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Fast track report

On the interactive influence of facial appearance and explicit knowledge in social categorization

NICHOLAS O. RULE[1]*, KONSTANTIN O. TSKHAY[1], JONATHAN B. FREEMAN[2] AND NALINI AMBADY[3†]

[1]University of Toronto, Toronto, Canada; [2]Dartmouth College, Hanover, USA; [3]Stanford University, Stanford, USA

Abstract

Although people form impressions of others with ease, sometimes one's initial perceptions of individuals conflict with what one knows about them. Here, we aimed to investigate the process by which explicit knowledge about people interacts with initial perceptions on the basis of cues from facial appearance. Participants memorized the sexual orientations of men's faces wherein half of the targets were encoded with a sexual orientation opposite to their actual orientation. Subsequent categorization showed that perceivers favored appearance-based information when temporally constrained but favored explicit knowledge about group membership with increased viewing time. Additionally, real-time measures of participants' categorizations showed greater vacillation between appearance-based cues and explicit knowledge as viewing time increased. These findings suggest that explicit knowledge does not simply overrule appearance-based cues past a particular threshold but that the two may interact recurrently with top-down knowledge directing attention and perception at later processing. Copyright © 2014 John Wiley & Sons, Ltd.

Theories of person perception and social categorization tend to conceptualize the process of construing others as consisting of multiple stages (Macrae & Quadflieg, 2010). A target must first be recognized by the sensory system, after which the mind retrieves stored information about the person and compares this with what has been perceived. In terms of visual perception, one sees a person, orients to the person's face, and begins assessing the configuration and characteristics of the face's features (Bruce & Young, 1986). These basic stages of face perception soon translate into person construal with several key dimensions immediately evaluated (age, race, and sex; Brewer, 1988). At this point, a basic categorization is formed: for example, our target may be a young, Caucasian man.

All of this may be achieved in milliseconds. With subsequent processing, however, we may discover that we are wrong—perhaps our target is actually our older, female neighbor whose bobbed hair and youthful skin have once again left us flummoxed. Achieving this change may consist of accessing explicit knowledge that modifies our initial impression based on cues in appearance. The present work was interested in developing a greater understanding of how it is that explicit knowledge and appearance-based cues interact to settle on a categorization of an individual, particularly when the appearance-based cues may be ambiguous. Thus, we investigated how explicit knowledge about targets' group membership interacts with conflicting cues from their appearance.

Previous studies have investigated conflicts between appearance-based cues and explicit knowledge in evaluations of individuals. Two studies examining evaluations of trustworthiness found that appearance-based cues influenced participants' judgments more than explicit knowledge about the targets' behavior. Rule, Slepian, and Ambady (2012) reported that participants remembered the faces of untrustworthy people better than trustworthy people and that this corresponded more to the perceived trustworthiness of the face than to knowledge supplied about the targets' character. Similarly, Rudoy and Paller (2009) found that appearance-based cues to trustworthiness (i.e., how trustworthy individuals' faces looked) influenced judgments of target trustworthiness earlier than knowledge about behavior that was associated with the targets, particularly when trustworthiness was judged in 1500 milliseconds or less. Work by Blair, Chapleau, and Judd (2005) described parallel effects for evaluations of aggression. Black men with more Afrocentric facial features were expected to behave more aggressively, even when controlling for knowledge about their past (non)aggressive behavior. These results collectively suggest that appearance-based (bottom-up) cues may be more readily available than explicit (top-down) knowledge during evaluations of people; thus, appearance may have an unfair advantage in how people evaluate others. Whether similar processes occur for social categorization, however, is less clear.

Rather than contrasting appearance-based cues with explicit knowledge about individuals, as in the research described on person evaluation, studies of social categorization processes

*Correspondence to: Nicholas O. Rule, Department of Psychology, University of Toronto, 100 St. George Street, Toronto, ON M5S 3G3, Canada.
E-mail: rule@psych.utoronto.ca
†Posthumous.

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have largely examined conflicts between competing appearance-based cues. For example, Macrae and Martin (2007) found that photos of men and women with hairstyles incongruent with Western gender stereotypes (i.e., men with long hair and women with short hair) were miscategorized as the opposite sex when viewing time was limited to 25 milliseconds but categorized correctly when viewing time was 200 milliseconds in length. Cranial hair is, indeed, a highly salient feature for distinguishing sex that becomes increasingly salient at rapid speeds (Ellis, Deregowski, & Shepherd, 1975; Rule & Ambady, 2008). Given that sex tends to be obvious from the face, participants in this instance simply needed enough time (i.e., supraliminal presentation) to categorize the targets correctly.

