The simultaneous extraction of multiple social categories from unfamiliar faces

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The Simultaneous Extraction of Multiple Social Categories from Unfamiliar Faces

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Article

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Abstract

Recent research suggests that when viewing a face two social categories (e.g., sex and race) can be activated simultaneously. However, multiple social categories – including age, race and sex – can be extracted from faces. In the present study we present a new method, previously used to explore the costs and benefits associated with language-switching, to examine whether performance on an attended social categorization task (e.g., sex classification) was impacted by changes – switches – in two unattended social category dimensions (e.g., race and age). We predicted an interaction between the effects of transition (switch versus repeat) on an attended social categorization task and transition on *both* of the two unattended social category dimensions. Specifically, we hypothesized that when, across two trials, the attended categorization repeated (e.g., male – male) people would be quicker and more accurate when the unattended social categories also repeated (e.g., younger face – younger face) relative to when they switched (e.g., younger face – older face). Conversely, when, across two trials, the attended categorization switched we expected people would be quicker and more accurate when the unattended social categories also switched relative to when they repeated. These predictions were supported across three experiments, in which it was found that when unfamiliar face stimuli were categorized according to age (Expt. 1a), race (Expt. 1b) or sex (Expt. 1c) performance was impacted by the switch/repeat status of the unattended categories. These results suggest that, even when cognitively occupied we automatically and simultaneously extract information from faces that pertains to two unattended, task-irrelevant social categories.

The Simultaneous Extraction of Multiple Social Categories from Unfamiliar Faces

Introduction

The faces of unfamiliar people provide us with an indication of the social categories to which their owners belong (e.g., age, race, sex; Brewer, 1988; Fiske & Neuberg, 1990; Freeman & Ambady, 2011). Because faces contain visual cues pertaining to more than one social category, there is the potential for multiple different social categories to be activated at any one time (Macrae, Bodenausen, & Milne, 1995). Freeman and Ambady (2011) recently advanced a dynamic, interactive theory of person construal that permits multiple social categorizations to be activated in parallel. Supporting Freeman and Ambady's theory, recent evidence suggests that two categories can indeed be activated in parallel, with performance on an attended social categorization task (e.g., sex classification) impacted by the presence of task irrelevant social category labels (e.g., race category labels; Cloutier, Freeman, & Ambady, 2014; Freeman, Nakayama & Ambady, 2013). Rather than competing categories inhibiting each other's level of activation (Macrae et al., 1995), Freeman and Ambady's theory presents the possibility that more than two social categories being active in parallel and that such categorizations can be driven by the mere presence of low-level category cues in a face, therefore without the need for category labels. With this in mind, the current research presents a new methodology – motivated by previous research into language-switching (Thomas & Allport, 2000; von Studnitz & Green, 2002) – and provides evidence that three social categories can be simultaneously extracted from faces (i.e., age, race & sex), in the absence of category labels, even when two of these categories are unattended and when a perceiver is cognitively busy on an attended social categorization task.

Spontaneously extracting face information pertaining to social categories is central to the leading theoretical models of person perception (Brewer, 1988; Fiske & Neuberg, 1990; Freeman & Ambady, 2011). Brewer's dual process model, Fiske and Neuberg's continuum model and Freeman and Ambady's dynamic interactive model of person construal all predict that our impressions of unfamiliar people begin with a bottom-up process that is stimulus-driven, pre-attentive and seemingly automatic. While these theoretical perspectives diverge in their treatment of how the process of person perception progresses, there is broad agreement and considerable evidence that initial primitive social categorizations are triggered by the presence of category-specifying facial cues (e.g., hairstyle and length as a cue of sex – Brebner, Martin & Macrae, 2009; Brown & Perrett, 1993; Burton, Bruce, & Dench, 1993; Macrae & Martin, 2007; Martin & Macrae, 2007; hair color/quantity and skin texture as cues of age - Berry & McArthur, 1986; Burt & Perrett, 1995; Mark et al., 1980; skin tone and the shape of individual face features as a cue of race - Enlow, 1982; Levin, 2000; Maclin & Malpass, 2001; for a review see Maddox, 2004). The rapidity and ease with which category-diagnostic cues are extracted from faces has led to suggestions that social categorization is the near-inevitable consequence of viewing a face (Allport, 1954; Bargh, 1999; Brewer, 1988; Fiske & Neuberg, 1990; Freeman & Ambady, 2011).

While social categorization often begins in a bottom-up manner with the detection of a category-specifying face cue, there is also abundant evidence that higher order social cognitive processes influence social categorization from the top down (for an overview see Macrae & Bodenausen, 2000). Encapsulating both bottom-up and top-down influences, Freeman and Ambady (2011) suggest a theory and model of person construal whereby low-level sensory information and high-level social factors interact. They suggest that viewing facial cues initially leads to the simultaneous extraction of all possible category representations, such that in the early stages of person construal multiple social categories are activated. Over time, top-down attentional control exerts excitatory pressure on certain categories while inhibiting others. The likelihood that one of multiple social categories extracted will dominate person construal at a given point in time is determined probabilistically by the relative influence exerted by low level cues and higher level cognitive states.

