.
(2) Ill-formed: The man checked his wallet for the truck.
(3) Well-formed: The broker persuaded to conceal the transaction was sent to jail.
(4) Ill-formed: The broker planned to conceal the transaction was sent to jail.

EEG Results: In our EEG data, we replicated both the N400 findings of Johnson & Hamm for (1)–(2) and the P600 findings of Osterhout and Holcomb for (3)–(4).

MEG Results: N400m: Using L2 minimum norm estimates, whole brain analysis revealed a widely distributed left temporal increase for the ill-formed condition, onsetting at 300ms. This was followed by a right temporal increase extending parietally to supramarginal and surrounding cortex.

P600m: In the P600 time window, the most reliable effects showed increased activity for the well-formed condition. The centers of these increases were in the left anterior temporal lobe and in occipital regions. Only a small increase was found for the ill-formed condition in the right temporal cortex.

Conclusion: Our N400 MEG results are broadly consistent with previous MEG findings showing a widespread increase in activation for the ill-formed condition in temporal cortex (Halgren et al., 2002; Helenius et al., 1998). Our MEG findings on the P600, however, suggest that increased activity is primarily observed for the well-formed condition, plausibly reflecting some aspects of the ongoing computation of the well-formed structure. Several researchers have (informally) suggested that the P600 is not observed in MEG. Our results do not rule out this hypothesis, but they do suggest an alternative account, namely that the P600 is indeed observed but the directionality of the effect is not what one would expect based on the typical functional interpretations of this effect in the ERP literature.

References:
CEREBRO-ACOUSTIC COHERENCE IN SPOKEN SENTENCE COMPREHENSION INFLUENCED BY LINGUISTIC INFORMATION

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The amplitude envelope of the speech signal conveys important phonological information for spoken sentence processing. As yet unresolved is how the brain processes this low frequency information. Here we assess whether cortical oscillatory activity in the frequency range of the amplitude envelope is linked to comprehension of spoken sentences. Previous studies have shown oscillations in the 4–8 Hz range are related to sentence processing (e.g., Ahissar et al. 2001; Luo & Poeppel, 2007). However, the degree to which these oscillations depend on linguistic rather than the acoustic content of the speech signal is unclear.

In the current study we investigated the relationship between oscillatory neural activity and acoustic stimuli (both speech and nonspeech). We used spoken English declarative sentences (e.g., "It was the old women who complained when the bingo hall was closed.") recorded by a native speaker of British English. Stimuli were digitally processed using a noise-vocoding algorithm to vary intelligibility (by varying the number of channels) while preserving the temporal pattern of the envelope, and were presented in random order to right-handed young adults with normal hearing acuity. Sentences were vocoded in one of 4 ways: 16 channel (highly intelligible), 4 channel (moderately intelligible), 4 channel spectrally rotated (unintelligible) and 1 channel (unintelligible). After hearing each sentence, listeners repeated as much as possible, providing a behavioral measure of trial-by-trial sentence intelligibility. We monitored neural activity using a 306-channel Elekta Neuromag MEG system. The data were analyzed using the DICS (dynamic imaging of coherent sources) algorithm (Gross et al., 2001), which quantifies the linear dependency of signals in the frequency domain. Computation of neural-acoustic coupling revealed significant coherence between MEG signals and the amplitude envelope of speech in the 4–8 Hz range for intelligible speech. Source analysis suggests these signals originate along the left superior and middle temporal gyri. Most importantly, we found that coherence was significantly impacted by speech intelligibility, with the intelligible speech conditions (16 and 4 channel) being associated with greater neural-acoustic coherence than the unintelligible conditions (1 and rotated-4 channel vocoded sentences). This suggests that oscillatory coherence between speech and cortical activity depends on linguistic content in addition to simple amplitude variation.

EYE MOVEMENTS IN READING OBJECT RELATIVE CLAUSES: HOW AND WHERE DOES DIFFICULTY ARISE?

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English subject relative clauses (SRCs; 1a) are easier to comprehend than object relative clauses (ORCs; 1b). Expectation-based [1,2] and memory-based [3] accounts of this phenomenon make distinct predictions regarding where, in the course of incremental processing of an ORC, difficulty should appear. The former predict difficulty on the subject of an ORC (the fireman), as it is at this point that the reader’s expectation for an SRC is undermined. The latter predict difficulty at the ORC verb (noticed), as this is the point at which a long-distance integration of the matrix subject is required. Self-paced reading [4; cf. 5] has supported the memory-based prediction, but recent experiments with the ‘maze’ task [6] have supported the expectation-based prediction. No controlled eye-tracking experiment has separately examined the critical sentence regions.

Experiment 1 (N = 28) used sentences like (1a-b) to test where difficulty appears in the eye movement record, focusing on each word of the noun phrase (the fireman) and the verb (noticed) within the relative clause. First-pass regressive eye movements out of the determiner (the) were much more frequent in an ORC than an SRC (36% vs. 12% of trials; p < .001, by mixed-effects logistic regression) with a corresponding difference in go-past time (i.e., reading time from first fixating the region until moving past it). The same pattern was obtained for the subsequent noun (40% vs. 16%; p < .001). On the other hand, clause type did not affect the rate of regressive eye movements from the relative clause verb. However, gaze durations were longer on verbs in ORCs (318 ms vs. 270 ms; p < .001).

Experiment 2 (N = 30) compared reading of a complement clause (CC; 2a) to the same material in an ORC (2b), and also examined the effect of removing the overt relative pronoun (2c). Readers regressed out of each word of the subject noun phrase of an ORC at a higher rate than when this phrase was a CC subject; when the relative pronoun was absent, the regression rate out of the noun was even higher. These differences gave rise to significant go-past effects. Again, there was also increased gaze duration on the verb within an ORC, but there was no increase in the regression rate.

In sum, eye movements are disrupted both at the subject of an ORC and at the verb. This disruption on the subject is even more pronounced without the relative pronoun. These results suggest that both violation of expectations and processes of memory retrieval play a role in the difficulty of ORCs. However, the disruption on the subject and the verb appear to be different in kind, with the former resulting in an increased probability of a regression, and the latter resulting in increased first-pass reading time without an increased regression rate.

(1)  
a. The employees that noticed the fireman hurried across the open field.
  b. The employees that the fireman noticed hurried across the open field.

(2)  
a. The employees hoped that the fireman noticed the people who were still in the building.
  b. The employees that the fireman noticed hurried across the open field.
  c. The employees the fireman noticed hurried across the open field.

‘NEEDING TO HAVE’ BUT NOT ‘NEEDING’: THE LIMITED MODAL POTENTIAL OF INTENSIONAL TRANSITIVE VERBS

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A widely held belief, with roots in the early days of generative grammar (McCawley 1974), is that the transitive configuration of intensional verbs like "want" and "need" (1b, 2b) is semantically equivalent to the infinitival configuration of the same verbs (1a, 2a). In this paper, we substantiate a semantic argument against this belief. We show that an intensional verb like English "need", which is free to express different types of modalities when it takes an infinitival (IP) complement, is restricted to a subset of these modalities in its transitive (DP) construction. In particular, "need to" can report both on requirements that follow from a rule (an external-deontic modality) and on what is required in order to achieve a goal (an internal-teleological modality). Transitive "need", on the other hand, is restricted to internal-teleological interpretations. Attitude verbs like "want", which expresses only one type of modality across the board (Heim 1992, von Fintel 1999), have obscured the different modal potential of the two syntactic configurations.

Two experiments were designed to test the correlation between the syntactic configuration of English "need" and its semantic interpretation in different discourse contexts.

Experiment 1 described contexts which were consistent with needs based on rules or regulations, but inconsistent with the subject's internal goals (+external -internal contexts, as in (1)). In these contexts, need-DP sentences like (1b) received significantly lower ratings of fit to the context compared to need-IP sentences with "have" or "take" like (1a) (2.94 versus 3.75, t=7.155, p<0.001 in a linear mixed model with crossed random effects for 40 subjects and 12 items).

In Experiment 2, external rules and the subject's internal goals were in agreement and both sanctioned a modal claim (+external +internal contexts, as in (2)). Accordingly, need-IP sentences and need-DP sentences both received high rating scores in these contexts, with no effect of complement type (4.43 versus 4.40, t=0.43, p=0.66). Responses to a forced choice comprehension question following each item revealed, however, that participants interpreted the modality conveyed by "need" differently in the two conditions. There was a significant tendency for external-deontic interpretations (i.e. mentioning the rules in response to questions like (2c)) to be paired with the IP configuration of the verb (2.16 times higher odds than in the transitive configuration, p<0.001).

Overall, the results provide quantitative evidence that transitive "need" is naturally used to express internal-teleological modality and that "need to" is significantly more open to expressing external-deontic modality. Since deontic and teleological modalities are both taken to be subtypes of circumstantial modality (Kratzer 1981), distinguished only by features of the contexts in which they are uttered, these findings motivate a new look at the syntax-semantics mapping of modal verbs and their context dependency.

(1) a. Gina needs to have hot chocolate. (IP condition)
   b. Gina needs hot chocolate. (DP condition)

   Context: + external: boss's instructions AND
   - internal: an aversion to chocolate

(2) a. Sarah needs to take a nap. (IP condition)
   b. Sarah needs a nap. (DP condition)

   Context: + external: a rule of the house requires napping AND
   + internal: very tired after a sleepless night

c. Why does Sarah need (to take) a nap?
This study examines whether and how the use of prosody in language comprehension is modulated by working memory (WM) capacity. Prior studies have shown that individual differences in WM capacity may cause qualitative differences in the interpretation of ambiguous sentences such as "The maid of the princess who scratched herself in public was embarrassed" (e.g., Felser et al., 2003; Swets et al., 2007; Traxler, 2007). Among them, Swets et al. (2007) have argued that readers with low WM capacity are more likely to attach the relative clause (RC) to the first noun, maid, than high capacity readers because of a tendency for low span readers to insert an implicit prosodic break between the second noun and the RC. Despite this claim, no previous work has explicitly investigated the relationship between the comprehender's sensitivity to prosody and WM capacity.

We tested this question using ambiguous sentences such as "Click on the candle (a) below the triangle (b) that's in the blue circle". According to previous work (Carlson et al., 2001), there should be a greater preference for attaching the RC to the candle when boundary (b) is stronger than boundary (a). Each auditory instruction was produced in four different prosodic conditions by crossing a stronger intonational boundary (IP) and a weaker intermediate phrase boundary (ip) at positions (a) and (b) ((IP, ip), (IP, IP), (ip, ip), and (ip,IP)). As soon as auditory instructions ended, participants were provided with a visual scene that contained two target pairs of the object (e.g., candle) and shape (e.g., triangle), which corresponded with the two possible interpretations, and two distracter pairs. They selected one of the pictures following the instructions. WM capacity was estimated by calculating the mean over 4 different span tasks (listening, reading, alphabet, and digit). If limited WM resources encourage comprehenders to use prosodic groupings, low span participants should rely more on boundary information than high span participants. If high WM capacity allows for the room to incorporate various sources of information in processing (e.g., Pearlmutter & MacDonald, 1995), high span participants should be more sensitive to intonational boundaries than low span participants.

The results from 56 participants showed that there was a main effect of boundary (b). Participants attached the RC to the first noun more frequently when there was an IP at (b) than when there was a weaker ip boundary ($\beta=2.7$, $z=2.4$, $p<.05$) regardless of the type of boundary at (a). There were no effects of boundary (a), nor was there any interaction. Crucially, there was a reliable interaction between the effect of boundary (b) and WM capacity ($\beta=0.7$, $z=2.7$, $p<.01$): the effect of boundary (b) was larger for the participants with high WM span than those with low WM span. This supports the view that WM influences the extent to which comprehenders use various sources of information in parsing. High span comprehenders are better at taking advantage of prosodic cues than low span comprehenders.