Not all social categories are as easily distinguished as sex; however, meaning that additional processing time of appearance-based cues may not necessarily help to resolve one's judgments. Sexual orientation, for instance, is a social category distinction that is considered to be "perceptually ambiguous" (Johnson & Ghavami, 2011; Rule, Ambady, Adams, & Macrae, 2007): because sexual orientation lacks a clear set of defining features, it is susceptible to conflicts in interpreting signals from multiple competing cues (e.g., Rule, Ambady, Adams, & Macrae, 2008); hence, the boundary between gay and straight is not as obvious as it is for many other social groups. People may therefore require explicit knowledge to correctly categorize individuals as gay and straight. Sometimes, this knowledge may conflict with what is perceived from appearance. Such instances may present opportunities to gain insight about the processes underlying how information based on explicit knowledge is integrated with information perceived from appearance-based cues. In the current work, we therefore studied judgments of gay versus straight men (a naturally ambiguous social distinction) to explore the relationship between information from knowledge and appearance in person categorization.

Sexual orientation is in some ways an ideal test-case for studying how explicit knowledge about individuals may interact with judgments made from appearance-based cues. First, sexual orientation is accurately categorized in roughly 64% of cases from still photos, including the face (Tskhay & Rule, 2013). This information is known to be extracted automatically (Rule, Macrae, & Ambady, 2009) and from multiple facial features (Rule et al., 2008). Thus, it is perceptually ambiguous but also reliably judged better than chance. Second, the miscategorization of individuals' sexual orientations is highly plausible in the real world. For instance, many people have had the experience of being surprised to learn that a friend or colleague is gay. As there is little motivation for an unstigmatized individual to express cues signaling a highly stigmatized identity that many strive to conceal (Yoshino, 2006), anecdotal experiences suggest that it is often difficult for one to overcome the perception that someone is gay despite explicit knowledge that the person is truly straight. This phenomenon therefore fits well with our question about potential conflicts between information about a person from what one sees versus what one knows.

Indeed, unlike sex, the correction of sexual orientation relies not on extended perceptual exposure but on explicit knowledge about a given target's group membership. Given that accurate perceptions of sexual orientation occur rapidly and do not improve with additional viewing time (Rule & Ambady, 2008), one's categorization based on appearance cues may often be incongruent with explicit knowledge about a target's actual sexual orientation. In particular, we expected that appearance-based cues would precede the application of explicit knowledge in categorizations of sexual orientation, as Rudoy and Paller (2009) found for evaluations of individuals' trustworthiness. This is consistent with related models of person perception suggesting that categorical information is processed prior to individuating information about identity (e.g., Gwyneth Paltrow is perceived as a woman before she is recognized as a movie star; Cloutier, Mason, & Macrae, 2005). In the case of sexual orientation, category information may be gleaned from appearance-based cues in the face. Once a target has been individuated, however, access to explicit knowledge may overwrite or confirm one's initial judgment. Should this be the case, we would expect that individuals who know the sexual orientation of a person may mistakenly construe the person's group membership when processing constraints are imposed. If so, this would suggest that categorization is not a fixed unidirectional sequence of stages but, rather, a dynamic bidirectional process in which appearance-based cues and explicit knowledge work interactively toward categorization (Freeman & Ambady, 2011).

In the present work, we therefore engaged participants in an iterative learning task in which they encoded the alleged sexual orientations of a series of male targets. Half of the targets were encoded with information that was congruent with their true sexual orientation (gay men described as gay and straight men described as straight), whereas the remaining half were encoded with information that was incongruent with their actual sexual orientation (gay men described as straight and straight men described as gay). We then measured the participants' categorizations of the targets when perceiving their faces for various durations. We hypothesized that participants who viewed the faces for brief durations would be more likely to make judgments consistent with appearance-based cues. In contrast, we expected that participants with additional time to process the faces might modify their initial perception and categorize the targets consistent with the explicit knowledge learned about the target's group membership. Furthermore, in a second experiment, we used a real-time behavioral technique sensitive to conflicting responses (mouse tracking) to better examine the processes involved in these categorizations.

EXPERIMENT 1

Method

One hundred undergraduates participated in the experiment, which consisted of four parts. In the first part (the encoding stage), participants were presented with 20 men's faces (10 gay and 10 straight, previously found to be accurately categorized according to their sexual orientations with high consensus; Rule & Ambady, 2008) in random order for 5 seconds each. Each face was preceded by a fixation cross for 500 milliseconds to cue participants that the next face was forthcoming. The faces were accompanied by labels that participants were told corresponded to the men's actual sexual orientations. Half of the gay and straight faces were randomly assigned to be presented with labels congruent with their true sexual orientations: "gay" and "straight," respectively. The remaining gay and straight targets were randomly assigned labels incongruent with their true sexual orientations: "straight" and "gay," respectively. Participants viewed all of the faces with their labels once.