Evidence that multiple social categories are extracted and simultaneously activated has been provided by studies examining the temporal dynamics of person construal via the proxy of a suggested perceptual-cognitive-motor coextension (e.g., Cloutier, et al., 2014; Freeman, Nakayama, & Ambady, 2013). The basic method of these experiments requires participants to classify target faces along a focal social category dimension, while actively attempting to ignore a non-focal dimension. On a typical trial a face appears in the centre of the screen surrounded by four possible category-response labels; two of these labels are focal (correct and incorrect) and two are non-focal (either relevant or irrelevant). Participants are instructed that when the face appears they should move the computer mouse pointer (or in some studies their finger), as quickly as possible to the correct response label for the focal category dimension, while ignoring the non-focal category dimension. Participants' movements towards the correct focal response label are influenced by the presence of the relevant non-focal category labels (Cloutier et al., 2014; Freeman et al., 2013). The influence of the non-focal category on the focal categorization task suggests that two social categories are being simultaneously extracted from the faces.

For example, Freeman and colleagues examined the influence of both race and sex (2013) and found that on trials when participants were required to make focal sex judgements (e.g., female), the trajectory of their hand movements veered towards the relevant non-focal race response option (e.g., if the face of a white female appeared, participants movement towards the female response option also veered towards the white option). Similarly, when people were asked to make focal race judgements their movements veered towards the relevant non-focal sex option. Cloutier and colleagues (2014) found that when people made age judgements about faces of younger and older adults of both sexes participants' hand movements were attracted towards the relevant non-focal sex category option. However, they found no evidence of attraction to the relevant non-focal age category when people were making sex categorizations of the same stimuli. To date, no research has explored the interplay between the categories of age and race.

The mouse-tracking methodology outlined above has led to theoretical advances in the understanding of real time dynamics of social categorisation. However, according to Cloutier et al. (2014) one limitation of this methodology is that it is only possible to explore the interaction between two social categories at any one time (e.g., age and sex or sex and race). As noted at the beginning of the introduction numerous social categories can be extracted from faces and therefore it is important to investigate whether *multiple* unattended social categories can be activated simultaneously. In addition, in the methodology used by Cloutier et al. (2014) and Freeman et al. (2013), participants' attention was explicitly drawn to the presence of the non-focal category dimension in two ways. Firstly, participants were asked to ignore the non-focal category and, secondly, the labels of both focal and non-focal categories remained on screen at all times while the participants made their judgements. Therefore the question still remains as to whether multiple non-focal categories would be extracted from faces even when participants are not made explicitly aware of these social categories.

In order to address this question we propose to adapt a behavioral paradigm that has been used to measure the effects of categorical changes in attended and unattended aspects of the environment in studies of language-switching (von Studnitz & Green, 2002; see also Jackson, Swainson, Mullin, Cunnington & Jackson, 2004; Thomas & Allport, 2000). For example, in one investigation bilingual participants made semantic judgments (animacy) judgments to words randomly presented in either of their fluent languages (von Studnitz & Green, 2002). Thus while participants efforts were focused on the attended category dimension of word animacy, the words also differed on the unattended category dimension of language. Performance on the task indicated an interaction between category-transition in the attended dimension and category-transition in the unattended dimension. Specifically, there was a significant *cost* of switching language on response-repetition trials (e.g., poorer performance for the word 'dog' when preceded by 'katze' than when preceded by 'cat') along with a significant *benefit* of switching language on response-switch trials (e.g., better performance for the word 'dog' when preceded by 'fußball' than when preceded by 'football'). For our purposes, the key feature of these experiments is that there were significant effects of transition within a category dimension that was completely irrelevant to the task; this shows that the unattended category information in question must have been extracted rapidly and presumably automatically, despite participants being cognitively otherwise engaged on the attended task.

The Current Research

If performance on a task that requires the semantic classification of words is sensitive to the status of unattended, goal-irrelevant but automatically extracted aspects of the stimuli (i.e., language), then perhaps the same might be true for a task that requires the semantic classification of unfamiliar faces. Specifically, if people are attending to a task that requires making a semantic classification of faces on one dimension (e.g., age categorization) will their performance be influenced by task-irrelevant aspects of the stimuli on other dimensions (e.g., category repetitions or switches in the race and sex of faces)? If this were the case then it might be possible to use this paradigm to detect the simultaneous activation of multiple unattended social categories.

To explore this possibility, we examined whether stimulus changes in two unattended social category dimensions impacted performance on an attended social categorization task. Participants were presented with a series of individual face images that differed along three social category dimensions (i.e., age, race & sex) and were required to attend to only one of these dimensions by making semantic judgments (i.e., Expt. 1a: age categorizations; Expt. 1b: race categorizations; Expt. 1c: sex categorizations). We hypothesized that people would rapidly extract all three social categories from faces and as a consequence unattended social categories would influence attended social categorization performance (Freeman & Ambady, 2011). Specifically, we predicted separate 2 X 2 interactions between attended judgments and each unattended category, with a potential performance *cost* for switching (versus repeating) category within either unattended dimension whenever response (determined by judgment along the attended dimension) repeated, and a potential performance *benefit* for switching category within either unattended dimension whenever response switched. Any evidence of the hypothesized interaction would suggest unattended category information is being extracted from faces and impacting performance on the attended categorization, irrespective of whether this interaction is driven by associated performance costs, performance benefits or by both performance costs and benefits.