**VISUAL BREAKS AND AMBIGUITY RESOLUTION IN READING**

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This study uses a novel technique to explore effects of visual grouping in reading ambiguous sentences (cf. Bever et al., 1990; Koizumi, 2009). It employs visual masking of the critical part of a disambiguating word by means of an ‘ink blot’. The word reported by the reader reveals the syntactic structure s/he assigned to the sentence. To allow comparison across tasks and modalities, the sentence materials are the same as in previous auditory studies, which used white noise to mask (in fact, replace) the critical part of the disambiguating word.

NP/clause coordination (1) and relative clause attachment (2) in Bulgarian were tested. Coordination items contain three NPs, which can group across clauses as 2+1 or 1+2; disambiguation is by number marking on the following verb. RC-attachment items contain N1 of N2 RC; disambiguation is by gender marking on the relative pronoun. In both experiments, the ink blot obscured the relevant morphological marking.

Experiment 1: Silent reading.
After reading a target sentence, divided over two screens, participants saw two words and indicated which completed/made sense with the sentence. The two words were those potentially obscured by the blot; they entailed (via morphological agreement) alternative analyses of the syntactic ambiguity. Unlike a standard comprehension questionnaire, this probe task eliminates the question sentence, reducing possible interference and the time between the stimulus and response.

Based on previously reported data for auditory phrasing, the visual sentence divisions were designed to favor one or other syntactic phrasing of the word string. For both item types the line break followed either the first noun (N1 break), or the second noun (N2 break). An N1 break might be expected to induce 1+2 grouping of the conjuncts in (1), and low RC-attachment in (2). An N2 break might induce 2+1 grouping of the conjuncts in (1), and high RC-attachment in (2). A control group saw the sentences on a single screen with no line break; responses could reveal any inherent parsing preferences.

Experiment 2: Reading aloud.
The task was streamlined, omitting the post-sentence lexical choice. The word a participant pronounced on-line in reading aloud revealed (through morphological agreement) the structure s/he assigned to the sentence. This protocol eliminated all intruding material between stimulus and response; and with no overt lexical choice to make, less attention was drawn to the presence of ambiguity.

Results:
For the coordination ambiguity, visual grouping favored the corresponding syntactic grouping in both silent reading (p<.001) and reading aloud (p<.001). For RC-attachment, the contrast between presentation conditions was less strong, with only numerical tendencies in the expected direction. With neutral (single-screen) presentation, silent-reading task responses were at chance for both item types, but reading-aloud responses showed a reliable preference for object coordination (2+1 grouping, p<.01), suggesting an influence of Late Closure.

These outcomes accord largely with results from the parallel auditory study. Visual grouping promotes corresponding syntactic/semantic analyses in this visual-masking paradigm, as prosodic grouping does (more robustly) in the reading-aloud responses showed a reliable preference for object coordination (2+1 grouping, p<.01), suggesting an influence of Late Closure.

(1) Nakraia sreshtnahme Ani i Ivan i Mimi beshe / biaha vav vaztorg.
In the end meet-past-1p.pl Ani and Ivan and Mimi was / were in ecstasy.
(2) Podtseniha advokata na pevitsata kojto / koiato kupi imenieto.
(They) underestimated the lawyer of the singer who bought the estate.

Are Executive Control Processes Involved in Garden Path Reanalysis?

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During reanalysis of garden path sentences, central executive control processes may serve to resolve interference from the initial garden path misanalysis (Novick, Trueswell, & Thompson-Schill, 2005). If that hypothesis is correct, individuals who are less able to resolve interference in working memory in general should be less able to resolve interference from the initial misinterpretation during garden path reanalysis. This study tested the hypothesis of the involvement of executive control by correlating comprehenders’ garden path recovery performance with their performance on a central executive control task – the Stroop task. No correlation would be expected if resolution is carried out through automatic processes.

Forty-eight participants read object/subject garden path sentences and comma disambiguated control sentences phrase-by-phrase at their own pace and judged the grammaticality of the sentences. Half of the sentences contained subordinate-clause verbs that were equi-biased between the object and subject analysis, the other half contained subordinate-clause verbs biased toward the object analysis. The noun phrase following the subordinate verb was a plausible object of the verb in all sentences (plausibility was equated across verb bias conditions). The sentence-final phrase was either consistent or inconsistent with the object interpretation of the noun phrase (consistency was equated across verb bias conditions).

<table>
<thead>
<tr>
<th>Equi-biased</th>
<th>While the man/ coached (,) / the woman/ attended/ to the helpful advice. (Consistent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>While the man/ coached (,) / the woman/ attended/ the party by herself. (Inconsistent)</td>
</tr>
<tr>
<td>Object-biased</td>
<td>While the uncle/ visited (,) / the child/ was/ acting nice and quiet. (Consistent)</td>
</tr>
<tr>
<td></td>
<td>While the uncle/ visited (,) / the child/ was/ missing him at home. (Inconsistent)</td>
</tr>
</tbody>
</table>

Results showed that garden path sentences were less often judged as grammatical (53.7%) than were comma-disambiguated control sentences (72.7%) (p1 and p2 < .0001). In addition, sentences with an inconsistent sentence-final phrase were less often judged as grammatical (59.1%) than were those with a consistent sentence-final phrase (67.4%) (ps < .05). There was no interaction between garden-pathing and consistency, indicating that consistency affected perceived grammaticality even when the comma was present. Critically, across participants, the size of the garden path effect (collapsed across verb bias and consistency) on the grammaticality judgment task correlated significantly with the interference effect on the Stroop task (r = .37, p < .05).

The positive correlation between the garden path effect and the Stroop interference effect provides support for the hypothesis that central executive control processes are involved in garden path reanalysis (Novick et al., 2005). The main effect of consistency on grammaticality judgment is in accord with the proposal that language comprehension follows a “good enough” processing principle (Ferreira, Bailey, & Ferraro, 2002), as participants were more willing to accept the sentences as grammatical when later semantic information matched with the grammatically unlicensed object interpretation. The lack of an interaction between consistency and garden-pathing also suggests that the object interpretation was made even on some of the comma-disambiguated trials.

ISLANDS UNDER THE PREDICTED STRUCTURE

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Although it has been suggested that the parser is predictive [1], it has never been clear what exactly is predicted. This study investigates how much structure can be predicted during the processing of Sprouting and Sluicing constructions (1). An acceptability rating and two reading experiments show that the parser predictively constructs a detailed grammatical structure which supports islands for Sprouting/Sluicing constructions. The contrast in (1) suggests that Sprouting (a clausal ellipsis with no explicit antecedent for the wh-phrase) is constrained by islands, contrary to Sluicing (which has an explicit antecedent for the wh-phrase). Offline acceptability ratings for (1) (1-5 scale) clearly suggest such contrast: Sprouting violating islands were judged less acceptable than their Sluicing counterparts (Relative Clause Island: 1.8 vs. 3.3 F1(1,45)=8.35, P<.01; F2(1,23)=18.41, P<.01: Coordination Islands: 2.7 vs. 3.7 F1(1,45)=56.19, P<.01; F2(1,23)=99.03, P<.01). Island domains crucially refer to specific syntactic structures [2]. Therefore this contrast strongly suggests that detailed structures are associated with the ellipsis in Sprouting. Previous studies show that Sprouting exhibits reading time slowdowns compared to Sluicing, due to the lack of parallelism between the antecedent and ellipsis in Sprouting [3]. Taking advantage of this parallelism penalty and the island sensitivity of sprouting, two word-by-word moving window experiments were conducted to investigate whether the parser can (i) anticipate possible Sprouting structure and (ii) use information from the already-seen material to posit islands inside the upcoming ellipsis structure. In two experiments, 32 participants read (2) and (3), respectively. The antecedent of the wh-phrase (explicit vs. implicit) and islands (islands vs. non-islands) were manipulated as factors in a 2X2 design. At the wh-phrase, the sentences can be continued as either ellipsis or non-ellipsis. If the parser is predictive, the upcoming ellipsis can be constructed upon encountering the wh-phrase, because the left-context is compatible with Sluicing/Sprouting. In (2a) and (3a) the parser can predict an upcoming island and discard the possible ellipsis structure, since a Sprouting continuation would induce island violations. As a result, the parallelism penalty associated with Sprouting is not expected in these sentences. On the other hand, (2c) and (3c) do not involve islands, making the ellipsis structure grammatical. Therefore, if the parser predicts a Sprouting structure at the wh-phrase, we expect a parallelism penalty in these sentences. In both experiments Sluicing sentences (which are immune to island effects) served as a baseline. In experiment 1, which examined RC-islands, we found an interaction of Ellipsis Type and Islands at the adverb immediately following the wh-phrase (F1(1,31)=10.81, P<.01; F2(1,23)=5.1, P<.05). Pairwise comparisons revealed that (2c) was slower than (2d) (F1(1,31)=7.45, P<.01; F2(1,23)=8.04, P<.01). We found basically the same results in experiment 2, examining Coordination Islands: there was an interaction of Ellipsis Type and Islands (F1(1,31)=7.02, P<.01; F2<1), and (3c) was significantly slower than (3d) (F1(1,31)=9.36, P<.05; F2<1). These results indicate that the parser posits an ellipsis structure upon encountering the wh-phrase, and immediately evaluates whether the upcoming structure contains an island.

(1) a. John scolded the boy who ate *(something), but I don’t know what.
(1) b. John drank beer and ate *(something), but I don’t know what.
(2) a./b. The store manager was unhappy because of the customer who snarled something/ø, but the cashier couldn’t tell what exactly the customer was frustrated about.
(2) c./d. The store manager noticed that the customer snarled something/ø, but the cashier couldn’t tell what exactly the customer was frustrated about.
(3) a./b. Nick was drinking beer and smoking something/ø in the garden, but it wasn’t clear what precisely he got out of smoking in hiding.
(3) c./d. Nick was smoking something/ø in the garden, but it wasn’t clear what precisely he got out of smoking in hiding.
THERE IS LESS SCOPE AMBIGUITY THAN IS COMMONLY ASSUMED
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In (psycho-)linguistics it is commonly assumed that doubly quantified sentences like Every boy climbed a tree are scope ambiguous. Based on this assumption, it has been repeatedly tested what happens when readers encounter a disambiguation following the ambiguous region. In our study, we present evidence from German that challenges the ambiguity assumption. We found evidence for scope ambiguity only in object topicalized (OS) sentences but not in SO sentences.

In an incremental version of the picture verification task, we compared potentially ambiguous SO and OS sentences like (1) and (2) with scopally unambiguous sentences like (3) and (4) in which the quantifiers jeder (each(= )) and genau ein (exactly one(= !)) are separated by a clause boundary. For each of our 32 items we constructed two disambiguating pictures showing set diagrams (like eg. Gillen 1991, Bott & Radó 2007). In the sample item, the ! -picture showed a teacher praising all pupils and one pupil being praised by a second teacher rendering ! false. In the ! -picture each child was praised by exactly one teacher but teachers varied between children. 40 participants first inspected a picture. After pressing a button the picture disappeared and the sentence was displayed using moving window presentation. For each segment participants had to decide whether the sentence could still turn out to be true given the preceding picture. If they felt it couldn’t, they had to abort the sentence. We analyzed rejection rates and RTs of “yes” button presses at the second quantifier region. If sentences (1) and (2) really are ambiguous lower rejection rates are expected after pictures forcing inverse scope than in the respective unambiguous conditions. Furthermore, scope conflict should lead to longer RTs of the second quantifier in the ambiguous than in the unambiguous sentences.