Participants then immediately began the second part (the iterative learning stage) in which they viewed all 20 faces in random order and were asked to recall the targets' sexual orientations (i.e., according to the labels in the encoding stage). Participants made their categorizations via key press ("F" = straight and "J" = gay) at a self-paced rate. Participants were informed that the trial would not advance until they had input the correct category response (i.e., the group indicated by the label). Thus, if the participant incorrectly categorized the face, they would not be able to continue until they had corrected their error. If any single face was miscategorized, participants were required to repeat the entire categorization task. This process repeated until every participant could correctly categorize all of the faces perfectly three times in a row. Hence, if a participant correctly categorized all of the faces in one loop, repeated this performance in the second loop, but then miscategorized a face in the third loop, he or she was required to demonstrate perfect performance three more times before advancing to the next stage of the experiment.

Once participants had successfully reported all of the faces' sexual orientations (i.e., according to their labels) three times in a row, the iterative learning stage terminated. They were then instructed to begin working on a word-search puzzle that had been placed next to them on the desk in the testing room (a filler task). Participants worked on the word search for 2 minutes, after which the computer screen flashed and beeped to recall the participants' attention and then provided them with further instructions.

Participants then moved on to the fourth and final part of the experiment. At this stage, participants were asked to categorize the same 20 faces, again without labels, as either gay or straight—similar to the iterative learning stage. However, unlike the iterative learning stage, participants were randomly assigned to view the faces for one of four stimulus presentation durations: self-paced, 1000 milliseconds, 500 milliseconds, or 50 milliseconds; $n = 25$ participants per condition. In the self-paced condition, participants viewed the faces in the same manner as they did in the iterative learning stage but without receiving feedback or halting of the task to correct their responses. The conditions with limited presentation times proceeded similarly except that participants viewed a fixation cross for 250 milliseconds before each face. The face image was then presented according to the specified condition duration and immediately replaced by a 100-millisecond backward mask matched for high and low spatial frequencies. Participants then received a new screen with the category response labels and were asked to make a categorization (cf. the self-paced condition where the labels were presented simultaneously and categorization input terminated the presentation of the face). Participants' responses in this final stage served as the critical dependent measure for analysis. Participants were instructed to respond as quickly and accurately as possible across all conditions. Afterward, the participants were debriefed and compensated but received no feedback about their performance in this final stage.

Results and Discussion

Data were analyzed using signal detection theory analyses in which "gay" stimuli (on the basis of assigned label and actual sexual orientation in the respective analyses) were arbitrarily considered as signal and "straight" stimuli were considered as noise. Data were calculated in two ways: sensitivity to information based on explicit knowledge acquired through the labels (henceforth referred to as "knowledge sensitivity") and sensitivity to information based on appearance cues in the faces (henceforth referred to as "appearance sensitivity"). Thus, categorizations of "gay" for gay faces or gay labels were counted as hits, whereas categorizations of "gay" for straight faces or straight labels were counted as false alarms.[1] Two sensitivity (d') statistics were therefore calculated for each participant to measure sensitivity based on knowledge and appearance whereby the criterion for whether a face was considered gay or straight when calculating the hits and false alarms was defined by the labels given to participants or the pre-established consensus for the faces, respectively.[2] We then submitted these d' scores to a 2 (sensitivity: knowledge, appearance) × 4 (perception time: self-paced, 1000 milliseconds, 500 milliseconds, and 50 milliseconds) analysis of variance (ANOVA) with repeated measures on the first factor. Results showed main effects of sensitivity, $F(1, 96) = 36.97$, $p < .001$, $\eta^2_{partial} = 0.28$, and perception time, $F(3, 96) = 42.81$, $p < .001$, $\eta^2_{partial} = 0.57$, but, more critically, a sensitivity × perception-time interaction: $F(3, 96) = 20.89$, $p < .001$, $\eta^2_{partial} = 0.40$.[3]

A linear contrast was used to test our hypothesis that people relied less on explicit knowledge and more on appearance-based cues as the time of stimulus-exposure decreased. To test the contrast of the interaction, we collapsed the scores for sensitivity to knowledge versus appearance by assigning contrast weights of 1 and −1, respectively, within each condition. This effectively generated difference scores, which we then used to assign contrast weights of −3, −1, 1, and 3 to the 50-millisecond, 500-millisecond, 1000-millisecond, and self-paced condition data, respectively. We regressed participants' appearance-knowledge difference scores onto these contrast weights in a multiple regression model that also included contrast weights for both quadratic (−1, 1, 1, and −1) and cubic (1, −3, 3, and −1) contrasts. The model fit for the linear contrast was significant, $B = 0.43$, $SE = 0.06$, $t(96) = 7.80$, $p < .001$, $r_{\text{semi-partial}} = .62$,

[1]Notably, similar results are observed when signal detection is not applied and percent-correct values are used instead.