Experiment 1a, 1b and 1c

Material and methods

Participants and Design

Undergraduate students from the University of Aberdeen completed the experiments for course credit. Eighty-four participants (58 female) completed Experiment 1a, ninety participants (68 female) completed Experiment 1b and ninety-eight participants (60 female) completed Experiment 1c[1]. Participants were excluded if they exhibited excessively high error rates or excessively slow reaction times (both > 3 S.D. above the median). This resulted in three male participants (Experiment 1a), two female participants (Experiment 1b) and one female and one male participant (Experiment 1c) being excluded from the final analyses. Each experiment had a 2 (Attended Category: repeat or switch) X 2 (Unattended Category A: repeat or switch) X 2 (Unattended Category B: repeat or switch) repeated measures design. All that differed between the experiments was the explicit categorization judgment that the participants were required to make (i.e., Attended Category: Experiment 1a – Age, Experiment 1b – Race, Experiment 1c – Sex).

Procedure

Participants were tested either individually or in groups of up to twelve people. On arriving at the laboratory participants were seated facing a computer screen and were informed that they would be taking part in a study examining the speed and accuracy with which people can categorize faces.

The face stimuli comprised 328 color digital headshot images of unfamiliar people selected from the Center for Vital Longevity face database (Minear & Park, 2004) and the color FERET face

[1] Each of the experiments reported here comprise data from two experimental conditions (participants were split evenly between each condition). We chose to collate the data because the same pattern of effects is replicated across both conditions and because there was no interaction between the conditions. The only difference between the conditions was that in one condition the stimuli were presented wearing glasses, whereas in the other condition the glasses were absent.

database (Phillips, Moon, Rivzi, & Rauss, 2000; Phillips, Wechsler, Huang, & Rauss, 1998). The face images included hair but the overall image was cropped to a standardized size of 200 x 240 pixels (1280 x 1024 screen resolution). The faces were drawn equally from three social category dimensions, *sex* (male or female), *age* (younger adults or older adults) and *race* (white or non-white). This meant there were 41 images in each of eight distinct social category dimension sub-types – younger white males, younger white females, younger non-white males, younger non-white females, older white males, older white females, older non-white males, older non-white females. The face images used in the experiment were chosen based on the criterion that they each indicated social category membership in an easily recognizable and unambiguous manner[2].

Stimuli were presented electronically using the E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). Each experiment consisted of 8 blocks of 41 trials[3]. Each trial comprised the presentation of a fixation cross for 500 ms followed by a target face image for 300 ms after which the image disappeared; to encourage speeded responses participants had to make a response within 1650 ms of the onset of the face image. The inter-trial interval was 1200 ms. Dependent on attended categorization dimension used in each experiment, participants were informed that they would be taking part in an experiment examining the speed and accuracy with which people can make either age, race or sex categorizations of faces. In Experiment 1a the participants' task was to report whether or not they considered each face to be 'under thirty years of age' or 'over thirty years of age'. Participants in Experiment 1b were asked to report whether or not they considered each face to be 'white' or 'non-white'. Participants in Experiment 1c were informed that their task was to report whether or not they considered each face to be 'male' or 'female'. In all three experiments, participants made their response by pressing the left and right buttons a computer mouse positioned centrally on the table in front of them with the meaning of the response buttons counterbalanced

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[2] This was evidenced in the high level of accuracy demonstrated by participants across the experiments. Due to the practical constraints of obtaining enough faces who met the three social category constraints (i.e., age, race and sex), whilst controlling for gaze direction, facial expressions, and identity repetition, the non-white faces were drawn from a mixture of different ethnic backgrounds (based on the experimenter's assessment of their facial characteristics 96 of the faces were determined to be "Black", 48 were "South Asian", and 20 were "East Asian").

[3] We discarded performance on the first trial of every block as we were interested in differences stemming from the relationship between the current and preceding trial.

across participants within each experiment. The order of trial presentation was randomized and the computer recorded the latency and accuracy of responses.

Each trial was designated as a repeat trial or switch trial dependent on the social categorical status of the current face relative to the face on the previous trial. For example, if a younger white male face was preceded by a younger white male face the trial transition would be designated as repeating sex, age and race. If, a younger white male face was preceded by an older white male face the trial would be designated as repeating sex and race but switching age. If a younger white male face was preceded by a younger non-white male face the trial would be designated as repeating sex and age but switching race. Because the order of face presentation was fully randomized, the number of trials per condition was free to vary across participants (See Supplementary Table 1 for a breakdown of the mean number of trials per condition)[4].