The unambiguous sentences were overwhelmingly rejected after scopally incompatible pictures. Construction (3) was rejected after a !-picture in 91.3% as compared to 10.6% after !-pictures. The reverse pattern was obtained in construction (4): after !-pictures the sentence was rejected in 78.1% (after !: 39.4%). The “ambiguous” SO-construction (1) was only accepted after !-pictures and numerically was even more extreme than (3) (rejections after !-pictures: 94.4%; !-pictures: 10.0%). OS sentences (2) and (4) also exhibited a clear preference for linear scope but there was a marginally significant interaction: Compared to the unambiguous conditions, ambiguous cases were more often aborted after a !-picture (50.6%) but less often after a ! -picture (77.5%). This indicates scope interaction in OS but not in SO order.

RTs of the second quantifier region in the compatible conditions (SO following !-pictures compared to OS following !-pictures) provides further evidence for scope interaction in OS but not in SO. In construction (2) RTs of the second quantifier were slower than in (4) (2162ms vs. 1542ms) but there was no reliable difference in RT between the purportedly ambiguous (1) and construction (3) (1320ms vs. 1203ms). Our results show that there is less scope ambiguity than is often assumed making it necessary to reconsider psycholinguistic investigations based upon the ambiguity assumption.

(1) Genau ein Lehrer lobte jeden dieser Schüler voller Wohlwollen.
   Exactly one teacher praised each of these pupils full of goodwill.

(2) Jeden dieser Schüler lobte genau ein Lehrer voller Wohlwollen.
   Each of these pupils was praised by exactly one teacher full of goodwill.

(3) Für genau einen Lehrer gilt: er lobte jeden Schüler voller Wohlwollen.
   Exactly one teacher is such that he praised each pupil full of goodwill.

(4) Für jeden Schüler gilt: ihn lobte genau ein Lehrer voller Wohlwollen.
   Each pupil is such that they were praised by exactly one teacher.

PRIMING OF NATURAL LANGUAGE STRUCTURES BY ARTIFICIAL LANGUAGE STIMULI

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The last fifteen years have seen an increasing interest in the use of artificial language paradigms (AL) in psycholinguistics (Perruchet & Pacton, 2006; Endress et al. 2009). AL experiments are typically used to study distributional aspects of language learning or processing, independent of factors such as meaning and real world knowledge. However, there are persistent questions about what we can learn from AL experiments about everyday language processing: Do AL tasks engage the same mechanisms as natural language?

We explored this question by testing whether AL stimuli influence the resolution of ambiguous natural language structures. Participants listened to an AL consisting of three syllable sequences that grouped either the first two or last two syllables together (e.g., [ba po] ti or ba [po ti]). For left-branching AL stimuli, each first syllable was paired with a unique second syllable with the third syllable varying freely and occurring with different pairs. For right-branching AL stimuli, syllable 1 varied freely while 2 and 3 were paired. We asked whether priming with such AL “phrases” influenced participants’ interpretation of ambiguous adjective-noun-noun (ANN) constructions (e.g., “big bus driver”: “a driver of big buses” (left-branching) or “a bus driver who is big” (right-branching)).

Participants were assigned to one of two ALs, both contained equal numbers of right-branching and left-branching stimuli but differed in the syllables assigned to these structures. The experiment consisted of 4 blocks. Each block contained an exposure phase (listening to phrases from the AL) and a test phase. On each test trial, participants heard two prime AL sequences, both of which were left- or right-branching. They then saw an English ANN construction followed by a left- or right-branching interpretation (gloss) of that construction. Participants judged whether the gloss was acceptable (yes/no) and reaction times were recorded. Critical and filler trials (half and half) contained ambiguous and unambiguous ANN constructions respectively.

A mixed-effects model with prime and gloss branching (left/right) as fixed effects and participant and ANN/gloss pairs as random effects was constructed for (log) reaction times. Participants were faster overall for left-branching than for right-branching glosses (beta=0.151, t=2.16, pMCMC<0.031), perhaps reflecting a statistical bias in English. There was a significant interaction of prime and gloss branching (beta=-0.182, t=-2.03, pMCMC<0.042). Participants were faster for right-branching glosses following right-branching primes and faster for left-branching glosses following left-branching primes. The effect was larger for the presumably harder right-branching glosses.

These findings show an influence of artificial language primes on the interpretation of ambiguous English noun phrases, suggesting shared processing mechanisms. Because the artificial language contains only distributional clues to grouping, the shared mechanism must be sensitive to sequencing independent of other factors like meaning. This is consistent with recent work showing priming of natural language structures by algebraic formulae (Scheepers, 2009). The shared nature of AL and NL processing has recently been argued from the point of view of individual differences (Misyak, et al. 2009). The present results further validate and emphasize the utility of using AL paradigms for studying the mechanisms underlying natural language.

Citations

DISASSOCIATING BRAIN CORRELATES OF SYNTACTIC AND PROSODIC STRUCTURE USING FUNCTIONAL MAGNETIC RESONANCE (FMRI)

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Many fMRI studies of sentence processing have manipulated syntactic structure, attempting to identify neural networks involved in syntactic computations. However, most of them have made use of materials that confounded structural complexity per-se with other factors such as working memory (Stromswold et al 1996), verbal valance (Shetreet et al 2009) or prosodic structure. More generally, since most of these studies contrasted different constructions (e.g. sentences containing appositive relatives vs. simple transitive ones in Makuuchi et al 2009), that differ along more than one single dimension, the interpretation of any brain differences is bound to be highly ambiguous. The present study manipulated syntactic and prosodic structure in a crossed design, minimizing other differences. The stimuli were 4-member coordinations exemplified in (1). Three types of syntactic structures were compared: fully right branching, complex middle branch, and complex left branch trees. The different structures were disambiguated using prosodic cues. For example, the string in (1) would be parsed as a right branching structure (2.ii) if the most prominent boundary would occur after ‘goat’ (### in 2.i). However, if the most prominent boundary should occur after ‘dog’ (3.i), the string would be parsed with a complex left branch (3.ii). Prosodic structure was manipulated by varying the number of prosodic embeddings (3 vs. 2) while maintaining the tree structure identical (Wagner 2008). (4.i) is parsed as right branching (4.ii), like (2.i), despite containing only 2 levels of prosodic bracketing. Lexical content was identical across conditions and the structures involved no long distance dependencies requiring additional working memory demands. Moreover, by using a single syntactic ‘rule’ we minimized eventual confounds due to differences in probability of the syntactic structure (Hale 2001,2006). Subjects performed a truth-verification task (requiring correct parsing of the input) against a display presented simultaneously with the utterance. Analyses demonstrate that prosodic complexity and tree complexity are associated with different neural activation patterns. Both left branching structures activated regions in the Precuneus and in the left angular gyrus more than the right branching structure. Three versus two levels of prosodic embeddings produced increased activation in the bilateral anterior Insula as well as the right inferior frontal gyrus and temporal pole. That the Precuneus and angular gyrus play a role in sentence processing has been pointed out by a number of recent studies (Ferstl et al 2008). Our results provide finer characterization of their function, demonstrating that their role is not tied (only) to lexical representation of certain verbs in the case of the Precuneus (Shetreet and colleagues) or lexical insertion in the case of the angular gyrus, but is implicated in the representation of the abstract syntactic structure itself. While it has been suggested that prosodic processing is (at least partially) right lateralized, this is the first neuroimaging evidence of a right lateralized effect of prosodic complexity. A possible interpretation of the results here is that the right homologue of the left inferior frontal-temporal-limbic network often associated with syntactic processing (Grodzinsky & Friederici 2006) is implicated in the mapping of prosodic structure onto syntax.

(1) “The goat or the dog and the pig or the chicken”
(2) i) The goat ### or the dog ## and the pig # or the chicken.
   ii) [ The goat [ or the dog [ and the pig or the chicken ] ] ]
(3) i) The goat # or the dog ## and the pig # or the chicken.
   ii) [ [ The goat or the dog ] and [ the pig or the chicken]]
(4) i) The goat ## and the dog ## and the pig # or the chicken
   ii) [ The goat [ and the dog [ and the pig or the chicken ] ] ]
MOVE requests can be expressed in one (1) or two clauses (2). We investigate how English and Spanish speakers deal with MOVE message complexity. We demonstrate that language specific properties allow speakers to plan a request in different ways. We hypothesize the resulting patterns are determined by an interaction between language-specific properties and production incrementality. Spanish speakers plan post-nominal modifiers ('la manzana pequeña') later than English speakers plan pre-nominal modifiers ('the small apple') [2], thus taking advantage of the head-modifier ordering. Spanish grammar makes frequent use of left dislocation (LD) (3), which has intermediate complexity between the mono- and bi-clausal realization (it requires more material than (1) but less than (2)).

Spontaneous productions from American English and Latin American Spanish speakers were elicited in a task-oriented paradigm [1]. Speakers instructed interlocutors to MOVE objects, in order to replicate a map. Theme expressions were either simple (an apple) or complex (the small/big apple). We analyzed 300 and 107 MOVE-requests from 13 English and 12 Spanish speakers, respectively.

Study1 English: We hypothesize that English speakers plan nouns and their modifiers at the same time and before the utterance onset. We find that English speakers prefer bi-clausal realizations of MOVE-requests when the 1st NP is longer, when it contains pre- or post-nominal modifiers (independent effects; ps<.0003). Speakers decide inter-clausal structure early, as evidenced by the first word choice in the request. Study2 Spanish: Based on [2], Spanish speakers are expected to plan modifiers after the planning of heads has mostly been completed. Consequently, we expect that 1st NP modifiers should not affect mono/bi-clausal choices. This is what we find (p>.62). We hypothesize that, since Spanish speakers can focus on the noun without planning its modifiers, they are less likely to relay on a bi-clausal strategy. Similarly, their clause structure choices are not dependent on the length of the theme expression (p>.5). From Table 1, we also see that Spanish and English speakers use different strategies to express MOVE-requests. As LD is common in Spanish, it is used to express accessible material earlier in keeping with its grammatical function (the LD element has to be definite) [5]. Study3 Spanish LD: We tested whether LD of goal expressions occurs when they are less complex than the theme. Indeed, Spanish speakers front the goal when (a) the goal expression is shorter (b= -.3, p<.02), (b) the theme expression contains a post-nominal modifier (la manzana pequeña) (b=1.8, p<.0001), and (c) when the utterance is mono-clausal (b=4.4, p<.0001). There was no effect of theme length or post-nominal goal modification. These results are consistent with the grammatical analysis of Spanish LD expressions as established topics (which tend to be short [4]).

While English speakers make early decisions (before utterance onset, based on 1st NP complexity [3]) about how to realize a message, using either a mono- or bi-clausal strategy [1], our results indicate that Spanish speakers delay some head attribute planning and do not have to choose simply between mono or bi-clausal strategies. Instead, Spanish speakers can use an LD realization to make a local decision based on the phrase availability which requires limited advanced planning.

(1) Mono-clausal Strategy in English and Spanish: Theme and Goal in a single clause
Mueve [una manzana]1st NP [al Parque Central]2nd NP  (Move an apple to Central Park)

(2) Bi-clausal Strategy in English and Spanish: Theme and Goal expressions in two clauses
(a) Agarra [una manzana pequeña]1st NP   (Take a small apple)
(b) Mueve[la]1st NP [al Parque Central]2nd NP  (Move it to Central Park)

(3) Mono-Clausal Left Dislocated goal expression:
En [el Parque Central] pon[le]i una manzana   (In Central Park put there an apple)

Table 1. Mono-Clausal non-LD  Mono-Clausal LD  Bi-clausal
English  50%  12%  36%
Spanish  54%  24%  20%

**A PUZZLE REGARDING RELATIVE PRONOUN CHOICE: WHEN FREQUENCY AND DIFFICULTY DISAGREE**

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Speaker choice between including or omitting an optional word, such as “that” before a non-subject extracted relative clause, can be influenced by production difficulty (e.g., Race & MacDonald 2003) and/or audience design (e.g., Jaeger 2005). There is not yet evidence of such an influence operating on suppletive speaker choice, where the choice is not between inclusion and omission but rather between two words of approximately equal meaning. We present two results suggesting that production difficulty and/or audience design affect suppletive choice, but the results introduce a puzzle: a conflict between production and comprehension accounts.