[2]Notably, these d' measures do not reflect the accuracy of participants' judgments of the faces, as is often used in social categorization tasks (e.g., Johnson & Ghavami, 2011). Rather, because of the nature of the task design (e.g., the presentation of conflicting information) and its analysis (e.g., separate calculation of d' scores based on the same data depending on the assignment of knowledge labels to stimuli), these data reflect sensitivity to one information source (appearance, knowledge) versus the other. Interpretation of these data relative to the baseline value of $d' = 0$ should therefore not be mistaken as measures of the accuracy of judgments of sexual orientation.

[3]The data for Experiments 1 and 2 are available in the Supporting information.

indicating that participants tended to make their sexual orientation judgments from appearance-based cues when they had less viewing time (Figure 1); the quadratic, $B = 0.09$, $SE = 0.12$, $t(96) = 0.77$, $p = .45$, $r_{\text{semi-partial}} = .08$, and cubic, $B = 0.06$, $SE = 0.06$, $t(96) = 1.12$, $p = .27$, $r_{\text{semi-partial}} = .11$, contrasts were nonsignificant.

One possibility for participants' sensitivity to appearance-based cues when they had less viewing time might have been that the speeded nature of the task encouraged them to categorize the faces more rapidly. We therefore analyzed participants' response latency scores for the 50-millisecond ($M = 1628$ milliseconds, $SD = 2416$), 500-millisecond ($M = 778$ milliseconds, $SD = 392$), 1000-millisecond ($M = 934$ milliseconds, $SD = 468$), and self-paced ($M = 1362$ milliseconds, $SD = 362$) conditions. We were unable to transform the data to achieve normality and therefore compared the conditions using a nonparametric one-way test, which was statistically significant: Kruskal–Wallis $H(3, N = 100) = 27.80$, $p < .001$, $\eta^2 = 0.28$. To test the hypothesis that participants might respond faster in the conditions with briefer stimulus presentations, we simultaneously regressed the participants' mean latency scores onto the linear, quadratic, and cubic contrasts using the same contrast coefficients for each condition as above. Owing to the non-normality of the data, we performed the test with 5000 bootstrapped resamples. Results showed that the 95% confidence intervals for the linear, $B = -32.03$, $SE = 72.15$, 95% CI [−197.70, 64.30], and cubic, $B = 36.74$, $SE = 30.18$, 95% CI [−16.24, 100.37], contrasts contained 0 but that the 95% confidence interval for the quadratic contrast did not: $B = -319.41$, $SE = 122.76$, 95% CI [−604.39, −141.89]. As we did not expect to find a quadratic effect and have no ready theory to explain it, further consideration may be warranted in future work.

EXPERIMENT 2

In Experiment 1, we found that people categorized sexual orientation according to appearance-based cues more than explicit knowledge about targets' group membership when they had less time to perceive them. To further explore how appearance-based cues interact with explicit knowledge during the process of social categorization, we measured these judgments using mouse tracking in Experiment 2. Mouse tracking records the *x* and *y* coordinates of an individual's mouse cursor as it is moved on his or her computer screen. Experiments capitalizing on these data typically require participants to begin moving the mouse's cursor at the beginning of each trial. Thus, as participants move the cursor toward their target response, their incidental movements are thought to index implicit processes involved in their decision (Freeman & Ambady, 2010). Traditional measures of categorization tend to focus only on the *outcomes* of participants' responses (e.g., whether the face was categorized correctly). Mouse tracking, however, provided us an opportunity for insight to the *process* through which participants reached their judgments. We therefore applied the mouse-tracking method to measure the extent to which participants changed the direction of their mouse's cursor in selecting a categorization response for each target. Specifically, we expected that participants would show evidence of greater conflict (vacillation) between explicit knowledge and appearance-based cues as they had more time to process the faces during their categorizations.

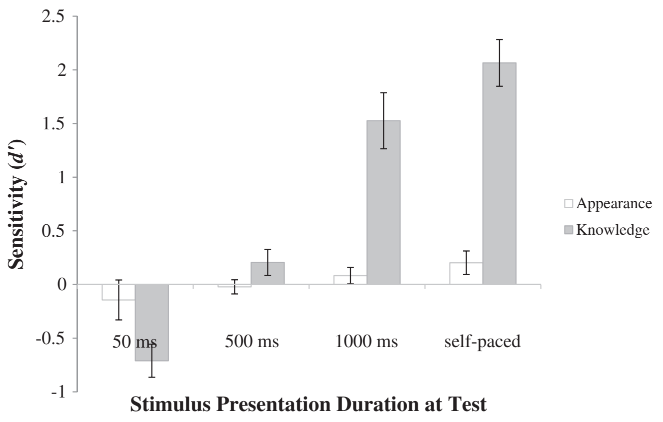

Figure 1. Participants' mean sensitivity to explicit knowledge versus appearance-based cues in their categorizations of men's sexual orientations at different stimulus presentation durations in Experiment 1

