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INTERACTIVE EFFECTS

FINGER IN FLIGHT REVEALS PARALLEL CATEGORIZATION ACROSS MULTIPLE SOCIAL DIMENSIONS

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On catching sight of another's face, multiple social categories may be potentially extracted. Prior work has often found that one category (e.g., sex) comes to dominate perception at the expense of others (e.g., race) being ignored. In the present study, participants categorized a face's sex or race by tapping a response with their finger. While the participants were en route to indicating their response, the authors measured the finger's trajectory through midair. Before tapping the correct category, the finger showed a partial, simultaneous attraction to the response location for the task-irrelevant (but nonetheless applicable) category membership, demonstrating that the task-irrelevant category was partially active in parallel. This is evidence that face-perceptual processing triggers parallel, partially active representations of a target's multiple applicable category memberships, which come to stabilize onto a focal categorization over time. Thus, even when perceivers focus on one category dimension, they also incidentally categorize by other dimensions in parallel.

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People readily and rapidly glean a variety of information from another's face. With just a fleeting glimpse of it, another person is slotted spontaneously into any number of social categories, including sex, race, and age. Once perceived, these categories often provide a lens for subsequent social interaction and trigger a variety of cognitive, affective, and behavioral consequences (Macrae & Bodenhausen, 2000). Of the many potential categorizations perceivers can make, however, which get the privilege of their attention, and which are thrown aside?

Several studies have demonstrated that attending to one of a target's category memberships increases the accessibility of the stereotypes tied to that membership, but inhibits the accessibility of the stereotypes tied to other memberships (Macrae, Bodenhausen, & Milne, 1995; Sinclair & Kunda, 1999). For instance, when participants were primed with an Asian woman's sex category, female stereotypes increased in accessibility, whereas Asian stereotypes decreased in accessibility. However, such studies have measured stereotype activation, which is dissociable from category activation (Brewer, 1988). Thus, although perceivers may inhibit stereotypes tied to a given category, it is not necessarily the case that the category representation itself would be actively inhibited as well (Quinn & Macrae, 2005).

For instance, multiple categorical construals are available for report if perceivers are given enough exposure to a target. Furthermore, perceivers' impressions and long-term memory often reflect the conjunction of multiple categories (Crisp & Hewstone, 2007; Strangor, Lynch, Duan, & Glas, 1992). But in perceivers' initial categorizations of others, an interesting question arises. When perceivers focus on one of a target's memberships, what is the cognitive fate of other nonfocal, but nonetheless applicable, memberships? Can perceivers compute a single categorical construal of interest, or do perceivers simultaneously categorize along multiple dimensions? Previous work has suggested that perceivers attend to multiple dimensions simultaneously. For instance, men are categorized more quickly by race than by sex, and women are categorized more quickly by sex than by race (Stroessner, 1996; Zarate & Smith, 1990).

In a recent series of studies, Johnson, Freeman, and Pauker (2012) found that sex and race categories systematically influence one another. Using several methods, sex categorization of a male face was found to be most efficient when Black, least efficient when Asian, and having an intermediary efficiency when White. Conversely, sex categorization of a female face was most efficient when Asian, least efficient when Black, and again having an intermediary efficiency when White. These sex-race interactive effects appeared to be driven by both bottom-up phenotype overlaps (where the perceptual cues supporting sex and race were shared) and top-down stereotype overlaps (where the stereotypes associated with sex and race categories were shared). Such work suggests that various social category dimensions may readily influence one another (in this case, sex and race), such that a task-irrelevant category membership (race) biases a focal categorization (sex).