We examine the choice of “who” or “that” as the relative pronoun (RP) in a relative clause with a human extracted NP (1-4). “That” is the default RP; it can be used regardless of whether the extracted NP is human, while “who” can only be used if the extracted NP is human. Thus using “who” as an RP requires the speaker to check that the NP is human, potentially incurring a cost in sentence production. As a result, we predict that “who” will be used more often when the relative clause that follows is easier, and that “that” will be more common with difficult RCs.

This prediction is borne out by a corpus study. We performed tgrep searches to find examples of subject- and object-extracted RCs in the Brown, Switchboard, and WSJ corpora, and hand-coded these for whether the RC-internal NP (object or subject, respectively) was a full NP or a personal pronoun (you, I, or me, which were shown to pattern similarly in Reali & Christiansen 2007). Non-restrictive “who” RCs were removed. “Who” was more common than “that” in subject-extracted RCs with RC-internal pronoun, while “that” was used more often than who in subject-extracted RCs with a full NP RC-internally. A Fisher’s exact test revealed a significant difference (p = .023) in the that-who ratio across the two conditions. This conforms with the prediction above, where “that” is preferred with more difficult RCs.

However, a reading time study finds the opposite pattern. From the corpus result, we predict that comprehenders will make use of the frequency distinction, with the choice of “that” reducing the reading times for the “hard” RCs. Instead, the reading times show that participants read the “easy” RC (subject-extracted with RC-internal you) more quickly with “that”, and that a “hard” RC (object-extracted with an RC-internal full NP) is read more quickly with “who”. These results are confirmed with two-tailed t-tests over the region consisting of the RC verb, main verb, and first spillover word. [F1(1,55) = 10.66, p = 0.002; F2(1,39) = 7.08, p = 0.011 for you; F1(1,55) = 18.59, p < .001; F2(1,39) = 11.79, p = 0.001 for full NPs]

Thus the corpus study suggests RP choice is driven by an attempt to alleviate RC production difficulty, while the reading time study suggests “who” serves as an audience-directed marker of upcoming difficulty. This discrepancy is surprising given the generally assumed coupling between production and comprehension.

(1) The chef [that/who] the waiter watched was famous for her butternut squash soup.  
(2) The chef [that/who] watched the waiter was famous for her butternut squash soup.  
(3) The chef [that/who] you watched was famous for her butternut squash soup.  
(4) The chef [that/who] watched you was famous for her butternut squash soup.
THE INTERACTION OF STRUCTURE AND PLAUSIBILITY IN COMPREHENSION IN TWO LANGUAGES

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Much of the previous literature on relative clause comprehension has been dominated by the comparison on object and subject relative clauses that vary in both word order and meaning. Gennari and MacDonald (2008) suggested comparing object relative and passive relative clauses, which are better matched for meaning. However, the markedly different word orders make it difficult to compare reading times or see how factors like verb plausibility unfold over time. A solution is to investigate these structures in languages like Korean, where object and passive relatives are matched for both meaning and word order, differing only in case and aspect markings (and thus grammatical role assignment). Korean object relatives are harder than subject relatives (Kwon, Polinsky & Kluender, 2006) but there are no comparisons with passive relatives in the psycholinguistic literature.

The effect of noun-verb plausibility relationships has informed the study of object relatives in English; King and Just (1991) found larger plausibility effects for object relatives than for easier subject relatives. We compared object relative plausibility effects as in (1), which have the word order patient-agent-verb to those in passive relatives as in (2), with the word order patient-verb-agent, as well as in Korean, where both relative clauses have the word order agent-verb-patient.

Twenty-four quadruplets as in (1-2) were created and normed for plausibility; the plausible items were reliably more plausible than the neutral ones. Korean translations were prepared and normed by native speakers, with similar norming outcomes. Plausible and neutral sentences contained the same noun pairs and differed only in the verb.

English (n=22) and Korean (n=23) participants read the materials, intermixed with 24 fillers, in a self-paced reading task with comprehension questions. In overall reading times, there was an effect of plausibility in object relative sentences in English (t(21)=3.05, p<0.01) and Korean (t(22)=4.14, p<0.001) as well as in the passive relative sentences in English (t(21)=2.76, p=0.02) but no effect in Korean (p>0.4). In Korean, the identical word order of the object and passive relatives allowed for an additional comparison of reading times of the two structures. At the head noun (the last word of the relative clause), there was a large main effect of structure (F(1,22)=51.07, p<0.001), such that object relatives were harder than passive relatives. Indeed, reading times for plausible object relatives were reliably longer than the passive-neutral sentences at this region (t(22)=2.97, p<0.01). Thus in a pair of structures matched for word order and meaning, there are large differences in reading times and different effects of plausibility.

Beyond the extension of the object-passive relative comparison to Korean, these results have several implications. First, they show the strong effect of case marking and/or relative clause structure independent of surface word ordering where in most prior investigations word order was confounded with these factors. Second, these results show that plausibility effects vary with relative clause type, even with word order matched. We will discuss the extent to which these complex patterns of grammatical role assignment can be learned from experience with the linguistic environment.

Examples:
1a. Object Relative, Plausible: The thief that the policeman arrested was known to carry a knife.
   b. Object Relative, Neutral: The thief that the policeman scared was known to carry a knife.
2a. Passive Relative, Plausible: The thief that was arrested by the policeman was known to carry a knife.
   b. Passive Relative, Neutral: The thief that was scared by the policeman was known to carry a knife.

Processing Wh-Movement Dependencies in a Language Without Wh-Movement

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Processing wh-dependencies in English-type languages necessarily involves retrieving a wh-filler from working memory, because the wh-phrase is linearly dislocated from its argument position. However, in wh-in-situ languages like Mandarin Chinese, the wh-phrase remains in a canonical argument position (1). The structural adjacency of a wh-phrase to its theta-role assigner raises the possibility that no memory retrieval and dependency-construction are necessary. On the other hand, syntactic theories posit that there is a dependency between the in-situ position and a clause-initial syntactic operator at Logical Form, rendering wh-in-situ languages and wh-movement languages abstractly similar[1]. Therefore it may still be necessary to retrieve information about the clause-initial position to correctly interpret a wh-in-situ question. The current study investigates whether the processing of Mandarin wh-in-situ questions indeed involves constructing a long-distance dependency.

The multiple-response speed-accuracy (SAT) paradigm was used to study the comprehension of Mandarin wh-questions. The SAT paradigm allows separate estimates of both the speed and accuracy with which a dependency is constructed [2]. The critical conditions consist of 6 pairs of sentences, each consisting of an acceptable and unacceptable sentence. The first two pairs were mono-clausal and bi-clausal non-wh controls (2a-b). Unacceptability was introduced by semantic anomaly between the verb and its object. The rest were mono-clausal and bi-clausal wh-in-situ questions, and the unacceptability was introduced in two ways: the presence of semantic anomaly (2c-d) and the insertion of an extra wh-phrase (e.g. why) in clause-initial position (2e-f). This latter anomaly is not detectable through any local strategy, since unacceptability is induced by blocking the dependency formation between the clause-initial position and the object argument, due to the unavailability of the clause-initial position. 40 sets of the 12 conditions were presented to 15 native Mandarin speakers in Beijing over 6 1-hour sessions, embedded with 720 fillers. From the onset of the last word, participants were cued by a sequence of tones (18 total, one in every 350ms) to make an acceptability judgment of each sentence at each tone. For each acceptable-unacceptable pair of condition, a d-prime score was calculated at each response-latency by scaling hits against false alarms. This time course data was modeled as a saturating exponential growth function.

The best-fitting function, evaluated by the adjusted R2[3,4] and paired t-tests of parameter values across individual subjects, reveals two key patterns. First, wh-in-situ questions are processed with a slower rate than the non-wh-controls [p<.01]. Secondly, within wh-in-situ questions, rate is identical across both lengths, although accuracy decreases [p<.01]; length doesn’t affect the accuracy of controls. These findings suggest some critical similarities between wh-in-situ questions and English-type questions: (i). processing Mandarin wh-questions also involves dependency construction (e.g. the slower rate), even though the wh-word is adjacent to its theta-assigner; (ii). processing speed is insensitive to the length of the dependency, suggesting a content-addressable querying mechanism; (iii). but accuracy suffers as a function of distance, suggesting interference or decay in the representations. It is notable that local semantic anomalies showed sim

(1) ni maile shenme?    
You bought what? (“What did you buy?”)
(2) (only English gloss is provided, the same in (4))
a. John applied to/*dry-cleaned that school.
b. The teacher hoped John applied to/*dry-cleaned that school.
c. John applied to/*dry-cleaned which school?
d. The teacher hoped John applied to/*dry-cleaned which school?
e. John applied to which school?/*Why did John apply to which school?
f. The teacher hoped John applied to which school?/*Why did the teacher hope John applied to which school?

PROCESSING COMPLEX SENTENCES IN NOISE REVEALS PRIORITIZING OF INFORMATIONAL CUES

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Understanding language in adverse noisy conditions is one of the most common yet demanding forms of everyday communication. However, we know very little about the exact influence of noise on the intelligibility and understanding of speech. Obviously, noise affects acoustic intelligibility due to an impoverishment of the signal. Furthermore, noise is also assumed claimed to affect higher cognitive levels (e.g. processing or working memory) so that even for young normally hearing adults, noise is expected to affect processing of syntactically complex sentences more than simpler sentences (compare Wingfield et al. 2003 for older adults).

In order to test the possibly varying effects of noise on understanding complex sentences, we investigated processing of German sentence structures with varying stages of complexity. In three reaction time studies, we tested at four critical words in each sentence using a word-monitoring paradigm. All structures were presented in silence and in loud stationary noise (-3dB SNR). Experiment 1 examined processing of canonical SVO (i) and non-canonical OVS sentences, the latter of which were presented with morphologically ambiguous (iii) and unambiguous (ii) case and θ-role marking. Object-initial sentences evoked a canonicity effect in (ii) or a reanalysis effect in (iii) and were more difficult to process. Experiment 2 examined center-embedded subject (iv, vi) and object (v, vii) relative clauses, which also varied in their θ-role ambiguity due to case marking. Since embedding adds complexity, it was slower to process in noise than non-embedded structures. Again, we found canonicity and reanalysis effects for the object relatives. Experiment 3 used embedded sentences with attachment ambiguity (viii, ix) where prosodic cues were expected to be disambiguating, thus not causing any extra costs (cf. Steinhauer, Friederici & Alter 1999), which is exactly what we found.

Our results show a strong general disadvantage for processing sentences in noise. However, we also find differences in noise effect across the different structures. Most notably, we find interactions between the effect of noise and complexity, such as canonicity and reanalysis effects, as well as embedding (experiments 2 and 3). While complexity already decelerates processing in silence, the effect of noise is much stronger in these cases compared to less complex structures. Surprisingly, prosody-related side effects that were not manipulated and that were not of consequence absent in silence emerge in the noise conditions for ambiguous structures. Concurrently, some syntactic effects (e.g. transitivity in (xi)) seem to lose their impact in noise. We thus conclude that noise not only corrupts general intelligibility of speech, but also poses and additional strain on cognitive resources, which affects processing of complex sentences more than simpler ones. Furthermore, it results in a shift of influence from structural plus acoustic cues to an increasing influence of prosody-related cues that culminates in the loss of a transitivity effect in (xi) and emergence of additional prosody-related effects in (vi) – (viii) where cognitive resources are especially affected by noise. This suggests that the increased strain loud noise poses on these cognitive capacities (e.g. working memory, attention) forces listeners to prioritize informational cues according to their necessity for sentence processing.