Results

Before analyzing response times trials on which errors were made and trials on which an error had been made on the previous trial were excluded from the analyses; before analyzing the proportion of correct responses trials on which an error had been made on the previous trial were excluded from the analyses. For each experiment, we then analyzed median response latencies and mean proportion correct using two separate repeated measures analysis of variance (ANOVA) with 3 factors; Age (repeat or switch), Sex (repeat or switch) and Race (repeat or switch). Thus, each experiment was analyzed using a 2 (Attended Dimension: repeat or switch) X 2 (Unattended Dimension A: repeat or switch) X 2 (Unattended Dimension B: repeat or switch) repeated measures ANOVA.

Attended Category Dimension – Age (Experiment 1a)

Analysis of response latencies revealed a main effect of Age [$F(1, 80) = 16.18$, $p < .001$; $\eta p^2 = .168$], with faster responses to repeat trials ($M = 513$) than switch trials ($M = 525$). The predicted significant interactions of Age x Race [$F(1, 80) = 18.56$, $p < .001$; $\eta p^2 = .188$] and Age x Sex [F(1,

[4] There were no significant differences in the mean number of trials between conditions.

80) = 10.26, p = .002; ηp^2 = .114] were also found. No other significant main effects, two-way or three-way interactions were found [all *F*s (1, 80) ≤ 2.92, ps ≥ .092, ηp^2 ≤ .035].

The significant two-way interactions were followed up with Bonferroni corrected tests of simple effects. Exploration of the Age x Race interaction revealed that when across successive trials Age repeated, participants were quicker to respond when Race also repeated compared to when it switched [$F(1, 80) = 14.30$, $p < .001$, see Figure 1, top left panel]. Similarly, when Age switched participants responses were quicker when Race also switched [$F(1, 80) = 5.51$, $p = .021$]. Follow up tests of the Age x Sex interaction revealed that when across successive trials Age repeated, responses were quicker when Sex also repeated relative to when Sex switched [$F(1, 80) = 8.16$, p -= .005, see Figure 1, top right panel]. When Age switched there was no significant difference in response latency between trials when Sex repeated relative to when it switched [$F(1, 80) = 2.56$, p = .114], although the numerical difference mirrored the effect for unattended Race.

Analysis of accuracy revealed a main effect of Age [$F(1, 80) = 13.29$, $p < .001$; $\eta p^2 = .143$], with a greater proportion of correct responses for repeat (.89) than switch (.86) trials. There was also a significant Age x Race interaction [$F(1, 80) = 35.21$, $p < .001$; $\eta p^2 = .306$] and Age x Sex interaction [$F(1, 80) = 42.41$, $p < .001$; $\eta p^2 = .346$]. No other significant main effects, two-way or three-way interactions were found [all *F*s (1, 80) ≤ 1.10, *ps* ≥ .298, ηp^2 ≤ .014].

Tests of simple effects to examine the significant Age x Race interaction indicated that when Age repeated people were more accurate when Race repeated than when Race switched [$F(1, 80) = 25.11$, $p < .001$]; when Age switched people were more accurate when Race also switched than when it repeated [$F(1, 80) = 12.81$, $p = .001$; see Figure 1, bottom left panel]. Breakdown of the Age x Sex interaction showed a similar pattern of results, indicating that when Age repeated people were more accurate when Sex also repeated than when Sex switched [$F(1, 80) = 44.58$, $p <$ .001] but when Age switched people were more accurate when Sex switched than when Sex repeated [F(1. 80) = 9.18, $p = .003$; see Figure 1, bottom right panel].

Attended Category Dimension – Race (Experiment 1b)

For response latencies there was a significant main effect of Race [$F(1, 87) = 9.02$, $p = .003$; $\eta p^2 = .094$], with faster responses to repeat ($M = 454$) than switch ($M = 462$) trials. The two-way interactions between Race and Age [$F(1, 87) = 7.00$, $p = .010$; $\eta p^2 = .074$] and Race and Sex were also significant [$F(1, 87) = 10.05$, $p = .002$; $\eta p^2 = .104$]. No other main effects, two- or three-way interactions were significant, all *F*s $(1, 87) \leq 2.35$, ps $\geq .129$, $\eta p^2 \leq .026$.

Tests of simple effects were carried out to follow up the Race x Age and Race x Sex interactions. When Race repeated, people were faster to respond when Age also repeated than when it switched [$F(1, 87) = 7.63$, $p = .007$]; when Race switched there was no significant difference in response time between trials when Age repeated or when Age switched [$F(1, 87) = 1.02$, $p = .315$; see Figure 2, top left panel]. Exploration of the Race x Sex interaction indicated that when Race repeated people were faster to respond when Sex also repeated relative to when Sex switched [$F(1, 87) = 8.81$, $p = .004$]; when Race switched there was no significant difference in response time between trials when Sex repeated or when Sex switched [$F(1, 87) = 2.15$, $p = .146$; see Figure 2, top right panel].