Although such work documents clear influences of one category dimension over another, do perceivers extract actual categorical meaning from these dimensions simultaneously? Quinn and Macrae (2005) addressed this question by using repetition priming as an index of category activation. They found facilitation effects when participants were primed with a target's task-relevant category membership, but not when primed with a task-irrelevant membership, thus suggesting that perceivers do not simultaneously categorize along multiple dimensions. Although perceivers were found not to extract categorical meaning from multiple dimensions simultaneously, Quinn and Macrae did find evidence that perceivers are perceptually sensitive to nonrelevant dimensions. Measuring response times in a selective attention paradigm, the authors found that incidental attention to a face's age interfered with the categorization of sex. This led to the conclusion that perceivers are able to attend to the features specifying multiple category memberships, but that they do not appear to extract any conceptual meaning from nonrelevant memberships. The authors did caution, however, that this conclusion may have been limited by using response times as an index of category activation. Might a more sensitive measure, therefore, reveal at least a partial extraction of conceptual meaning from nonrelevant categories when initially perceiving others? Recent work provides good reason to suspect that this might be the case.

DYNAMIC INTERACTIVE NATURE OF SOCIAL CATEGORIZATION

The measurement of hand movements traveling toward potential category responses on a screen has suggested that ongoing results from the perceptual extraction of targets' facial cues continuously update partially active category representations (e.g., "he's [tentatively] male"). Ongoing updates of these partially active category representations are then used to guide response generation over time (Freeman, Pauker, Apfelbaum, & Ambady, 2010; Freeman, Ambady, Rule, & Johnson, 2008; also see Dale, Kehoe, & Spivey, 2007). This is buttressed by neurophysiological evidence. A series of event-related potential (ERP) studies demonstrated that the process of extracting a social category from another's face immediately shares its ongoing results with the motor cortex to guide action continuously over time (Freeman, Ambady, Midgley, & Holcomb, 2011; also see Cisek & Kalaska, 2010). Thus, in the context of social categorization, perceptual, cognitive, and motor processing are coextensive. Cognitive representations of a face's category memberships develop over hundreds of milliseconds while perceptual processing is still ongoing, and these representations evolve alongside accruing perceptual evidence for category alternatives. Moreover, because ongoing results of social category processing are immediately cascaded into the motor cortex over time, the real-time evolution of a social categorization is able to be "seen" in perceivers' motor behavior, such as a hand movement.

This perceptual–cognitive–motor coextension suggests that perceivers might be able to extract some conceptual meaning from non-dominant categories. This is because the extraction of conceptual meaning from another's multiple category memberships would be dynamically yoked to the ongoing perceptual accrual of those memberships. Thus, prior to one category eventually coming to dominate processing, the perceptual processing of other non-dominant categories could, in theory, trigger partially active conceptual representations of those categories. Indeed, such was proposed by a recent computational model of social categorization.

According to this dynamic interactive model (Freeman & Ambady, 2011), bottom-up face processing weighs in on all possible category representations (e.g., male, female, White, Black), while other information sources (e.g., top-down attentional states due to task demands) simultaneously weigh in on those category representations as well. As such, bottom-up face processing and top-down attention jointly constrain the activation of social categories through an ongoing interactive process. In this process, top-down attentional states gradually exert excitatory pressure on certain categories (leading them to become focally attended) while exerting inhibitory pressure on others (leading them to become relatively ignored). Because it takes time for these pressures to exert their biases on category activation, while the pressures are still at work the model predicts that multiple applicable categories (e.g., female, White) would actually be flexibly active in parallel. This is consistent with neural dynamic models of visual attention as well (Desimone & Duncan, 1995), which assume a similar parallel activation of multiple representations. In this dynamic interactive model, many other factors beyond top-down attention from task demands could weigh in on the categorization process as well, influencing which category comes to dominate. For instance, categories that are salient with respect to the context (Biernat & Vescio, 1993), that are chronically or recently activated (Higgins, 1996), or that are relevant for processing goals (Bodenhausen & Macrae, 1998) are likely to dominate. However, although this dynamic account of real-time multiple social categorization has been theoretically predicted, it has lacked a direct empirical test.

THE PRESENT RESEARCH

By examining the real-time process by which one of multiple categories is selected, we can assess whether, during this process, perceivers compute only one dominant category of interest, or whether they are obliged to compute a target's multiple categories in parallel. To do this, we exploited perceivers' motor behavior to provide an ongoing "read-out" of the categorization process, as motor behavior offers online access to this process (Freeman, Dale, & Farmer, 2011; Song & Nakayama, 2009; Spivey & Dale, 2006).