(i) Der kleine Junge umarmt den dicken Nikolaus. (The-NOM little boy hugs the-ACC big Santa Claus)
(ii) Den dicken Nikolaus umarmt der kleine Junge. (The-ACC big Santa Claus hugs the-NOM little boy)
(iii) Die dicke Köchin umarmt der böse Bäcker. (The-AMBIG big cook-FEM hugs the-NOM evil baker)
(iv) Der Bauer, der die Ärztinnen fängt, lächelt. (The farmer-NOM.SG who-NOM the doctorsPL catches, smiles)
(v) Der Bauer, den die Ärztinnen fangen, lächelt. (The farmer-NOM.SG who-ACC.SG the doctorsPL catch, is smiling)
(vi) Die Bäuerinnen, die die Ärztin fangen, lachen. (The farmers-AMBIG.PL, who-AMBIG the doctor-AMBIG.SG catch-PL, are smiling)
(vii) Die Ärztinnen, die die Bäuerin fängt, lachen. (The doctors-AMBIG.PL, who-AMBIG the farmer-FEM.SG catches-SG, are smiling)
(viii) Der Mann verspricht Anna zu helfen und das Büro zu putzen. (The man promises [Anna to help]-D.O. and [the office to clean]-D.O.)
(ix) Der Mann verspricht Anna zu arbeiten und das Büro zu putzen. (The man promises [Anna]-D.O. [to work]-I.O. and [to clean the office]-I.O.)
THE EFFECTS OF EXPECTATION AND UNCERTAINTY ON SENTENCE PROCESSING

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Recent work in computational psycholinguistics has shown that word-occurrence probabilities, as estimated by probabilistic language models, are predictive of word-reading times. For example, it is well established by now that the reading time on a word in sentence context is positively correlated to its surprisal (i.e., the negative logarithm of its probability given the sentence so far), which has an intuitive interpretation as the extent to which the word came unexpected (Boston et al., 2008; Demberg & Keller, 2008; Frank, 2009; Roark et al., 2009; Smith & Levy, 2008).

Other probabilistic measures have also been suggested as predictors of reading time. Roark et al. (2009) showed that the entropy of the next-word probability distribution, which quantifies uncertainty about the upcoming word, accounts for the word’s reading time over and above its surprisal. However, Hale (2003, 2006) argued that processing effort is predicted by the reduction in entropy (rather than entropy itself) that results from processing a word. Furthermore, he assumed that the relevant entropy is computed over complete sentences, not just over one upcoming word. Unfortunately, this computation is not feasible when the language is of realistic size.

Here, it is shown that Roark et al.’s next-word uncertainty measure is in fact an approximation (albeit highly impoverished) of Hale’s sentence-entropy reduction. Next, the entropy-reduction hypothesis is investigated on a larger scale than has been done before. A recurrent neural network was trained on the part-of-speech (POS) tags of the Wall Street Journal part of the Penn Treebank. Next, the network generated probability distributions over the upcoming POS tag at each point in the sentences (i.e., POS-tag sequences) of the Dundee corpus (Kennedy & Pynte, 2005). These probabilities provide estimates of surprisal (unexpectedness of the actual next POS tag) and entropy (uncertainty about the upcoming POS tag). In addition, the network estimated probabilities of the next two, three, and four POS tags, thereby providing estimates of the entropy over these longer strings. These estimates form increasingly closer approximations of the entropy over full sentences.

The Dundee corpus texts come with eye-tracking data from 10 participants, from which first-pass reading times were extracted. Regression of these reading times on surprisal and entropy reduction (as well as several well-known predictors such as word frequency and length) revealed that both surprisal and entropy reduction account for a significant fraction of variance in reading times. Moreover, increasing the length of strings over which entropy is computed improved reading-time predictions, suggesting that it is indeed the reduction in uncertainty about the complete sentence (rather than just the upcoming input) that drives the effect. These results confirm both surprisal theory and entropy-reduction theory: The time needed to read a word depends on the word’s unexpectedness and on its effect on the uncertainty about the current sentence.

INTEGRATION COST OR STRUCTURAL FREQUENCY? THE EVIDENCE FROM CHINESE RELATIVE CLAUSES
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Hsiao & Gibson (2003) demonstrated using a self-paced reading study that Chinese object relatives (OR) are easier to process than subject relatives (SR): reading times at the head noun are generally faster in OR than SR structures. Gibson and colleagues explain this OR-preference in terms of the Dependency Locality Theory (Gibson 2000): resolving the gap-head noun dependency is harder in SRs vs ORs, due to the greater gap-head distance in SRs. This OR-preference is an important empirical result because it helps decide between DLT and other accounts, such as the structural frequency account (e.g. Mitchell et al 1995). The latter predicts an SR-preference due to their higher frequency of occurrence.

We present four self-paced reading studies which show that, consistent with the structural-frequency account and inconsistent with the DLT’s prediction, Chinese ORs are harder to process than SRs.

Experiment 1 (60 participants), conducted in Taipei, used singly embedded SRs and ORs presented word-by-word; items were taken from Hsiao & Gibson’s (2003) experiment. An SR-preference was seen at the head noun (t=2.42, p<0.05).

Experiment 2 (60 participants), conducted in Dalian, used different items from Experiment 1, and in addition compared SRs and ORs that were either subject- or object-modifying. In subject-modifying RCs a tendency was seen for an SR-advantage (t=1.33, n.s.); in object-modifying RCs, an SR advantage was found (t=2.74, p<0.05).

Experiment 3 (60 new participants), also conducted in Dalian, had the same items as experiment 2 but were preceded by a context that led the reader to expect an RC construction; this design was motivated by claims in the literature that Chinese RCs presented out of context have temporary ambiguities in SRs that could lead to a garden path effect and slower reading times in SRs vs ORs. Here, too, we found an SR-advantage at the head noun in both subject- (t=2.87, p<0.05) and object-modification conditions (t=4.12, p<0.05).

Experiment 4 (72 participants), done in Nanjing, also compared SRs and ORs, but in addition we tested the DLT’s predictions regarding integration cost differently. In object RCs, an adjective (which did not introduce a discourse referent) or a prepositional phrase (which did introduce a DR) either intervened, or did not intervene, between the head noun and the gap. DLT predicts increased integration cost at the head just in case a DR intervenes between a head and dependent. Interestingly, here we found (a) a significant OR-advantage as predicted by DLT (t=-2.25, p<0.05), but this effect was no longer significant once we took spillover from the preceding region into account (t=-0.85, n.s.); (b) no effect of adjective insertion (t=-0.77) but a slowdown at the head noun due to PP insertion (t=2.15, p<0.05), as predicted by DLT.

In sum, the Chinese RC data show overwhelmingly strong evidence for structural frequency as an explanation for relative-clause processing difficulty, and little evidence for locality-based explanations. However, experiment 4 shows in addition that dependency-resolution cost per se (however quantified) is also an important factor in Chinese RC processing.

WHEN PREDICTABILITY IS NOT ENOUGH: THE ADDITIONAL CONTRIBUTION OF GIVENNESS TO DURATIONAL REDUCTION

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More predictable and previously mentioned (i.e. given) words in a discourse tend to have shorter spoken durations than less predictable or unmentioned words (Bell et al. 2009). Because mentioned words often recur, predictability and givenness are confounded as predictors of durational reduction. This experiment separately manipulates the two to isolate each effect. An effect of givenness with predictability held constant would suggest that reduction is partly a function of activated representations (linguistic or conceptual). An effect of predictability with givenness held constant would suggest that reduction is partly a function of anticipatory processing.

A speaker and a listener completed an instruction-giving task in which both saw an eight-object array on a computer. An object on the speaker’s screen would move; for example, she might see an airplane rotate to the right and would describe this to the listener (e.g. “the airplane rotates right”), who would click to make his airplane rotate. Each display had three instructions, in one of three conditions: control, linguistic, or non-linguistic. In the linguistic condition, after the object array appeared, both participants heard the names of the three objects that would move on the trial, in no particular order. This made reference to those objects predictable within the task, and made their names given linguistically. In the non-linguistic condition, the participants saw the objects flash, which made reference to them predictable, and made them given conceptually, not linguistically. Contrastively, objects in the control condition were relatively less predictable, with no evoked representations.

Participants saw 24 experimental items in all three conditions (counterbalanced for order), always as the third (target) instruction. We constructed multi-level models for the log-transformed durations of four segments of the utterances: onset to speak, determiner (“the”), object word (“airplane”), and action phrase (“rotates right”). Analysis of the fixed effects (using MCMC sampling; see Baayen 2008) revealed significant effects of condition on the targets, and instruction number within trials (across the three instructions), suggesting that predictability and givenness both lead to reduction.

Givenness effects were measured by comparing the target instructions across conditions. Non-linguistic givenness resulted in shorter onset to speak and object durations than the control condition; this was either due to activation of the object’s concept, its predictability, or both. Critically, linguistic givenness produced shorter durations than non-linguistic on all segments. This additional reduction suggests that hearing the word activated linguistic representations, which increased reduction beyond informational predictability and conceptual activation.

Evidence for predictability effects emerged from within-trial comparison of the three instructions, across which the predictability of reference steadily increased. Onset duration decreased across instructions, particularly in the linguistic and non-linguistic conditions. This suggests that predictability decreased utterance planning time, independently of visual exposure to the arrays.

These findings contrast with accounts that translate givenness into predictability (e.g. Levy & Jaeger, 2007). Both predictability and givenness led to reduction, suggesting that production internal states do not fully reduce to predictability.

SCENARIO BASED ROLE ASSIGNMENT AS A DETERMINANT OF PLURAL PRONOMINAL REFERENCE TO INDIVIDUALLY MENTIONED CHARACTERS

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When do we create a Complex Reference Object (CRO) from two individual characters so that plural pronominal reference is possible, as in (a)?

(a) Sara and David went to the park./Sara went to the park with David. They… fed the ducks.

Many factors affect CRO formation, some syntactic (as above, (1)), others pragmatic e.g. the physical proximity of characters (2), or ontological status (3). The Equivalence hypothesis (4) suggests that any property which increases the equivalence of the characters can increase CRO formation. We have argued (5) that Equivalence can be interpreted within the framework of the Scenario-mapping and Focus Theory (6). We report three sentence continuation experiments which support this view.

In all three experiments participants continued sentences containing two characters conjoined by and or with. Continuations were categorised according to character reference. Designs were balanced for character gender and order of mention and results analysed using loglinear analysis.

In Experiment 1 participants were presented with sentences like (a). In the control condition both characters had familiar British first names; in experimental conditions only one character had such a name, the other having a formal name (e.g. Mr. Smith), a non-British name, (e.g. Luigi); or a name associated with older individuals (e.g. Agnes). We predicted that participants would produce more plural pronominal references when the characters have “equivalent” names compared to the experimental conditions. Consistent with previous results there were more plural pronouns produced after and than with. However there were no differences between name conditions. It seems that equivalence cannot be based on name-type alone.

The name-types used in Experiment 1 do not suggest different roles within the scenarios used e.g. being old, foreign, or of higher status does affect role assignment in the context of a park. Experiment 2 used scenarios which have status-differentiating roles e.g. manager vs secretary are possible roles in (b). Both characters in one condition had first names; in the other one character name was formal (e.g. Mr. Smith). Results suggest that for characters conjoined by with, there were more plural references in the control condition than in the formal condition, where singular reference was more likely. Thus when there are status-relevant roles in the scenario role assignment can depend on name-type, and the equivalence of roles is predictive of CRO formation.