Analysis of accuracy revealed that the Race x Age interaction [$F(1, 87) = 14.47$, $p < .001$; $\eta p^2 = .143$], and Race x Sex interaction [$F(1, 87) = 9.03$, $p = .003$; $\eta p^2 = .094$] were significant. None of the main effects or remaining two- and three-way interactions reached significance, all *F*s $(1, 87) \leq 1.51$, ps $\geq .223$, $\eta p^2 \leq .017$.

Further analysis of the Race x Age interaction revealed that when Race repeated people were more accurate when Age also repeated relative to when Age switched [$F(1, 87) = 10.47$, $p = .002$]; when Race switched people were more accurate when Age also switched relative to when Age repeated [$F(1, 87) = 5.89$, $p = .017$; see Figure 2, bottom left panel]. Follow up tests of the Race x Sex interaction revealed that when Race repeated people were more accurate when Sex also repeated relative to when Sex switched [$F(1, 87) = 5.41$, $p = .022$]; when Race switched there was no significant difference between trials when Sex switched and when Sex repeated although the numerical difference mirrored the effect for unattended Age [F(1, 87) = 2.70, p = .104; see Figure 2, bottom right panel].

Attended Category Dimension – Sex (Experiment 1c)

Findings for response latency indicated a main effect of Sex [F(1, 95) = 8.80, p = .004; ηp^2 = .085], with faster responses to repeat (M = 488 ms) than switch (M = 496 ms) trials. There was also a significant Sex x Age interaction [F(1, 95) = 6.46, p = .013; ηp^2 = .064] and a Sex x Race interaction [F(1, 95) = 12.88, p < .001; ηp^2 = .119]. The remaining main effects, two- and three-way interactions were not significant, all Fs (1, 95) ≤ 2.49, ps ≥ .118, ηp^2 ≤ .026.

To follow up the significant Sex x Age and Sex x Race interactions tests of simple effects were carried out. Examination of the Sex x Age interaction revealed that when Sex repeated people were numerically faster when Age repeated relative to when Age switched and this difference approached statistical significance [F(1, 95) = 3.81, p = .054]; when Sex switched there was no significant difference between trials when Age switched and Age repeated [F(1, 95) = 2.55, p = .114; see Figure 3 top left panel]. Analysis of the Sex x Race interaction revealed that when Sex repeated people were faster when Race also repeated than when Race switched [F(1, 95) = 9.05, p = .003,]; when Sex switched participants responded more quickly when Race also switched than when Race repeated [F(1, 95) = 4.48, p = .037, see Figure 3, top right panel].

Findings for accuracy indicated a significant Sex x Age interaction [F(1, 95) = 11.84, p = .001; ηp^2 = .111] and a Sex x Race interaction [F(1, 95) = 7.87, p = .006; ηp^2 = .076]. None of the main effects, or any of the other two- or three-way interactions were significant, all Fs (1, 95) ≤ 3.00, ps ≥ .087, ηp^2 ≤ .031.

Test of simple effects to explore the Sex x Age interaction revealed that when Sex repeated people were more accurate when Age also repeated than when Age switched [F(1, 95) = 10.45, p = .002]; when Sex switched there was no significant difference between trials when Age switched or repeated [F(1, 95) = 1.36, p = .247; see Figure 2, bottom left panel]. Analysis of the Sex x Race interaction indicated that when Sex repeated there was no was no significant difference between trials when Race repeated relative to when Race switched although the numerical difference mirrored the effect for unattended Age [$F(1, 95) = 2.91$, $p = .092$]; when Sex switched people were more accurate when Race also switched relative to when Race repeated [$F(1, 95) = 5.83$, $p = .018$; see Figure 3, bottom right panel].

To summarize, a consistent pattern of results was seen in response times and accuracy rates across all three Experiments – in all cases we found the hypothesized 2 X 2 interactions for attended and unattended social category dimension comparisons. When across consecutive trials the attended category repeated there was always a numerical cost when the unattended category switched relative to when it repeated (10 out of 12 response time and accuracy costs reached significance). Conversely, when across consecutive trials the attended category switched there was always a numerical benefit when the unattended category also switched relative to when it repeated (6 out of 12 response time and accuracy benefits reached significance).

Discussion

The central question we wished to address in the current research was whether multiple unattended social categories can be simultaneously extracted from unfamiliar faces. Interactions between attended and unattended categories were found for three different attended social category judgments – sex, race and age – and were reliable for both reaction time and error data. These findings indicate that people have the ability to extract information pertaining to multiple social categories from unfamiliar faces even when the category dimensions are irrelevant and incidental and when people are engaged in making explicit categorizations on another social dimension. Furthermore, the lack of significant three-way interactions indicates that each social category affected performance independently of the other.

Studies of categorization and linguistic structure indicate that bilinguals are better at repeating responses on an attended dimension (e.g., semantic judgments) when the language in which the stimuli are presented repeats than when it switches but that they are better at switching responses when the language switches than when it repeats (Thomas & Allport, 2000; von Studnitz

& Green, 2002). The current research extends these findings by demonstrating that similar effects occur with respect to social category information in faces in that people appear to automatically detect such categories, resulting in effects upon performance upon the primary task. Just as bilinguals' semantic word judgments (animacy judgments) are affected by task-irrelevant changes in language (von Studnitz & Green, 2002), so semantic classifications of people are impinged on by changes in task-irrelevant social categories.