We measured a participant's finger through midair en route to tapping one out of four category responses on a display (Male, Female, White, Black). See Figure 1A. On each trial, participants were instructed to categorize along one dimension (e.g., sex) and ignore the other dimension (e.g., race). If perceptual processing of a face's multiple category memberships triggers partially active representations of both applicable memberships, the partial activation of the nonfocal (but applicable) category would lead the finger to partially swerve toward its response location before arriving at the focal category. If, however, such perceptual processing is not sufficient to activate multiple categories and conceptual meaning may be extracted from only one dominant category, as suggested by previous work, the finger would proceed directly to the focal category without swerving toward the nonfocal (but applicable) category.

METHOD

PARTICIPANTS

Twenty-two right-handed volunteers participated in exchange for $5.

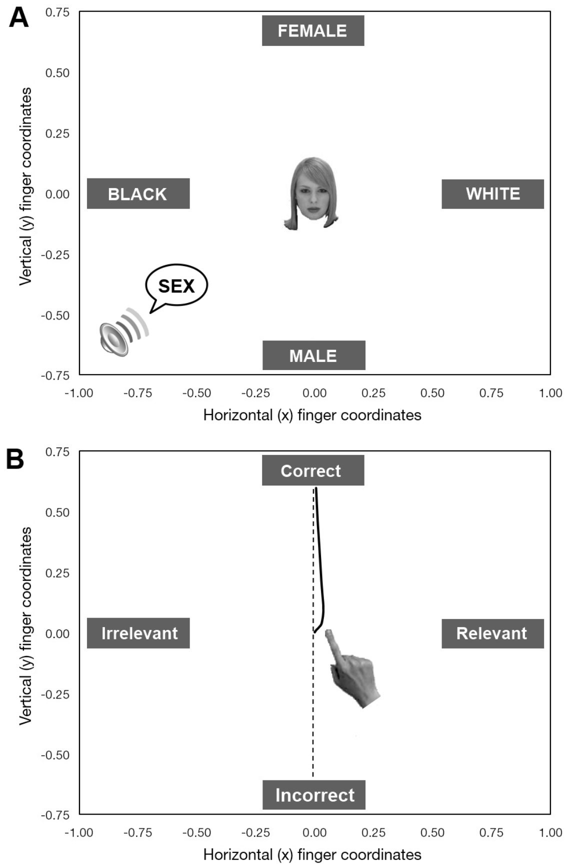

FIGURE 1. (A) An example trial. Participants heard a voice instructing them to categorize either "sex" or "race," and then they finger-tapped one of four category responses. (B) The mean finger trajectory shows a partial, simultaneous attraction to the relevant distractor category ("Relevant") before arriving at the correct category response ("Correct"). For instance, when categorizing the sex of a White woman (as seen in the example of Figure 1A), the finger swerved towards the nonfocal (but applicable) WHITE response (on the right) before arriving at the correct focal FEMALE response (at the top). The portion of the dashed line between the center start location and the correct response ("Correct") represents what the mean trajectory would be if the finger were not attracted to the relevant distractor.

STIMULI

Photographs of directly oriented, neutral expression faces were obtained from public-domain websites, including eight White men, eight White women, eight Black men, and eight Black women. Faces were removed from their original context and placed onto a white background, fitted into a 140 × 140 pixel image, and converted to grayscale.

PROCEDURE

Participants were seated 48 cm in front of a visual display (approximately 50 × 37.5 cm), with a small position sensor attached to the index fingertip of the right hand. For presentation and tracking purposes, a 2D coordinate space was used to represent the display: [0.75, −1.00] denoting the top-left corner and [0.75, 1.00] denoting the bottom-right corner, leaving [0, 0] at the starting center location (see Figure 1A). Four category labels appeared on the display: Male, Female, White, and Black. All labels were equidistant from the center (0.70 units away); two labels were directly above/below the center, and two were directly to the left/right of it. For each participant, the assignment of the categories to the label locations was randomized, but the pair of sex categories and pair of race categories were always located either above/below or left/right. This placed sex categorization along either the horizontal or vertical dimension and race categorization along the other dimension (see Figure 1A).