Method

Procedures were identical to Experiment 1 except that stage 4 was administered to the 85 participants ($n_{\text{self-paced}} = 20$, $n_{\text{1000-ms}} = 22$, $n_{\text{500-ms}} = 23$, $n_{\text{50-ms}} = 20$) using MouseTracker (Freeman & Ambady, 2010). In MouseTracker, each trial begins with clicking a "Start" button at the bottom-center of the screen, which (in this case) was replaced by a face. Participants then clicked on one of two response buttons indicating the category labels ("gay" and "straight") in either of the top corners of their computer's screen to categorize each face. Similar to Experiment 1, participants viewed a fixation cross first, followed by the condition-dependent presentation of the face, which was replaced with a backward mask on each trial in the conditions where presentation time was limited. This all occurred before encountering the mouse-tracking screen where the categorization was made. In these conditions, the "Start" button was disabled, and the trial began immediately upon clearance of the backward mask. In the self-paced condition, the face was presented simultaneously with the mouse-tracking screen and the selection of a category response ended the trial.

The mouse-tracking technique enabled us to analyze the individual mouse trajectories to assess vacillation during the real-time categorization process (Freeman & Ambady, 2010). That is, we hypothesized that participants receiving conflicting information about targets (via mismatches between the targets' labeled sexual orientations and previously established consensus perceptions for these faces; Rule & Ambady, 2008) would vacillate when making their categorizations. Critically, however, we expected this equivocation to occur as a function of the time that the participants had to perceive the faces. Specifically, we expected that when participants had less time to perceive the faces, they would show less vacillation because their limited perceptions would favor use of the appearance-based information, as they may only have enough time to process the faces at the category level. In complement, we expected that participants who had more time to perceive the faces would call upon the information that they had learned about them because they had the opportunity to process them more deeply. We expected this to therefore promote greater deliberation in making an ultimate categorization, which MOUSETRACKER enabled us to measure via the mean number of "*x*-flips" (instances in which the participant reversed direction along the *x*-axis) on each trial (Freeman & Ambady, 2010). Independent of participants' overt responses, the mouse trajectories leading up to those responses may reveal partial attraction toward the response associated with appearance cues despite the participants ultimately selecting the "correct" response that accords with their explicit knowledge about the targets' group memberships. Hence, we expected more *x*-flips among participants with more time to view the faces.

Results and Discussion

First, we examined participants' categorizations. As in Experiment 1, we used signal detection theory analyses to calculate participants' sensitivity to knowledge versus appearance in their final categorizations of the faces, testing again for the hypothesized linear trend observed earlier. Results of the 2 (sensitivity: knowledge, appearance) × 4 (perception time: self-paced, 1000 milliseconds, 500 milliseconds, and 50 milliseconds) ANOVA with repeated measures on the first factor paralleled those reported above. We observed main effects of both sensitivity, $F(1, 81) = 25.05$, $p < .001$, $\eta^2_{partial} = 0.24$, and perception time, $F(3, 81) = 13.11$, $p < .001$, $\eta^2_{partial} = 0.33$, as well as the sensitivity × perception-time interaction: $F(3, 81) = 6.25$, $p = .001$, $\eta^2_{partial} = 0.19$. A linear contrast once again showed that categorizations depended more on appearance-based cues than on explicit knowledge about targets' sexual orientations as participants had less time to view the targets: $B = 0.013$, $SE = 0.003$, $t(81) = 3.89$, $p < .001$, $r_{semi\text{-}partial} = .39$ (Figure 2). The quadratic, $B = 0.011$, $SE = 0.007$, $t(81) = 1.57$, $p = .12$, $r_{semi\text{-}partial} = .17$, and cubic, $B = 0.004$, $SE = 0.003$, $t(81) = 1.26$, $p = .21$, $r_{semi\text{-}partial} = .14$, contrasts were again nonsignificant.[4]

As above, we explored whether participants might respond faster according to stimulus presentation duration ($M_{50\text{-ms}} = 1980$ milliseconds, $SD = 498$; $M_{500\text{-ms}} = 1588$ milliseconds, $SD = 447$; $M_{1000\text{-ms}} = 1700$ milliseconds, $SD = 475$; $M_{self\text{-}paced} = 1975$ milliseconds, $SD = 407$). After transforming the response latency scores using the natural logarithm to achieve normality (Shapiro–Wilk $W = 0.98$, $p = .13$), the one-way ANOVA showed a significant effect: $F(3, 81) = 4.95$, $p = .003$, $\eta^2_{partial} = 0.16$. We then simultaneously regressed the same linear, quadratic, and cubic contrast coefficients used above onto the transformed response latency scores. Results paralleled those of Experiment 1, showing a nonsignificant effect for the hypothesized linear contrast, $|B| < 0.001$, $SE = 0.001$, $t(81) = 0.35$, $p = .73$, $r_{semi\text{-}partial} = .04$, a nonsignificant effect for the cubic contrast, $|B| < 0.001$, $SE = 0.001$, $t(81) = 0.85$, $p = .40$, $r_{semi\text{-}partial} = .09$, and a significant effect for the quadratic contrast: $B = -0.005$, $SE = 0.001$, $t(81) = -3.73$, $p < .001$, $r_{semi\text{-}partial} = -.38$. Thus, participants in both Experiments 1 and 2 showed a consistent quadratic effect such that

