The Latency of Lexical Access in Visual and Spoken Word Recognition

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Introduction

Word recognition appears similar across visual and auditory modalities. The cortical timing and location of N400/N400m effects associated with word predictability in sentential context in ERP/MEG reading studies are similarly elicited by speech (Helenius et al., 2002).

Previously we found that the meaning entropy of homographic homophones (orthographically and phonetically identical words like *wind*) modulated a temporal response similar to the N400m at ~300ms post stimulus onset (Simon et al., in press; Lewis et al., in progress) whether the words were presented visuall or aurally.

The present study tested two competing hypotheses about the similar timing of these effects across modalities: that word recognition is modulated by

(a) an interaction between the rate of stimulus input and processing mechanisms shared across modalities, or
(b) an intrinsic brain clock set off by the onset of the stimulus.

We tested these hypotheses by increasing the rate of stimulus input for auditory words through time-compression to track whether increased rate of stimulus input expedited brain sensitivity to input variables reflecting lexical access.

Methods

Stimuli

- 200 bi-syllabic monomorphemic nouns and
- 200 nonwords of similar length and bigram frequency

Speech files were generated from the words and reduced in tempo to 75% to derive compressed stimuli. Average difference in duration between compresseed and uncompressed stimuli was ~245 ms.

Variables

- surface frequency
- derivational family frequency (DFE): summarizes the frequency distribution of a derivational family.

In previous work these variables were highly predictive of response time in lexical decision and suggest that DFE should modulate lexical access to a stem (Moscoso del Prado Martin et al., 2004).

Analysis

Subjects

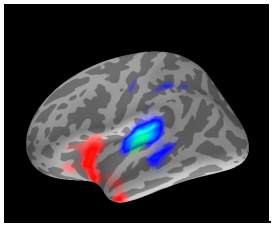
- seven males, two females
- right-handed native English speakers with structural MRIs

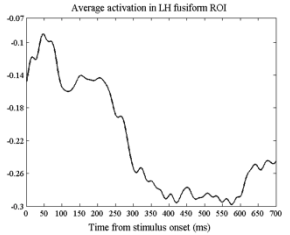
Experiment

- auditory lexical recognition task
- stimuli presented across four randomized blocks
- MEG data acquired continuously throughout the experiment

Brain Data

- structural MRIs reconstructed in FreeSurfer
- activation within FreeSurfer transverse temporal label
- minimum norm solutions computed for each label, for each subject, for each trial in the raw data

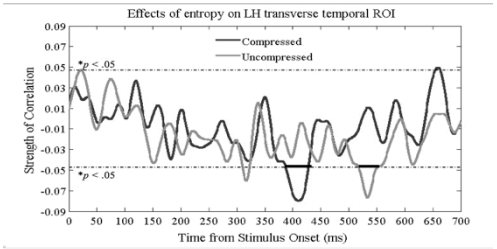




Average activation in LH transverse temporal ROI (9 subjects)

Results

- DFE most strongly correlated with activation ~389ms for compressed items* and ~519ms for the uncompressed items* (~130ms acceleration).
- SF most strongly correlated with activation ~316ms for compressed items* and at ~528ms for uncompressed items (~212ms acceleration).
- RT was faster for the compressed items* (average acceleration of ~118ms), and was negatively correlated with SF and DFE.**



*p = .05 significance level following correction for multiple comparisons. The bold line identifies temporal clusters subject to the Monte-Carlo correction procedure.

Conclusion

Speeding up information relevant to lexical access decreased the latency of correlations between variables associated with lexical access and the brain response in the temporal lobe proportionately to the amount of compression, and sped up RT supporting the hypothesis that the similarity in latency between visual and auditory word recognition is not due to an intrinsic brain clock (hypothesis (b)), but to an interaction between rate of stimulus input and processing mechanisms shared across stimulus modalities (hypothesis (a)).

References

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