Before each trial began, a fixation cross appeared in the center of the display. Participants then placed their finger on a start-position marker on the table in front of them (approximately 20 cm from the display), which was aligned with the body midline. A crosshair appeared on the display, which moved according to the finger's *x, y* coordinates (thus acting similar to a computer-mouse cursor). To initiate the trial, participants moved their finger directly upwards (off the table) so that the finger's position, indicated by the crosshair, overlapped with the fixation cross in the center of the display. Once the finger reached this center location, the crosshair disappeared, a voice saying either "sex" or "race" played, and a face replaced the fixation cross. The onset of the voice preceded the onset of the face by 200 ms. Participants were instructed to categorize sex if they heard "sex" and categorize race if they heard "race," and to do this as quickly and accurately as possible. To categorize, participants launched their finger forward from the starting position toward the display in order to tap on the correct category response. Once tapping the response, a 1000-ms intertrial interval followed, and a fixation cross appeared for the participant to initiate the next trial. Before the experiment began, participants learned the locations of the category labels in a series of practice trials. Each of the 32 faces was presented twice in the experiment, once for sex categorization and once for race categorization. Trials were presented in randomized order.

The location of the sensor was measured with a Fastrak electromagnetic position-measuring system (Polhemus Inc., Colchester, VT). To record, process, and analyze finger trajectories, we adapted a customized version of the MouseTracker software package* (Freeman & Ambady, 2010). The finger's *x, y, z* coordinates were recorded (sampling rate ≈ 120 Hz) beginning with the face's onset and ending once the finger tapped the visual display, defined as the finger being within 1 cm of the display (using the *z* coordinate). Only *x* and *y* coordinates (the plane of the visual display) were retained for analysis.

RESULTS

We use "correct"/"incorrect" to refer to the categories along the focal dimension and "relevant distractor"/"irrelevant distractor" to refer to the categories along the nonfocal dimension that are applicable/inapplicable for the face. For instance, if instructed to categorize the sex of a White woman, Female would be the correct category, Male would be the incorrect category, White would be relevant dis-

*http://mousetracker.jbfreeman.net

tractor, and Black would be the irrelevant distractor. Trials involving categorization errors (5.2%) were discarded. Consistent with previous work (Freeman et al., 2008), each trajectory was plotted and examined for aberrant movement such as noninterpretable looping or the trajectory crossing over itself. This resulted in the additional discard of 1.0% of trials.

Because raw trajectories varied in duration, they were normalized into 101 time steps (100 time bins) using linear interpolation to permit averaging of their full length across multiple trials. For comparison, all trajectories were remapped such that they were directed at the response at the top of the display with the relevant distractor located at the response location on the right. This was done by inverting trajectories along the x-axis, y-axis, and/or x, y-rotating them 90° (permissible because each response was equidistant from the center start position). To obtain a by-trial index of the finger's attraction toward the relevant distractor category (indexing how much that category was simultaneously active), we computed maximum deviation (MD): the largest x-coordinate deviation from an idealized response trajectory (a straight line trajectory between the center start position and the correct response) out of all time steps. Because, after remapping, an idealized response trajectory is a vertical line ($x = 0$), with the relevant distractor located on the right ($x > 0$) and irrelevant distractor on the left ($x < 0$), positive MD values indicate attraction toward the relevant distractor, negative values indicate attraction toward the irrelevant distractor, and values no different than 0 indicate a lack of interference altogether from the alternate category dimension.[1]

On average, it took participants 1390 ms (SE = 52 ms) to tap the correct response with their finger. For each participant, we computed mean trajectories collapsing across all trials within a condition. The mean trajectory aggregated across all trials and participants is plotted in Figure 1B, which reveals the finger's conspicuous attraction to the relevant distractor category en route to tapping the correct response. As indexed by MD, the finger's attraction to the relevant distractor category (M = 0.045, SE = 0.008) was significantly more positive (rightward-going) than 0, one-sample $t(21) = 5.95$, $r = .79$, $p < .0001$ (Figure 2A). Because the mean trajectory is composed of trials involving movement leftward, rightward, upward, and downward (which were subsequently all remapped upward), the finger's attraction to the relevant distractor category could not be spuriously biased by mere right-handed kinematics (see Footnote 1). Rather, it reflects a genuine swerving to the relevant distractor category while traveling en route to the correct category.