The mechanism we propose to explain the current findings is based on the premise that categorical age, race and sex are automatically extracted from faces on every trial and that this information becomes bound to the response they make via a process known as rapid stimulus response learning (Dobbins, Schnyer, Verfaellie, & Schacter, 2004; Schnyer, Dobbins, Nicholls, Schacter, & Verfaillie, 2006; Schnyer et al., 2007; see also Altmann, 2011 for a conceptually analogous theoretical account). On any single trial, when a participant makes their response on the attended category dimension (e.g., presses the left mouse button in response to a younger face), the age, race and sex categorizations are all bound in memory to the specific response that was made (Dobbins, et al., 2004; Schnyer et al., 2006; Schnyer et al., 2007). If the unattended category is repeated the reactivation of the category-response binding facilitates making the same button press and interferes with making the alternative response. To illustrate this mechanism, in the following example we will assume that a participant is performing an attended age categorization and that race and sex are the unattended categories. On trial *n*-1 the face image is a younger, white, male, and the participant makes a correct left-hand response to indicate that the face is younger than thirty. As a consequence of trial *n*-1 an implicit memory trace is created that temporarily binds the categories of young, white and male to the left-hand response. If trial *n* is a <u>response repeat</u> trial the reactivation of the category-response binding from the previous trial makes repeating a left-hand response easier when the unattended categories also repeat (i.e., younger, white, male) relative to when one or more of the unattended categories switches (e.g., younger, non-white, male). If trial *n* is a <u>response switch</u> trial the reactivation of the category-response binding from the previous trial makes switching to a right-hand response more difficult when one or more of the unattended categories repeat (e.g., older, non-white, male) relative to when both of the unattended categories also switch (e.g., older, non-white, female).

Based on the mechanism we outline above one would expect performance to be best when the attended response and both unattended categories repeat and worst when the attended response switches and both of the unattended categories repeat. Indeed, this pattern of effects is seen in the means from all three experiments (see supplementary Table 1). In each experiment people are numerically fastest and most accurate when the attended and unattended categories all repeat; similarly, people are numerically slowest and least accurate when the attended category switches but the unattended categories repeat. This pattern of results is not supported by a three-way interaction in any of the experiments. The lack of any three-way interactions might indicate that there is no over-additive effect when two unattended categories share the same transitions relative to when they differ. It is also possible that the current method is not sensitive enough to detect the presence of any over-additive effect. If it is a goal of future research to determine whether such an over-additive effects exist or not then the sensitivity of the current method might be improved by constraining the order of trials to ensure that there are equal numbers of all trial-types within participants. Similarly, sensitivity might be improved if the races of faces used were limited to two tightly confined racial categories rather than the broader “white/non-white” categorical distinction that was used here.

While the current results support the idea that transitions in unattended social category information impact performance on an attended face categorization task, it is less apparent what information is driving the effects. It is possible the effects are driven by fully fledged social categorizations including the activation of any stereotype knowledge, beliefs and prejudices associated with the unattended categories of the previous trial. Alternatively, if processing of the unattended social categories is truncated before higher-order stored knowledge is activated it is possible that only the basic initial categorization persists across trials. This interpretation would fit data from previous research suggesting that when categorization is applied in person processing, the activation of multiple categories results in inter-category competition rather than sustained simultaneous activation (Macrae et al., 1995). A third possibility is that unattended social categories are not activated at all and that people are merely sensitive to changes in lower-level visual features of the stimuli and it is these that are bound to the previous response and therefore impact cross trial performance. The latter of these explanations seems least plausible given the extensive evidence that extracting category diagnostic feature based cues triggers the activation of the associated category (for a review, see Martin & Macrae, 2010). However, it should be a goal of future research to ascertain whether the pattern of findings we see here is driven by full activation of social category information, truncated categorizations or merely changes in lower-level visual features.

Irrespective of whether our results are indicative of the activation of higher-order social cognitive representations, the current findings undoubtedly add to a growing body of research supporting the idea that individual social categories are not extracted from faces in isolation (e.g., Bestelmeyer, Jones, DeBruine, Little, & Welling, 2010; Bestelmeyer et al., 2008; Johnson, Freeman, & Pauker; 2012; Enns & Oriet, 2007; Quinn & Macrae, 2005). For example, there is evidence that sex is processed interdependently with identity (Ganel & Goshen-Gottstein, 2002; Rossion, 2002) and that both race and sex are processed interdependently with expression (Bestelmeyer et al., 2010; Enns & Oriet, 2007). Similarly, using a Garner interference paradigm, Quinn and Macrae (2005) found that sex categorization performance was poorer when the categorical age of the face stimuli also varied (i.e., faces of younger and older men and women), relative to when stimuli were all drawn from a single age category (e.g., only faces of young men and women). In contrast, they found that age categorizations were unaffected by whether the stimuli were of a single sex or both sexes. In light of these previous findings, the novel method we outline here could be adapted to further examine the apparent interdependence of multiple aspects of face categorization including more transient dimensions such as emotional expression or gaze direction..