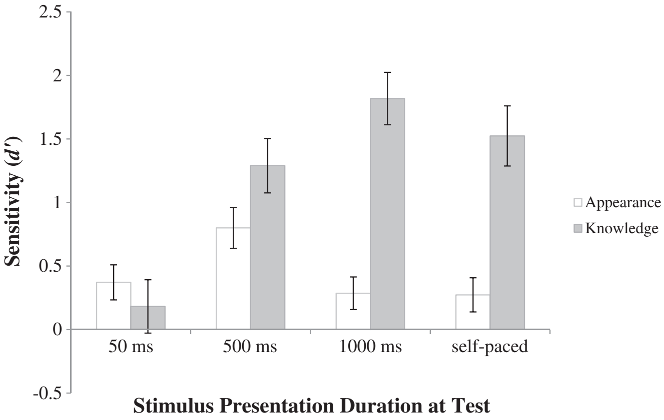

Figure 2. Participants' mean sensitivity to explicit knowledge versus appearance-based cues in their categorizations of men's sexual orientations at different stimulus presentation durations in Experiment 2

participants were slower in the 50-millisecond and self-paced conditions than in the 500-millisecond and 1000-millisecond conditions. Again, as this effect was unanticipated, this remains an area needing future exploration.

Most important, however, we used the data about the participants' mouse movements recorded by MOUSETRACKER (Freeman & Ambady, 2010) to compute the average number of reversals in the direction of the participants' mouse movements for the incongruent trials (i.e., when the appearance-based cues did not match participants' explicit knowledge about sexual orientation). Here, we were particularly interested in the incongruent trials in which the participant ultimately categorized the targets according to their explicit knowledge about sexual orientation because those trials were the most likely to be subject to interference from the originally encoded information based on the targets' appearance cues. Although the omnibus one-way ANOVA for perception time did not reach significance, $F(3, 81) = 2.26$, $p = .09$, $\eta^2_{partial} = 0.08$, we found the expected linear trend of increased vacillation (*x*-flips) with more exposure time, $B = 0.008$, $SE = 0.004$, $t(81) = 2.20$, $p = .03$, $r_{semi\text{-}partial} = .24$. Similar to the results for participants' categorizations, the quadratic, $B = 0.012$, $SE = 0.008$, $t(81) = 1.40$, $p = .16$, $r_{semi\text{-}partial} = .16$, and cubic, $B = -0.001$, $SE = 0.004$, $t(81) = -0.21$, $p = .84$, $r_{semi\text{-}partial} = -.02$, contrasts were nonsignificant (Figure 3).

This result suggests that participants showed less conflict between explicit knowledge and appearance-based cues as their time to perceive the targets was more limited. Briefer exposures to the target faces may have therefore hindered the participants' access to the explicit knowledge they learned about the targets' group memberships, tandemly suggesting an explanation for why they were also less likely to categorize the targets on the basis of knowledge (versus appearance cues) when they had less time to perceive the faces. One question that arises from this, however, is why should participants show any knowledge-based categorizations at all when processing time is more limited? Owing to the ambiguity of male sexual orientation, there will be cases in which participants misperceive targets. Participants may idiosyncratically think that a particular target is gay (straight) contrary to consensus, therefore experiencing that experimentally-designed incongruent trial as one in which appearance and knowledge are congruent. Indeed, the study

[4]Because the sample sizes in Experiment 2 were not equal, we weighted the contrast coefficients according to sample size following standard cross-multiplication procedures (e.g., Rosenthal, Rosnow, & Rubin, 2000). Using the unweighted contrast weights returned similar results.

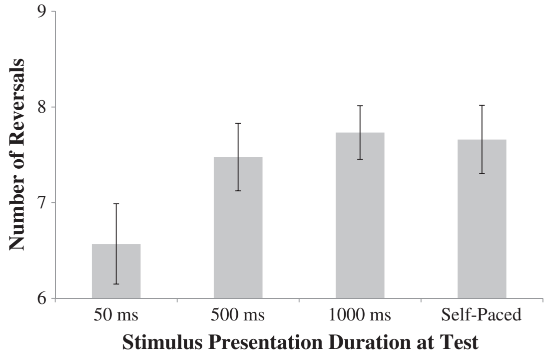

Figure 3. The mean number of mouse trajectory reversals (grand-mean-centered) for different stimulus presentation durations in Experiment 2

from which these faces were borrowed (Rule & Ambady, 2008) did not find complete consensus for the categorization of any single face, leaving room for idiosyncratic variability in participants' perceptions (see also Rule, Ishii, Ambady, Rosen, & Hallett, 2011). This may be a limitation of the present work, and further testing would be needed to resolve this speculation. However, what is clear from these data is that, with increased viewing time, participants appear to have vacillated more as they jockeyed between the information derived from appearance-based cues and the explicit knowledge they possessed about the targets' group memberships, supporting our hypothesis that the initial processing of appearance-based cues interacts with explicit knowledge when construing men as gay and straight.