1. It is nevertheless possible that some response locations influenced the magnitude of the attraction effects. For example, rightward movements tend to elicit more robust effects in hand-tracking tasks, likely due to right-handedness (e.g., Spivey, Grosjean, & Knoblich, 2005). Even though the overall attraction effect in Figure 1B is an average of trajectories that originally headed toward all four locations, it is possible that some correct-response and relevant-distractor locations elicited stronger or weaker effects. We separated trialts based on whether the correct-response location or relevant distractor was at the left, right, top, or bottom, and submitted MD values to two separate one-way ANOVAs. Correct-response location did significantly influence MD, $F(3, 63) = 2.95$, $p < .05$. Trajectories heading toward the top (M = 0.07) and bottom (M = 0.07) locations tended to have more pronounced MD effects than those heading toward the left (M = 0.03) or right (M = 0.03). Relevant-distractor location had a marginally significant influence on MD, $F(3, 63) = 2.29$, $p = .09$. Trajectories deviating toward the right location (M = 0.11) had especially large MD effects, relative to those heading toward the left (M = 0.3), top (M = 0.02), or bottom (M = 0.03) locations. Interestingly, this suggests that vertical destinations are more sensitive than horizontal destinations in eliciting attraction effects, and that having the relevant distractor at the right location also leads to greater sensitivity (likely due to right-handedness). Future studies might consider these methodological points.

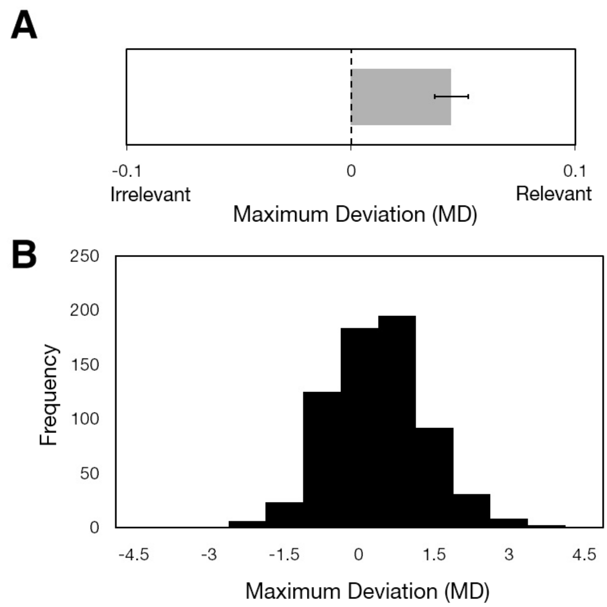

FIGURE 2. (A) Finger trajectories' maximum deviation (MD) was significantly more positive than zero (rightward, in the direction of the relevant distractor category). (B) A histogram depicting the z-distribution of MD values, illustrating unimodality and a lack of bimodality.