In their model of Dynamic Person Construal, Freeman and Ambady (2011) argue that social category information is automatically activated by visual input (e.g., by the mere presence of category-specifying feature-based cues). The findings of the current study support this assertion in a number of ways. First, all three social categories were capable of being activated in parallel by the presence of only visual information from the face and in the absence of category labels. Second, people extracted multiple sources of category information from faces very rapidly (i.e., typically less than 500 ms following the onset of a face). Third, people were sensitive to changes in categories that were unattended and irrelevant to their current processing goals. Fourth, people not only had the ability to rapidly extract unattended category information from faces, they also had the capacity and propensity to do so while cognitively busy performing another task. Given the proficiency with which people extracted unattended age, race, and sex from faces it should be a goal of future research to determine whether, as one might expect, some categories or sub-categories exert greater influence than others (Stroessner, 1996; Zárate & Smith, 1990) and whether these effects are context dependent (Macrae et al., 1995).

Conclusions

In the earliest stage of person perception the faces of unfamiliar people provide us with an initial indication of the social categories to which each person belongs (Cloutier, Mason, & Macrae, 2005; Cloutier & Macrae, 2007). Utilizing a novel methodology inspired by previous language-switching research, the current study presents the first evidence of the simultaneous and automatic activation of social categories from within the big three social category dimensions (i.e., race, sex and age). These effects occur even when two of these categories are unattended, unlabeled and when perceiver is cognitively busy on an attended social categorization task. Providing support for theoretical suppositions outlined in Freeman and Ambady's (2011) dynamic, interactive theory of person construal, our findings indicate that multiple social categories are activated in a seemingly automatic manner, as a result of extracting low-level categorical cues from the face.