GENERAL DISCUSSION

How one categorizes a man as gay or straight depends not only on what one knows about him but also on how much time one has to perceive him. After learning a target's sexual orientation, participants were still more likely to subsequently categorize him according to what they perceived from his face than according to what they knew about him when their time to perceive him was limited. When participants had more time to perceive the target's face, they appeared to modify their initial impressions and categorize him on the basis of the group to which they had encoded him—a conclusion supported by the greater amount of vacillation present in conditions where participants viewed targets longer.

These data may provide support for social categorization as a continuous, bidirectional, and potentially open-ended process (Freeman & Ambady, 2011). The observation that the relationship between appearance-based cues and explicit knowledge was linear across viewing time could suggest that explicit knowledge does not simply overrule appearance-based categorization at a particular milestone in the social categorization process. Instead, the mind may continuously integrate information from explicit top-down knowledge and bottom-up appearance-based cues via a dynamic and gradual process in which one's impressions are updated over hundreds of milliseconds (Freeman & Ambady, 2011). Rather than proceeding in a linear series of stages, social categorization may therefore consist of a set of recursive processes. As such, explicit knowledge about individuals may not just inform the impressions that people make of them but may actually provide feedback that influences the basic perceptual process. As information about a target becomes integrated into the ongoing construction of a categorization, it may amplify or attenuate the salience of particular visual features that are also influencing that ongoing construction.

This continuous framework for social categorization might also apply analogously at an interpersonal level. If a categorization based on appearance may be updated by explicit knowledge once a target is individuated, this could guide behavior in interactions as well as subsequent perceptual processing. In the present research, appearance-based cues led perceivers to categorize men as gay and straight in instances where they had knowledge that the targets were of the opposite sexual orientation. This suggests that individuals may default to an appearance-based judgment of a known target each time the person is perceived. First impressions may therefore be recurrent, even for individuals one knows well. Perceiving someone one knows may initially be similar to meeting him or her for the very first time, only becoming updated (confirmed or corrected) after individuation has occurred. Suggestive as these data may be, however, they are simply an overture to this possibility; thus, additional future work is needed to confirm and explore these findings in greater depth (e.g., might something qualitatively different occur during the learning of incongruent versus congruent person information?) and breadth (e.g., exploring these effects among other social groups). This could also help to generalize the findings beyond the faces used in these particular experiments.

This possibility holds many implications for the consequences of social categorization and person perception. For instance, not only might we ephemerally mistake a heterosexual friend as gay every time we seem him, we might make similar errors when catching a glimpse of a trusted confidant who happens to have a particularly untrustworthy face (as in Rudoy & Paller, 2009) or when encountering a friend who is a member of a stigmatized racial group (as in Blair et al., 2005). Anecdotes about fashionable straight men being misperceived as gay notwithstanding (St. John, 2003), the misperception of sexual orientation can be a serious issue with violent and fatal consequences (Herek, 2004; Patrick, Bell, Huang, Lazarakis, & Edwards, 2013). Moreover, these brief moments of shock, fear, or discomfort that may precede the recognition of individuals that we know, like, and trust could be subtly communicated and perceived (Ekman & Friesen, 1969). These might not only strain relationships but could also cumulate in a stressful burden for the target who is chronically misperceived. As such, these data may be relevant to the study of stigma and prejudice, and future research should explore the present phenomena in new domains to better understand the experiences of both targets and perceivers in cases where perceptual ambiguity and misidentification may occur.

To date, studies of processes in social categorization have almost exclusively examined characteristics about people that are perceptually obvious, such as age, race, and sex (Macrae & Bodenhausen, 2000). Yet there are many other important social groups, like sexual orientation, that do not have clear perceptual markers (see Tskhay & Rule, 2013, for review). Because they are perceptually ambiguous, accuracy in categorizing individuals into these groups is typically lower than it is for groups with obvious perceptual markers (Tskhay & Rule, 2013). Similar to the way that lesion patients are used in neuropsychology to understand the functions of the healthy brain, studying the processes involved in the imperfect categorization of ambiguous groups may also allow for insight to the general processes involved in perceiving all social groups, obvious and ambiguous (e.g., Rule et al., 2008). Thus, the present data help to further basic understanding of how bottom-up (appearance-based) cues and top-down (explicit) knowledge may interact throughout the time-course of social categorization.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher's web-site.