MD BY TARGET SEX AND RACE

Rather than collapsing across targets' sex and race, we also wanted to explore whether certain category combinations influenced the attraction effect. As discussed earlier, recent work finds that sex and race are processed interactively; thus, combinations such as Black men and Asian women are processed more efficiently than Black women and Asian men (Freeman & Ambady, 2011; Johnson et al., 2012). We submitted the MD values of participants' mean trajectories to a 2 (trial type: sex or race) × 2 (target sex: male or female) × 2 (target race: White or Black) ANOVA. This revealed a significant main effect of target race, $F(1, 21) = 6.55$, $p < .05$, which was qualified by a significant trial type × target race interaction, $F(1, 21) = 11.16$, $p < .01$. On race categorization trials, MD for White ($M = 0.05$) and Black ($M = 0.06$) targets did not differ, $t(21) = 0.25$, $p = .81$; but on sex categorization trials, MD for White targets ($M = 0.10$) was significantly larger than for Black targets ($M = -0.02$), $t(21) = 3.12$, $p < .01$. No other effects reached significance (all *p*s > .1). This suggests an asymmetry between sex and race categorization. When categorizing sex, trajectories were particularly attracted toward the White response for White targets but considerably less attracted toward the Black response for Black targets. This was unexpected, given that nonnormative categories such as Black rather than a normative category such as White tend to capture perceivers' attention (Smith & Zarate, 1990). Future studies could examine this interesting difference in race-category activation during sex categorization more deeply. For now, however, the finding provides further evidence that a task-irrelevant category dimension (race) influences task-relevant categorizations (sex).

PARALLEL ATTRACTION VERSUS DISCRETE SWITCHING

It is important to confirm that the finger was indeed attracted to the relevant distractor in a simultaneous manner. For instance, it is possible that the attraction effect was spuriously produced by averaging across two separate populations of trajectories: one population of trajectories that moved straight to the correct category (unperturbed by the relevant distractor), and a second population of trajectories that initially moved straight to the relevant distractor, which were then sharply redirected straight to the correct category by a discrete-like "switching" movement. One might expect this pattern of results if the attraction effect merely reflected task-switching interference. Because the task of sex versus race categorization randomly switched across trials, a prior trial's task (e.g., sex) may have carried over into a subsequent trial requiring the other task (e.g., race), producing task-switching interference manifest in discrete-like "switch" trajectories.

Specifically, a prior trial's task set might initially lead to initial activation of the distractor category, causing the finger to move straight to that category, and after the task "switch," a corrective movement would redirect the finger straight to the correct category. On other trials where there was no task "switch," however, the finger would simply move straight to the correct category without any deviation. Problematically, if these two subpopulations of trajectories (extreme attraction due to switching vs. zero attraction) were averaged together, they could produce the partial, graded attraction effect seen in Figure 1B. However, that effect would not genuinely reflect parallel categorization along both sex and race dimensions; it would merely reflect discrete-like "switch" errors. We can use a distributional analysis to detect this pattern, as averaging across two such subpopulations of trajectories would result in a bimodal distribution (see Freeman & Ambady, 2010). This is because the MD values of one subpopulation would be very high (extreme attraction due to initial movement toward the distractor category) and those of the other subpopulation would be very low (zero attraction due to a straight movement toward the correct category). Inconsistent with this, the distribution of MD values (skewness = 0.14; kurtosis = 1.04) was within the $b < .555$ bimodality-free region (SAS Institute, 1989): $b = .252$ (Figure 2B). This ensures that the attraction effect was unimodally distributed, with trajectories exhibiting a range of large, medium, and small deviations toward the relevant distractor category.

To further eliminate the possibility that the results can be explained by mere task-switching interference, we separated "switch" trials (when the previous trial's task was different) from "stay" trials (when the previous trial's task was the same). MD_{switch} and MD_{stay} were statistically indistinguishable ($p = .53$), and both were significantly more positive than zero ($p < .001$ and $p < .01$, respectively). Together, these analyses ensure that the attraction effect was not spuriously produced by a combination of discrete-like movements or amenable to task-switching interference. Rather, they suggest that the attraction effect reflected the parallel activation of both relevant sex and race categories, which came to stabilize onto one focally attended categorization over time.

DISCUSSION

Although participants correctly categorized along a focal dimension of interest (e.g., sex), we found that they were obliged to also categorize along another nonfocal dimension (e.g., race) in parallel. This was evidenced by the finger's partial and simultaneous attraction toward the target's nonfocal, but nonetheless applicable, category membership before ultimately arriving at the correct response. At each moment during real-time sex and race categorization, the finger was neither in a discrete pursuit straight to the correct focal category, nor in a discrete pursuit straight to the nonfocal, applicable category. Rather, the location of the finger was always in a weighted combination between one pursuit toward the focal category and a simultaneous pursuit toward the nonfocal, but applicable, category, while the finger gradually stabilized onto a single, dominant categorization. Thus, participants' finger trajectories reflected tentative, partially active categorizations of multiple applicable category memberships, until one focal categorization stabilized over time.