(b) Sara (and David) sat in the office (with David).

Experiment 3 directly examines the relationship between scenario-related roles and CROs. Roles associated with a scenario vary in the extent to which their likely actions overlap. For example the waitress shares more scenario based activities with the waiter in (c) than the chef:

(c) The waitress (and the waiter/chef) worked in the restaurant (with the waiter/chef).

Results suggest that if character descriptions map onto similar roles within a scenario, participants are more likely to form a CRO than if they map onto roles which are associated with different activities.

Overall these results suggest that the equivalence of two roles within a scenario is predictive of CRO formation.


(5) Moxey, Sanford, Wood, and Ginter When do we use ‘they’ to refer to two individuals?: Scenario-mapping as a basis for equivalence, submitted to Language and Cognitive Processes.

THE ROLE OF PITCH ACCENT TYPE DURING THE PROCESSING OF ACCESSIBLE REFERENTS

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In the present research, we wanted to find out whether prosodic cues influence the processing of inferentially accessible referents in German. We recorded electrophysiological responses to referring expressions that can be linked to prior discourse via a bridging relation (e.g. bottle of wine – the cork) employing three different types of accentuation. The data indicate that the language processor is sensitive to these prosodic distinctions.

Different degrees of accessibility are not only marked through morphosyntactic means, but also through prosodic marking. A general assumption for West Germanic languages is that new information is accented while given information is unaccented or rather deaccented (cf. Cruttenden 2006). However, there is no agreement as to the prosodic marking of accessible referents (figuring between new and given). Only a few approaches correlate different types of accent with different degrees of activation (e.g. Pierrehumbert & Hirschberg 1990; Kohler 1991). For German, Kohler (1991) distinguished early peak accents (equivalent to e.g. H+L* in ToBI notation) for activated information and a medial peak on an accented syllable (H*) for new information. Experimental support for this comes from a perception study that demonstrated a significant correlation between the accessibility of the referent and the type of pitch accent (Baumann & Grice 2006). The findings suggest a scale of intonational marking with new information carrying a primary accent (H*), accessible information a secondary accent (L*), and given information no accent.

We examined the real-time implications of this scale during sentence comprehension utilizing event-related potentials (ERPs). Previous research on the processing of inferentially accessible referents has identified an N400 for difficulties during linking with prior discourse, and a late positivity for costs from discourse updating and restructuring (Burkhardt 2006, 2007). In accordance with this account, investigations of focus prosody have reported N400 effects for integration difficulties due to missing accentuation, as well as late positivities for the reorganization of discourse structure due to mismatches between discourse and prosodic information (e.g. Heim & Alter 2006, Toepel et al. 2007). We tested the comprehension of accessible referents as in (1). Based on prior research on inferential accessibility, an early peak accent (H+L*) was hypothesized to be the most appropriate accentuation (1.b). Deviations (1.a/c) were predicted to engender an N400 for integration difficulties and a late positivity for mismatches between prosody and degree of accessibility. The ERP data (time-locked to the sentence-final noun phrase) showed increased N400-amplitudes as a function of prosodic marking (b<a<c) and a significant late positivity for given/deaccented referents (c).

While prior research on the processing of pitch accents has revealed a binary distinction between accented and unaccented contours, we found a three-way N400 contrast indicating that finer-grained distinctions are drawn during referential processing. The biphasic pattern for (c) further shows that, from a prosodic point of view, accessible information (b) is more closely connected to new than to given information, since given accentuation (c) evoked the most pronounced N400 followed by a late positivity, indicating a clear mismatch between prosodic information and the discourse status of the referent.

Example stimuli (N=90).

1. Tilmann kaufte sich eine Flasche Wein. Dann entfernte er den Korken.
   ‘Tilmann bought a bottle of wine. Then he removed the cork.’
   a) ‘newness accent’ (H*) on KORken
   b) ‘accessibility accent’ (H+L*) on KORken
   c) ‘givenness accent’ (deaccentuation) on Korken

THE SEMANTIC INTERFERENCE EFFECT AND THE DISTRACTER FREQUENCY EFFECT ARISE AT DISTINCT LOCI IN SINGLE WORD PRODUCTION

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In the picture-word-interference paradigm (PWI), pictures are presented with a superimposed distractor word and participants have to name the pictures while ignoring the distractors. Models of word production based on lexical selection by competition make a straightforward prediction with respect to the effect of the frequency of unrelated distractor word in PWI. In fact, the lexical selection mechanism is sensitive to the relative level of activation of the competing lexical nodes: the higher the activation of the competing representations, the longer it takes to select the target representation. Since high frequency distractor words activate their lexical representations more strongly than low frequency distractor words, high frequency distractor words are predicted to interfere more strongly with the selection of the target representation than low frequency distractor words. However, Miozzo and Caramazza (2003) reported that low frequency distractors interfere more than high frequency distractors in picture naming. This result clearly challenges the lexical selection by competition account.

Recently, Caramazza and collaborators (Finkbeiner & Caramazza, 2006; Mahon, Costa, Peterson, Vargas & Caramazza, 2007) proposed a late, response-selection account for the distractor frequency effect in picture naming. In a PWI context, the response selection stage deals with a response that needs to be blocked and rejected (the response to the distractor) to favour the picture's name processing. Since high frequency words are processed faster than low frequency words, the former are dealt with faster than the latter, and thus produce less interference. Noteworthly, within this proposal, the response selection stage is also the stage the semantic interference in PWI comes from: since it is more difficult to reject a distractor semantically similar to the target than an unrelated distractor, semantically related distractors interfere more than semantically unrelated distractors. Thus, according to Caramazza and collaborators, the response selection stage - as the primary mechanism of PWI - is the locus of both the frequency of the distractor effect and the semantic interference effect.

We report two experiments using either a single-task (PWI) or a dual-task (task1: tone discrimination; task2: PWI). We show that a) the semantic interference effect and the distractor frequency effect are additive on RTs, and that b) whereas, in the dual-task, the semantic effect gets absorbed into the cognitive-slack, the distractor frequency effect cannot be absorbed. If additive effects of two factors on RTs are the signature of distinct processes that occur sequentially, the results of the first experiment suggest that the processes underlying the semantic interference effect are distinct form the processes underlying the distractor frequency effect. In addition, if the locus-of-slack logic holds even when a PWI is involved, then the locus of the semantic interference effect is not only distinct from the locus of the distractor frequency effect but the former precedes the latter.

Taken together, the results of our experiments strongly suggest that the distractor frequency effect and the semantic interference effect have two distinct loci and thus challenge the Caramazza and collaborators’ proposal, which posits a single locus for the two effects.

VIRTUALLY ACCOMMODATING: ALIGNING SPEECH WITH A VIRTUAL INTERLOCUTOR

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Why do people accommodate to each other’s linguistic behavior? Studies of natural interactions have identified social factors that influence how much speakers accommodate (Giles, Taylor & Bourhis, 1973). Based on these studies, it appears that a speaker accommodate towards or away from their interlocutor to achieve interactional goals: to convey information about their social stances, or even to change their relationships through linguistic accommodation.

But is this the only reason speakers accommodate? Mechanistic theories of dialogue (Pickering & Garrod, 2004) propose that automatic alignment processes could also account for convergence in linguistic behavior. Yet, in real-world conversations, interactional motivations are ubiquitous, making it difficult to assess the extent to which accommodation depends upon them, as opposed to automatic processes. Do speakers still accommodate even when interactional goals cannot be achieved, for instance, when their interlocutor cannot interpret their accommodation behavior?

To find out, we asked participants to enter an immersive virtual reality (VR) environment and to converse with VIRTUO, a male virtual interlocutor whose speech was pre-recorded by a native Dutch speaker. Participants in the FAST condition heard these recordings sped up by 12%, and in the SLOW condition slowed down by 12%. VIRTUO asked participants questions about the human world, which created a conversational setting, but he did not have the ability to understand or respond to their utterances. Participants’ speech was recorded and their speech rates calculated during two time periods: before speaking to VIRTUO (BASELINE rate) and then during their conversation with VIRTUO (CONVERSATION rate).

Results showed that VIRTUO’s speech rate influenced how fast the participants spoke in their conversation with him. Participants in the FAST condition spoke significantly faster during their conversation with VIRTUO than during their baseline measurement (t(1,32)=4.02, p=.0003), and significantly faster than participants in the SLOW condition (t(1,60)=2.24, p=.03), whose conversational rate did not differ from their baseline rate (t<1); this resulted in the predicted interaction between Condition (FAST, SLOW) and Measurement (BASELINE, CONVERSATION) (F(1,60)=4.36, p=.04).

Participants accommodated to the speech rate of their virtual interlocutor. This occurred even though VIRTUO could not interpret participants’ linguistic behavior, and thus accommodation could not possibly help them to achieve interactional goals. Why, then, did participants accommodate to VIRTUO? According to debriefing data collected after the experiment, participants accommodated more to VIRTUO when they judged themselves to be more similar to him (r=.25, p=.05). Similarity does not constitute an interactional motivation to accommodate. Rather, this correlation suggests that people may accommodate more to an interlocutor they identify with.

In real-world conversations, accommodation may often be motivated by efforts to achieve interactional goals. However, the present data show that accommodation behavior is engaged automatically, even when these goals cannot be met. Social motivations at a broader level may combine with automatic factors to produce linguistic accommodation.
RECALL PREDICTED BY REDUCTION IN INTENSITY BUT NOT DURATION: IMPLICATIONS FOR THEORIES OF PROMINENCE

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The present study evaluated multiple source accounts of prosodic prominence by testing the relation between memory and multiple acoustic correlates of prominence. Participants completed a modified version of the map task (Anderson et al., 1991) and a free recall test for the referents. Reduction in intensity across mentions of an item predicted poorer memory for the item, but reduction in duration did not, consistent with a multiple source account.

Watson (in press) proposes a multiple source account in which prosodic prominence results from the interaction of several cognitive processes, including both the semantic and phonological priming of repeated words in production and the listener-centered signaling of discourse status. Consistent with this, in experiments, discourse predictability reduces intensity, but word repetition reduces duration (Lam & Watson, submitted). These findings suggest that intensity may be linked more to explicit knowledge and duration more to implicit production processes.

A test of this hypothesis is the relation of prominence to later explicit memory. If intensity reflects newness or predictability in a conscious discourse model, reduction in intensity from a speaker’s first mention of a referent to the second should demonstrate awareness of the first mention, which many theories argue modulates later recall. For example, one theory is that when participants do not consider a prior presentation, they encode a second less similarly, which may facilitate subsequent recall (Cepeda et al., 2006, for review). Thus, if intensity reduction is most related to discourse status, greater reduction in intensity should reflect remembering the first mention and predict lower probability of later recall. In contrast, if duration reduction largely indexes implicit production priming, it may less strongly predict recall.

Naïve dyads (N=15) completed a modified map task. One participant described to the other maps containing numbered arrows between pictures. Target referents appeared first within two different instructions, as in (1) and (2), with 0, 1, or 3 instructions intervening. Targets had monosyllabic names. After the map task, participants completed a free recall test for the referent names.

Results were analyzed using a hierarchical linear model with crossed random effects for subjects and items. Intensity reliably decreased between first (M=73.52 dB) and second mentions (M=72.94). Moreover, as predicted, amount of reduction predicted the speaker’s subsequent recall (Wald z=-2.15, p=.03); non-recalled items were more reduced (M=0.68 dB reduction) than recalled items (M=0.38).

Duration also reliably decreased between first (M=562 ms) and second mentions (M=470 ms). However, amount of reduction did not reliably predict explicit recall (z=0.75, p=.45), consistent with the idea that reduction in duration may result primarily from production priming.