REFERENCES

Blair, I. V., Chapleau, K. M., & Judd, C. M. (2005). The use of Afrocentric features as cues for judgment in the presence of diagnostic information. *European Journal of Social Psychology*, *35*, 59–68.

Brewer, M. B. (1988). A dual process model of impression formation. In R. S. Wyer, Jr., & T. K. Srull (Eds.), *Advances in social cognition* (Vol. *1*, pp. 1–36). Hillsdale, NJ: Erlbaum.

Bruce, V., & Young, A. (1986). Understanding face recognition. *British Journal of Psychology*, *77*, 305–327.

Cloutier, J., Mason, M. F., & Macrae, C. N. (2005). The perceptual determinants of person construal: Reopening the social-cognitive toolbox. *Journal of Personality and Social Psychology*, *88*, 885–894.

Ekman, P., & Friesen, W. V. (1969). Nonverbal leakage and clues to deception. *Psychiatry*, *32*, 88–105.

Ellis, H. D., Deregowski, J. B., & Shepherd, J. W. (1975). Descriptions of white and black faces by white and black subjects. *International Journal of Psychology*, *10*, 119–123.

Freeman, J. B., & Ambady, N. (2010). MouseTracker: Software for studying real-time mental processing using a computer mouse-tracking method. *Behavior Research Methods*, *42*, 226–241. doi: 10.3758/BRM.42.1.226

Freeman, J. B., & Ambady, N. (2011). A dynamic interactive theory of person construal. *Psychological Review*, *118*, 247–279.

Herek, G. M. (2004). Beyond "homophobia": Thinking about sexual stigma and prejudice in the twenty-first century. *Sexuality Research and Social Policy*, *1*, 6–24.

Johnson, K. L., & Ghavami, N. (2011). At the crossroads of conspicuous and concealable: What race categories communicate about sexual orientation. *PLoS One*, *6*, e18025.

Macrae, C. N., & Bodenhausen, G. V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, *51*, 93–120.

Macrae, C. N., & Martin, D. (2007). A boy primed Sue: Feature-based processing and person construal. *European Journal of Social Psychology*, *37*, 793–805.

Macrae, C. N., & Quadflieg, S. (2010). Perceiving people. In S. T. Fiske, D. T. Gilbert, & L. Gardner (Eds.), *Handbook of social psychology* (Vol. *1*, 5th ed., pp. 428–463). Hoboken, NJ: John Wiley & Sons Inc.

Patrick, D. L., Bell, J. F., Huan, J. Y., Lazarakis, N. C., & Edwards, T. C. (2013). Bullying and quality of life in youths perceived as gay, lesbian, or bisexual in Washington State, 2010. *American Journal of Public Health*, *103*, 1255–1261.

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). *Contrasts and effect sizes in behavioral research: A correlational approach*. Cambridge: Cambridge University Press.

Rudoy, J. D., & Paller, K. A. (2009). Who can you trust? Behavioral and neural differences between perceptual and memory-based influences. *Frontiers in Human Neuroscience*. doi: 10.3389/neuro.09.016.2009

Rule, N. O., & Ambady, N. (2008). Brief exposures: Male sexual orientation is accurately perceived at 50 ms. *Journal of Experimental Social Psychology*, *44*, 1100–1105.

Rule, N. O., Ambady, N., Adams, R. B., Jr., & Macrae, C. N. (2007). Us and them: Memory advantages in perceptually ambiguous groups. *Psychonomic Bulletin and Review*, *14*, 687–692.

Rule, N. O., Ambady, N., Adams, R. B., Jr., & Macrae, C. N. (2008). Accuracy and awareness in the perception and categorization of male sexual orientation. *Journal of Personality and Social Psychology*, *95*, 1019–1028.

Rule, N. O., Ishii, K., Ambady, N., Rosen, K. S., & Hallett, K. C. (2011). Found in translation: Cross-cultural consensus in the accurate categorization of male sexual orientation. *Personality and Social Psychology Bulletin*, *37*, 1449–1507.

Rule, N. O., Macrae, C. N., & Ambady, N. (2009). Ambiguous group membership is extracted automatically from faces. *Psychological Science*, *20*, 441–443.

Rule, N. O., Slepian, M. L., & Ambady, N. (2012). A memory advantage for untrustworthy faces. *Cognition*, *125*, 207–218.

St. John, W. (2003, June 22). Metrosexuals come out. *New York Times*. Retrieved on October 13, 2011, from: http://www.nytimes.com

Tskhay, K. O., & Rule, N. O. (2013). Accuracy in categorizing perceptually ambiguous groups: A review and meta-analysis. *Personality and Social Psychology Review*, *17*, 72–86.

Yoshino, K. (2006). *Covering: The hidden assault on our civil rights*. New York: Random House.