Using a sensitive measure of motor output, we found evidence for the partial and parallel extraction of cognitive meaning from multiple social categories. This is consistent with recent evidence that the extraction of cognitive meaning from another's category memberships is dynamically yoked to the perceptual accrual of those memberships (e.g., Freeman et al., 2008; also see Dale et al., 2007). Thus, the perceptual accrual of facial features supporting multiple social categories triggers partially active representations of those categories, and these gradually settle into initial, focal categorizations of others. As discussed earlier, previous studies using reaction-time measures have concluded that although perceivers are perceptually sensitive to nonrelevant category dimensions, they do not trigger cognitive representations or conceptual meaning from those nonrelevant dimensions (Quinn & Macrae, 2005). In contrast, the present work suggests that although a full-blown cognitive representation of a nonrelevant category may not be triggered, it nevertheless becomes partially activated. This suggests that task goals do not completely eliminate the possibility of activating nonrelevant category representations; instead, as bottom-up visual cues are processed, task goals amplify relevant categories and attenuate nonrelevant ones, until a dominant category stabilizes for the particular task. This therefore opens up the opportunity for nonrelevant category representations to become temporarily active during initial perception. Thus, while it is true that perceivers' perceptual sensitivity to nonrelevant categories may not lead to wholesale cognitive activation of a nonrelevant category (Quinn & Macrae, 2005), it does seem to lead to partial cognitive activation, in turn driving behavior such as the motor patterns found here.[2] A number of ERP stud-

2. An interesting question arises with respect to perceivers' awareness (or lack thereof) of a nonrelevant category's partial activation. The awareness and explicit versus implicit nature of the attraction effects in hand-tracking tasks have not been systematically examined. Prior studies do suggest that the effects may in some cases reflect relatively implicit processes of which participants presumably are not aware (Duran, Dale, & McNamara, 2010; Freeman, Penner, Saperstein, Scheutz, & Ambady, 2011), but this has not been directly tested. Future studies could examine perceivers' awareness of nonrelevant categories' partial activation, as well its susceptibility to top-down control. These characteristics would likely bear numerous implications for downstream social processes, such as stereotype activation and subsequent behavior.

ies have shown that early perceptual processing is modulated by nonfocal, task-irrelevant category memberships. For instance, regardless of whether participants are instructed to encode sex or age or whether to encode sex or race, researchers have found early ERP components to be sensitive to the task-irrelevant category membership (Ito & Urland, 2003; Mouchetant-Rostaing & Giard, 2003; Mouchetant-Rostaing, Giard, Bentin, Aguera, & Pernier, 2000). However, these early attentional effects likely reflect the low-level processing of category-specifying facial features rather than the actual derivation of cognitive meaning from those categories (see VanRullen & Thorpe, 2001), and thus these findings provide a neural characterization of the manner by which participants are perceptually sensitive to task-irrelevant categories (Quinn & Macrae, 2005). They do not, however, provide evidence that participants actually categorize targets along multiple dimensions in parallel. In the present study, the finger's conspicuous curvature toward the relevant distractor category is direct evidence of such parallel categorization.

The finding that multiple parallel categorizations occur when initially perceiving others helps account for growing findings of the interactive nature of social categorization. For instance, activation of a face's emotion category influences race-category processing (Hugenberg & Bodenhausen, 2003, 2004), and activation of race category influences sex-category processing (Johnson et al., 2012; Stroessner, 1996; Zarate & Smith, 1990). These findings suggest that category memberships are not extracted independently, but rather interactively, with particular combinations shaping perception (Adams, Reginald, Franklin, Nelson, & Stevenson, 2011; Freeman & Ambady, 2011; Johnson et al., 2012). For multiple categories to interact with one another, however, they must be active in parallel during categorization. The present finger-movement data thus help account for cross-category interactions by revealing how multiple categories become activated in parallel in the first place.