Together, these results support a multiple source account of prosodic prominence. Intensity, which may reflect an explicit discourse model, predicted recall for the referents; duration, which may primarily reflect implicit production processes, was unrelated to explicit memory. This difference is inconsistent with models attributing prominence to a single source such as informational redundancy (Aylett & Turk, 2004) or repetition (Fowler & Housum, 1987). Rather, it suggests that multiple cognitive processes may interact to produce prosodic prominence.

(1) Number one, go from the ski to the slide.
(2) Number two, go from the ski to the ghost.
INVESTIGATING SEMANTIC INTEGRATION’S EFFECT ON THE FUNCTIONAL AND POSITIONAL LEVELS OF GRAMMATICAL ENCODING DURING PRODUCTION

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Semantic integration is the degree of conceptual relatedness between parts of an utterance to be planned (Solomon & Pearlmutter, 2004). In the phrase "the bracelet made of silver," "made of" induces integration by conceptually linking the nouns. Similarly, a picture of an object and attribute (e.g., an apple with a spot on it) leads to a more integrated message than would a picture of two separate objects (e.g., a sink with a shelf above it).

Pearlmutter and Solomon (2007; P&S) argued that integrated elements are activated simultaneously and so are more likely to interfere with each other during processing. They found exchange errors to be more likely in integrated than in unintegrated scenarios but could not determine if errors arose at the functional or positional level (Bock & Levelt, 1994) of grammatical encoding. We investigated how far into sentence production processes integration penetrates with stimuli allowing for differentiable phrase (always functional-level) and word (potentially positional-level) errors.

In Experiment 1, 100 participants saw 18 integrated (e.g., "the green spot on the blue apple") and 18 unintegrated (e.g., "the red shelf above the green sink") pictures, describable with two nouns linked with a preferred ("the green spot on the blue apple") or unpreferred preposition ("the blue apple with the green spot") or the conjunction "and" ("the blue apple and the green spot/the green spot and the blue apple"). The prepositions were intended to force the preferred or unpreferred noun order; "and" allowed for flexible ordering. Stimuli were previously normed for integration and preference. Word and phrase exchanges were differentiable, as nouns, adjectives, or full noun phrases could exchange.

During training, each picture was presented in its black-and-white version with its intended nouns. During testing, the colored version of each picture appeared, then the linking word (not seen during training) appeared below it 2000 ms later. Participants described each picture using the trained nouns, appropriate colors, and linking word. Responses were coded as correct responses versus ordering errors.

Most (95%) of the errors were phrase exchanges. Within the phrase errors, the integrated conditions generated more errors than the unintegrated conditions (see Table 1), replicating P&S, suggesting that P&S’s effects arose primarily from functional-level errors and showing that integration can influence at least the functional level. The rarity of word errors indicated that few errors arose at the positional level. Experiments 2 and 3 modified the task to attempt to rectify this. Because the relatively long SOA may have allowed participants to plan entire NPs in advance, Experiment 2 used a ~500 ms SOA to prevent advance planning. Because color adjectives and nouns may have been unlikely to separate with the picture onscreen during speech, in Experiment 3 the picture disappeared when the linking word appeared (after a 2000 ms SOA). These experiments so far show largely phrase exchanges—demonstrating that these issues cannot explain the word exchange rarity—along with effects of integration. We will discuss these effects and the task’s potential for eliciting word errors and examining positional level phenomena.

Table 1. Experiment 1 Response Counts and Error Rates by Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Correct</th>
<th>Phrase</th>
<th>Noun</th>
<th>Adjective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated</td>
<td>Preferred</td>
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SENTENCE-DRIVEN MOTOR SIMULATION IS SENSITIVE TO SOCIAL CONTEXT

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Behavioral and brain imaging evidence shows that processing action language engages the mental simulation of described motor actions (e.g., [2-4]). Key evidence comes from the “action-sentence compatibility effect”: manual responses to make sentence sensibility judgments are facilitated when the motion of the physical response is compatible with the sentence’s implied direction. For instance, ‘You handed the puppy to Katie’ speeds manual responses away from the body, while ‘Katie handed the puppy to you’ speeds movements toward to the body (e.g., [2]).

It is unknown, however, whether language-driven motor simulation is sensitive to social constraints on action. For instance, in Korean culture, people use both hands when giving an object to someone of senior or higher social status, but one hand with close peers or social inferiors. Are social prescriptions for motor action so deeply ingrained that simply hearing about action in social situations elicits simulation of the prescribed physical behaviors?

Thirty native Korean speakers heard sentences describing object-transfer to either a social superior (1a) or inferior (1b), and made a sentence-meaningfulness judgment by pressing pre-assigned buttons with one hand or two (i.e., unimanual or bimanual button press). Each participant was randomly assigned to begin in the Bimanual-Yes or Unimanual-Yes condition.

The response-button assignment was reversed midway through the experiment, and there was additional practice with the new configuration. Crossing two Sentence-Types (Superior and Inferior) with two Response-Types (Unimanual-Yes and Bimanual-Yes) generated four within-subjects conditions (2). The dependent measure was time to press the correct buttons.

If comprehenders mentally simulate culturally prescribed actions, there should be an interaction between Sentence-Type and Response-Type. But in what direction? If Korean is like English, then these sentences should produce an action-sentence compatibility effect—sentences about superiors should facilitate bimanual responses, but sentences about inferiors should facilitate unimanual responses. However, previous work shows that mental simulation can actually inhibit compatible motor responses when action verb processing and motor planning are performed simultaneously (e.g., [5]). Since Korean sentences have their main verb at the end, participants will likely be performing motor simulation appropriate to the verb while simultaneously planning their subsequent motor response. This could produce an action-sentence incompatibility effect.

Results showed a significant interaction between Sentence-Type and Response-Type (F1=7.604, p=0.01; F2=6.594, p=0.02). Bimanual responses were slower when sentences described object transfer to superiors (2a) than inferiors (2b), whereas unimanual responses were slower when sentences mentioned object transfer to inferiors (2d) than superiors (2c). Mean response times in milliseconds for each condition are given in (2).

This study yields three new findings. First, motor simulation includes the number of hands one would use to perform a described action. Second, cultural-specific rules for motor control enter into these mental simulations. Finally, the direction of action-sentence interactions is different in Korean and English—arguably due to differences in word order. We will discuss the implications of these findings for sentence processing mechanisms and embodied theories of meaning (e.g., [1, 2]).

   ‘You are now (humbly) giving a letter to (your) teacher.’
   ‘You are now giving a letter to (your) younger sibling.’


Work on pronoun resolution has shown that these expressions elicit a set of possible antecedents seemingly limited to referents in appropriate grammatical positions. The resolution of the pronoun "they", however, posits an interesting question: how is it possible that, in some cases (known as associative anaphora), "they" is co-referential with singular expressions denoting either plural or single entities, or with (singular) collective terms denoting collections of entities? Consider, for instance, the English version of one of the texts we actually used in Experiment 2, below: "In order to go abroad, the army division was reorganized. They departed in the winter" and "In order to go abroad, the army division was vaccinated. They departed in the winter". It looks like we are dealing with ambiguous readings of the subject NP ("the army division"). In the first case, a collective reading is required to reach a plausible semantic interpretation. In the second, a distributive (plural) reading is called for (i.e. each one of the soldiers in the army division was vaccinated). The resolution of NP ambiguity (collective vs. plural readings) is thus determined at the level of the predicate, in the sentence containing it. If this is so, one can postulate that the reading preferred by the predicate might have a predictive influence on the resolution of the anaphora. To determine whether a putative distributive or collective/singular prediction influences subsequent processing, we ran two experiments. In Experiment 1, we investigated whether such expectations do indeed play a role in how subjects provide continuations for passive sentences. Subjects were presented with sentences such as "In order to go abroad, the army division was reorganized..." or "In order to go abroad, the army division was vaccinated..." and required to supply a continuation containing an apt agent for each verb. The results indicate that whenever a collective reading is favored, subjects are prone to choose a singular continuation for the sentence (78% of the times); conversely, faced with a verb favoring a distributive reading, they opted for plural continuations (63% of the times). Differences were significant (McNemar $\chi^2$ test: 4.93, $p = 0.0264$). In Experiment 2, a self-paced reading task, subjects were required to read the two versions of the texts, one in which the reading of the first sentence was collective (e.g., prompted by "reorganize") and another in which the favored reading was distributive (e.g., prompted by "vaccinate"). There was only one explicit antecedent for the pronoun in each text pair. The critical reading time was, of course, the one for the pronoun "they" in either a collective or a distributive condition. We expected that the incongruence between a collective context (collective predicate in the first sentence) and the plural pronoun would lead to increased times with respect to the times for "they" in a distributive context (distributive predicate in the first sentence). The results confirmed our hypothesis: the reading time for "they" in a collective context was 792 ms and in a distributive context it was 563 ms — repeated measures ANOVA: $F_1 (1,150) F = 8.324315, p = 0.004489$; $F_2 (11, 140) F = 1.907526, p = 0.043088$. It thus seems that the predictions generated by the predicate of the sentence containing the antecedent might have a role in the resolution of the anaphoric pronoun. (Supported by FAPESP (06/59156-6))
MEASURING THE TIME-COURSE OF SENTENCE PROCESSING WITH PUPILLOMETRY

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Advances in technology have allowed the measurement of sentence processing to move from off-line analyses (where conscious reflection and problem-solving form part of the measureable output) to on-line analyses. In the present study we add to the quiver of on-line methods by revisiting an old technique, pupillometry. The magnitude of pupil dilation is a function of the processing load required to perform a task (see Beatty, 1982, for an historical review). More recently, pupillometry has been used to measure the processing load that results from syntactic complexity (Just & Carpenter 1993) and the resolution of syntactic ambiguity by prosody and context (Engelhardt et al., 2009). These efforts have averaged pupil responses across relatively large time windows, from 1 second to several seconds post-target.

In the present study we aurally presented three types of grammatical/ungrammatical pairs to college-age participants (N=13). Participants were required to attend to the sentences (followed by yes/no questions) while fixating on a centrally placed cross, and pupil diameter was recorded. Unlike previous efforts, we measured pupil diameter every 17ms across the entire sentence and examined where the pupillary response differed within each minimal pair. In this way we were able to locate where in the processing stream the various types of grammatical information exerted an influence.

For each participant, baseline pupil diameter was calculated by averaging across the 500ms prior to the ‘violation’ point in each sentence. We then calculated percent change from baseline and discovered the following patterns:

1. Violation of subject-verb agreement resulted in an increase in processing load for ungrammatical relative to grammatical sentences at approximately 700ms post-violation (p<.001 for 700-850ms range).
2. Filled gap constructions produced an increase in processing load for ungrammatical relative to grammatical sentences at approximately 450ms post-violation (p<.001 for 450-600ms range).

Recent ERP work has revealed a left anterior negativity (LAN) occurring between 300-500ms post-agreement violation, as well as an early-LAN occurring between 100-300ms post-filled gap violation (Friederici, 2002; Hestvik et al., 2006). Given that there is approximately a 250ms delay between stimulus change and pupil dilation, these patterns conform quite nicely to our data.

3. For subcategory violations, an increase in processing load occurred for grammatical relative to ungrammatical sentences almost immediately, approx. 250ms post-violation (p<.01, 250-400ms range), but then switched to the reverse pattern well past the violation (approximately 1000ms). This phenomenon has been observed in working memory: when the demands become too great to continue, the pupils constrict as the processor temporarily gives up on the task.