Previous hand-tracking research on social categorization has used a two-choice paradigm. Such studies have found that perceptual cues tied to alternate categories trigger multiple partially active, competing categories *within* a single category dimension (e.g., both male and female). Here we provide evidence using a novel four-choice paradigm for partially active categories *across* two separate category dimensions (e.g., both male and White). This is not a trivial distinction. Current models of social categorization argue that categories within a single dimension directly compete for activation by mutually inhibiting each other. This allows the social categorization system to take the natural diversity in another's perceptual cues and transform it into a categorical representation (Freeman & Ambady, 2011). However, such models do not argue that categories across different dimensions compete with one another; instead, their simultaneous activation is winnowed into a single dominant categorization through continuous modulation by top-down forces, in this case, task demand pressures. Specifically, as the categorization process unfolds, current task goals have been argued to amplify the activation of certain to-be-attended categories while attenuating the activation of others to-be-ignored. Thus, future research could potentially exploit the present study's four-choice paradigm to directly test this theoretical distinction (the winnowing of multiple category dimensions through lateral competition vs. top-down modulation). For now, the present results provide an important extension of previous hand-tracking research by demonstrating partially active category representations across separate social category dimensions.

Beyond the theoretical implications, the present results also have implications for real-world social behavior. If targets' multiple category memberships are initially represented, they are likely to bear a variety of downstream consequences. For instance, it has long been known that once a category becomes activated, it triggers related stereotypes that change how we think about others, judge them, and remember them (Bodenhausen, 1988; Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990). Thus, if the stereotypes tied to a target's multiple category memberships were to become simultaneously active, their joint activation could potentially shape subsequent interactions (Strangor et al., 1992). Indeed, recent work found that the partial activation of a social category can cascade into the triggering of associated stereotypes even when that category is not ultimately perceived. For instance, slight feminine cues on a man's face trigger a partial activation of the female category, which partially triggers related stereotypes (e.g., caring), even when the target is perceived to be male (Freeman & Ambady, 2009). Thus, a given category representation need not come to the fore in order for its partial activation to trigger related stereotypes. Beyond activating stereotypes, category representations can also activate associated attitudes and behavioral tendencies, in turn changing how we feel about others, how we evaluate them (Fazio, Sanbonmatsu, Powell, & Kardes, 1986), and how we interact with others and treat them (Bargh, Chen, & Burrows, 1996; Chen & Bargh, 1999). Thus, by using a sensitive motor measure that taps into the simultaneous activations of multiple category dimensions, as shown here, future research could examine how such joint activations exert downstream and likely complex influences on social behavior. Moreover, given the flexible interaction suggested here between goal-induced top-down attention and the bottom-up visual extraction of social category cues, future research could use the present paradigm to examine how such downstream effects in behavior are moderated by top-down goals and by relevant individual differences.

It is important to note potential limitations of the present work. Specifically, evidence for partial activation of a nonrelevant category membership might, in part, be contingent on the task setup. Because the nonrelevant category labels were always present, one might worry that participants' curvature toward the task-irrelevant category merely reflected "preactivation" due to task demands rather than a spontaneous activation of multiple construals that naturally occurs in the real world. However, there is a long history of measuring the influence of distractor response labels on participants' ocular or manual behavior to determine whether a distractor was partially activated during the task, and the results of these studies have been found to be quite generalizable outside the experimental task (e.g., Freeman et al., 2008; Spivey et al., 2005; Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy, 1995). Future work could investigate the generalizability directly. Nevertheless, the present results suggest a parallel activation of multiple possible categorical construals, even when the particular task at hand demands just one.

In summary, although one category may come to dominate perception, we showed that perceivers first flexibly compute partially active representations of another's multiple category memberships. Thus, even when perceivers focus on one dimension (e.g., sex), they may also incidentally categorize by other dimensions (e.g., race) in parallel.

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