Our initial results, then, look quite promising. We are currently presenting sentences that manipulate plausibility via thematic role information. Our purpose here is to test claims that such information is used early relative to syntactic information. With this method, we also intend to examine other factors claimed to impact language processing, including working memory, interference from intervening NPs, etc. Our ultimate goal is to shed light on the functional architecture of the sentence processing system with methodology that requires minimal tampering with normal processing routines.

Subject-verb agreement:
1a. Last Friday the impatient chef cooked a marvelous dinner for the family reunion.
1b. *Last Friday the impatient chef cook a marvelous dinner for the family reunion.

Filled-gap effect:
2a. The zebra thought that the hippo had kissed the camel on the nose and then ran far away.
2b. *The zebra that the hippo had kissed the camel on the nose and then ran far away.

Subcategorization:
3a. The dog that runs fast chased a cat around the yard.
3b. *The dog that runs fast slept a cat around the yard.

RELATIVE VS. COMPLEMENT CLAUSES IN SUBJECT-VERB AGREEMENT ATTRACTION

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Verbs in English typically agree in number with the head noun of their subject, however under certain conditions, speakers make errors in which the verb agrees with another noun instead, as in (1) below, in which the verb to be should agree with the subject head noun 'key' but instead reflects the plural number of the attractor noun 'cabinets' (e.g., Bock & Miller, 1991). Not only do speakers make this type of error, but readers are less likely to notice an ungrammatical number mismatch between the subject and its verb under the same circumstances (Pearlmutter et al., 1999).

A recent study (Wagers et al., 2009) shows that the attractor noun does not need to be intervening between the subject head noun and the verb in order to attract agreement. Readers did not slow down at the ungrammatical embedded relative clause (RC) verb in sentences like (2) below relative to the grammatical (3). This effect is striking because the subject head noun is adjacent to its verb and so one might expect the attractor noun(e.g., 'musicians') to only have a weak effect, if any. Further, it opens the question of what relationship the attractor must have with the verb in order to attract agreement. The answer to this question has important implications for how agreement processes function.

In (2), the attractor is the head of the RC containing the verb and is thus involved in a filler-gap dependency with that verb. It may be that such a relationship is necessary for agreement attraction to occur. We tested this hypothesis in a self-paced reading study by comparing Wagers et al.’s relative clause conditions in (2) and (3) with complement clause conditions which differed from the RC version only by having a verb follow the attractor, as shown in (4) and (5) below. In these sentences, the relative positions and local relationship between the embedded subject and its verb are maintained, but crucially the attractor no longer has a filler-gap relationship with the embedded verb.

Reading times for the embedded verb and following word reveal that for the RC conditions, the ungrammatical condition is actually faster than the grammatical, while this pattern is reversed for the complement clause conditions, with slower times for the ungrammatical condition. This confirms Wagers et al.’s finding that the head of an RC can act as an attractor for an embedded verb, but also shows that relationship between the attractor and the verb formed by the RC may be crucial to this effect. These results thus suggest that when an attractor is not intervening between a subject head noun and its verb, another relationship between the attractor and verb must exist in order for the attractor to have an influence.

(1) *The key to the cabinets are …
(2) *The musicians who the reviewer praise so highly …
(3) The musicians who the reviewer praises so highly …
(4) *The musicians know who the reviewer praise so highly…
(5) The musicians know who the reviewer praises so highly…

INTERFERENCE BETWEEN CONVERSATION AND A CONCURRENT VISUOMOTOR TASK

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Previous research has established that conversation can interfere with simultaneously performing a visually guided motor task, but thus far the focus has been largely on two conditions: listening and talking (Strayer et al., 2003; Kunar et al., 2008). Thus, the true complexity and richness of natural conversation, where interlocutors often speak simultaneously and during which their attention constantly shifts back and forth from their own speech to that of their partner’s (Clark, 1996; Pickering and Garrod, 2004) has remained largely unexplored. In this study, we examined participants’ performance of a smooth pursuit task (tracking a smoothly moving target with a computer mouse) while they were engaged in a free-form conversation with a friend in a different room using a hands-free communication system. We relied on results from a post-experiment survey to determine how natural participants and their partners felt their conversation had been. The smooth pursuit task varied in difficulty as a function of target speed. We compared participants’ performance in this task (residual distance to target) under the following conditions: control (no conversation), speaking, listening, preparing to speak, and overlapping speech. Following previous research (Almor, 2008), we hypothesized that planning what to say and speaking pose the greatest executive demands and that in these conditions participants will perform worst on the smooth pursuit task.

We did indeed find that participants performed worse when speaking as compared to listening, t(15) = 4.62, p < .001. Counter to Almor’s (2008) findings, participants were performing better on the smooth pursuit task when preparing to speak as opposed to talking, t(15) = 3.02, p = .008. There was no difference between the control and listening condition, nor was there a difference between talking and overlapping. Results from this analysis suggest that participants had an easier time shifting their attention back and forth between the two tasks during comprehension than production and that during overlaps participants were focusing on talking and not simultaneously speaking and listening. Following the smooth pursuit performance analysis, we analyzed linguistic task performance, measured by duration of turn as a function of target speed (low vs. mid vs. high) and conversational condition (listening vs. talking segments). We hypothesized that there would be an interaction, such that longer talking segments would occur in the slow target speed conditions and would be shorter in high speed conditions, while listening segments would follow the opposite pattern. There was an interaction but not the expected one. Greatest differences between listening and talking segments occurred in the mid speed range, suggesting varying patterns in how attention was allocated across the three speed ranges, such that during the mid speed range attention was divided evenly between the visuomotor and linguistic tasks. Overall these results suggest that it is the production aspect of conversation that poses the greatest attentional demands.

LINGUISTIC COMPLEXITY AND THE STRUCTURE OF SLUICES AND FRAGMENT ANSWERS

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Since Merchant (2001), the possibility of preposition omission under sluicing (1) has been characterized as following from the availability of preposition stranding under regular wh-movement (2), and hence as evidence for underlying structure. Merchant (2004) suggests that this analysis be extended to fragment answers (3). These proposals are based on the distribution of prepositionless sluices and fragment answers across languages with and without preposition stranding; this distribution, however, is more complex than what can be gleaned from Merchant’s data. We hypothesized that preposition omission is independent of the availability of preposition stranding but sensitive to the linguistic complexity of the correlate processed prior to the ellipsis remnant. Our hypothesis was tested in five experiments using stimuli from Polish (a non-preposition-stranding language). In the first experiment, we crossed preposition omission and the amount of linguistic information encoded in a sluice: the sluice’s correlate contained either a multi-syllabic preposition (complex condition) or a monosyllabic one (non-complex condition). Acceptability judgments data show that sluices without non-complex prepositions were degraded with respect to sluices without complex prepositions – a significant interaction.

The stimuli in the second experiment paired complex correlates (NPs) and corresponding sluices (complex wh-phrases) with non-complex correlates (pronouns) and corresponding sluices (bare wh-phrases), see (4). The acceptability of the sluices without prepositions in the complex condition was higher than that of the sluices without prepositions in the non-complex condition. This interaction, too, was significant.

In another experiment, we tested this correspondence by pairing cataphoric sluices with anaphoric ones, with all prepositions multi-syllabic and sluiced wh-phrases bare (5). If the effect of linguistic complexity is reliable, the reversed order of the correlate and sluice should lead to a reduction in acceptability in this condition. Acceptability judgments data show a main effect of correlate placement by items and by subjects, where the acceptability of preposition omission was significantly lower in the reverse condition than in the anaphoric condition. This indicates that preposition omission critically depends on a linguistically complex correlate preceding a sluiced wh-phrase.

A similar pattern emerged from the experiment testing the role of complex NPs used as correlates and remnants in fragment answers. Preposition omission was judged worse in the non-complex condition, yielding a main effect of linguistic complexity.

Our last experiment shows that manipulating linguistic complexity at an ellipsis site has no impact on acceptability when the ellipsis has a covert correlate and no prepositions are omitted. We compared the acceptability of complex and non-complex wh-phrases under sprouting, and found no significant difference between them.

These data support our hypothesis: the acceptability of preposition omission is degraded in the absence of a linguistically complex correlate. There is no obvious role that the availability of preposition stranding, or lack thereof, could play here. Therefore, we argue that our findings strengthen the evidence in favor of non-transformational accounts of ellipsis by dissociating the possibility of preposition omission under ellipsis from movement operations in non-elliptical clauses.
SECOND LANGUAGE LEARNERS’ SENSITIVITY TO THE RELATIVE CLAUSE ISLAND IN ONLINE PROCESSING

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Research has shown that native speakers’ processing of filler-gap dependencies is immediately sensitive to the island constraint, with the parser suspending its usual active gap search inside an island (Stowe, 1986; Traxler & Pickering, 1996). Yet, little is known about how this constraint operates in second language (L2) filler-gap processing. The present study investigates this question in L2 English from two different first language (L1) background, in the context of the debate over the depth of syntactic representation of L2 processing (Shallow Structure Hypothesis; Clahsen & Felser, 2006).

Learners’ grammatical knowledge of and real-time sensitivity to the relative clause island (Ross, 1967) were examined using an acceptability judgment and a stop making sense judgment task (Boland et al., 1995), respectively. The acceptability judgment task included 20 sentences involving extraction from a relative clause and 20 grammatical counterparts (1a-b). The stop making sense judgment task included 20 sets of 4 sentences (2a-d), following Traxler and Pickering (1996). In the non-island conditions (2a&2b), the filler (which book/city) can be temporarily interpreted as the object of the embedded verb (wrote), although this local dependency must be abandoned at the preposition about. In the island conditions (2c&2d), such local interpretation is grammatically unavailable because the relevant verb is inside a relative clause. Plausibility of the filler as the object of the relevant verb was manipulated (which book is a plausible (2a&2c) vs. which city is an implausible (2b&2d) object of wrote). Traxler and Pickering found a plausibility effect only in the non-island conditions: the reading times at wrote passionately were shorter in (2a) than (2b), but not in (2c) and (2d), suggesting that although the L1 parser actively creates a gap at the earliest grammatically possible position (Active Filler Strategy; Clifton & Frazier, 1989), it does not establish a filler-gap dependency within an island. If the L2 parser is also immediately sensitive to the island constraint in online sentence reading, a comparable pattern of plausibility effects will emerge.

Participants were 22 L1-Korean advanced L2-English learners, 18 L1-Spanish advanced L2-English learners and 24 English native speakers. Whereas the RC island works in a similar way in English and Spanish, it does not restrict Korean (in-situ) wh-question formation (Choi, 1987). The acceptability judgment data indicates both L2 groups have grammatical knowledge of the relative clause island constraint. The stop making sense task data (i.e., how often the participants judged a sentence as implausible at a given region) show a significant island * plausibility interaction, but no island * plausibility * group interaction at the earliest possible gap region (wrote passionately), suggesting L1-L2 parsing similarity and a limited role of learners’ L1: The L2 parser, regardless of whether relative clauses work as an island in their L1 wh-question formation, suspends the active gap search soon after the island boundary is encountered. This real time sensitivity to the island constraint and L1-L2 parsing similarity provides initial evidence against the view that L2 parser cannot compute detailed syntactic hierarchical structure in incremental sentence comprehension (Clahsen & Felser, 2006).

Sample sentences
1. offline acceptability judgment task
   1a. (acceptable) I asked which publisher the writer who wrote the book passionately saw while he was traveling.
   1b. (unacceptable) *I asked which book the writer who wrote passionately saw the publisher while he was traveling.

2. online stop making sense judgment task
   2a. (non-island/ plausible) I asked which book the writer who wrote passionately about while he was traveling.
   2b. (non-island/ implausible) I asked which city the writer wrote passionately about while he was traveling.
   2c. (island/ plausible) I asked which book the writer who wrote passionately saw while he was traveling.
   2d. (island/ implausible) I asked which city the writer who wrote passionately saw while he was traveling.

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