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Figures

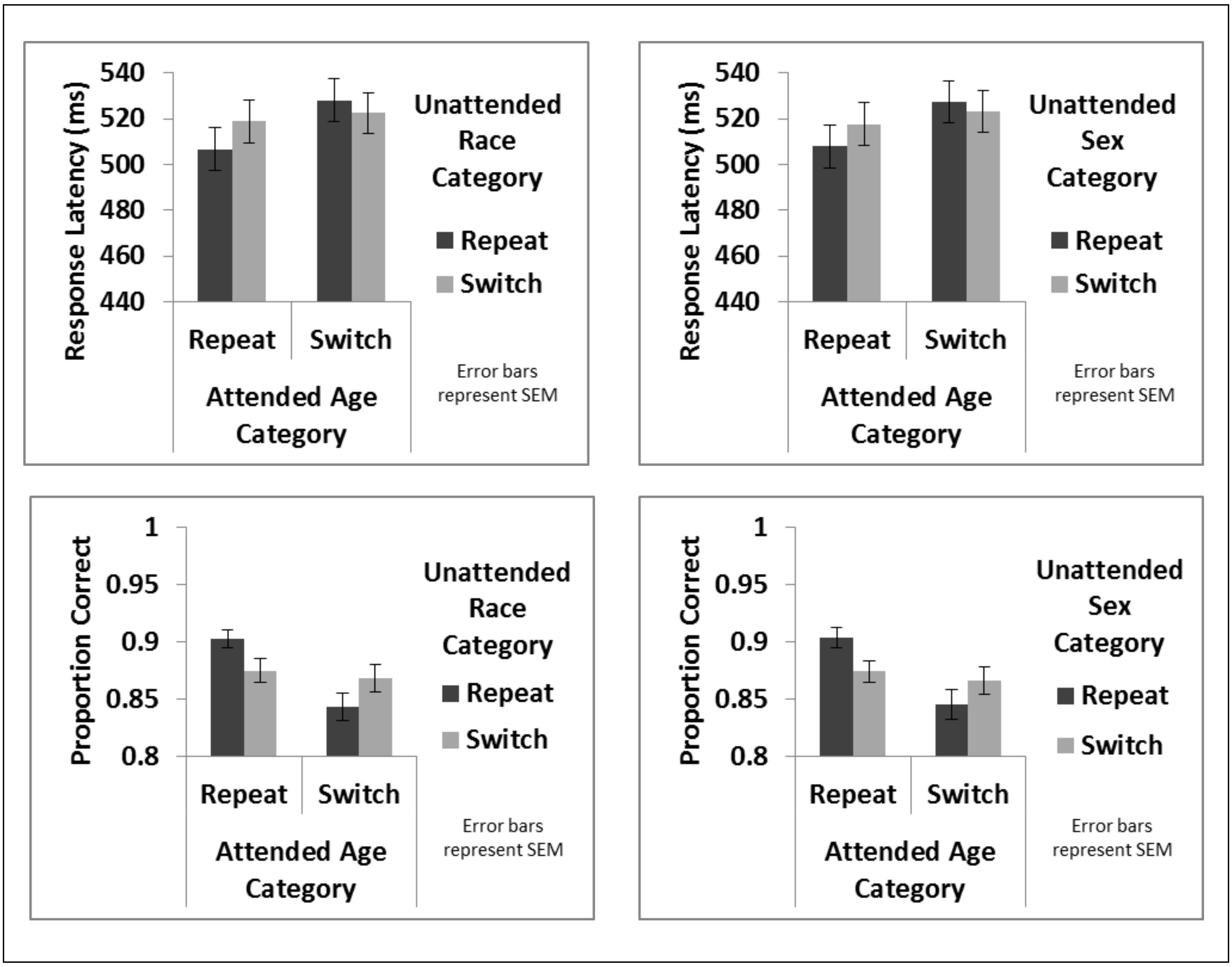

Figure 1. Mean task performance, when age was the attended category (Expt. 1a), by unattended category; response latency (top panel), proportion correct (bottom panel). Error bars denote standard error.

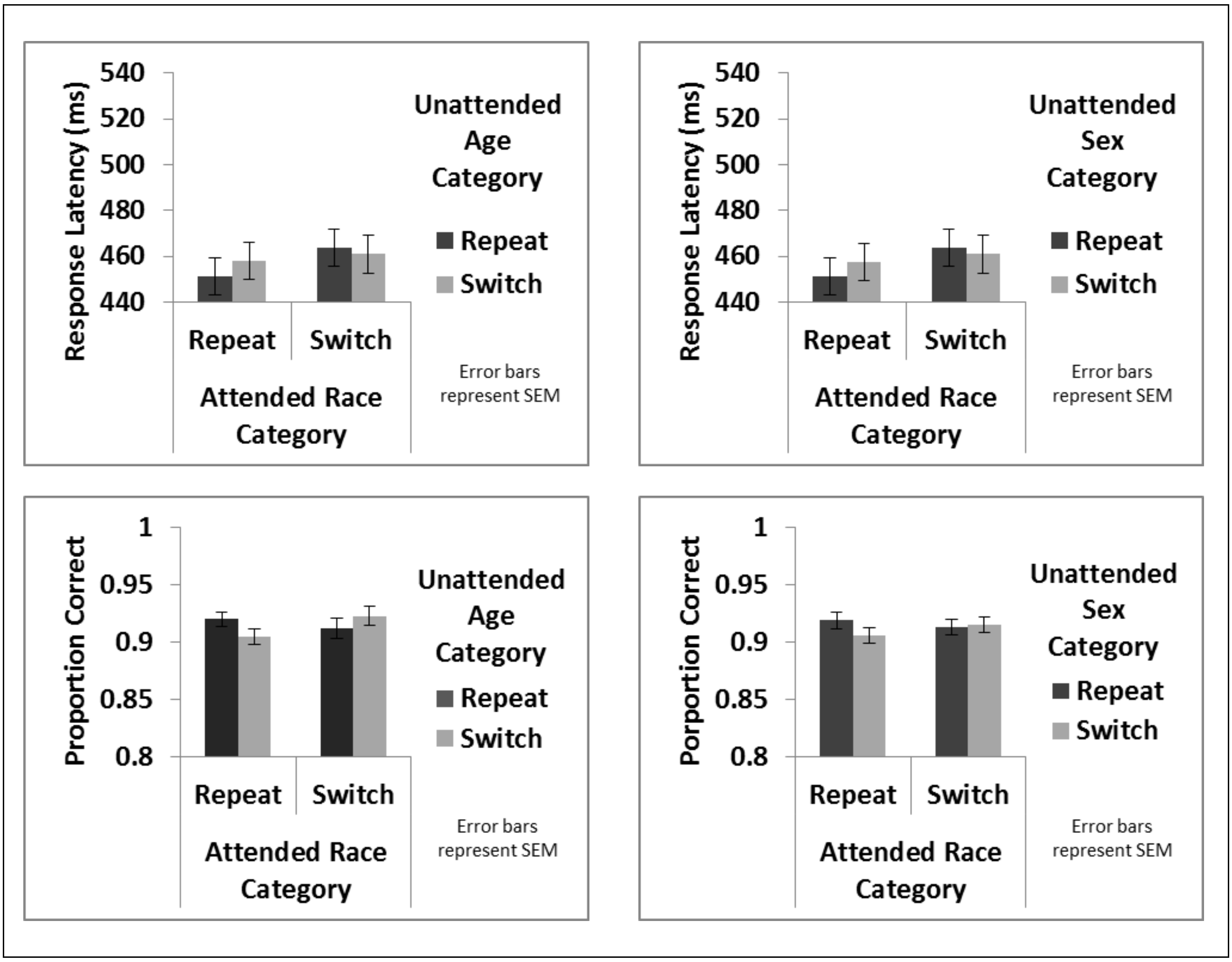

Figure 2. Mean task performance, when race was the attended category (Expt. 1b), by unattended category; response latency (top panel), proportion correct (bottom panel). Error bars denote standard error.

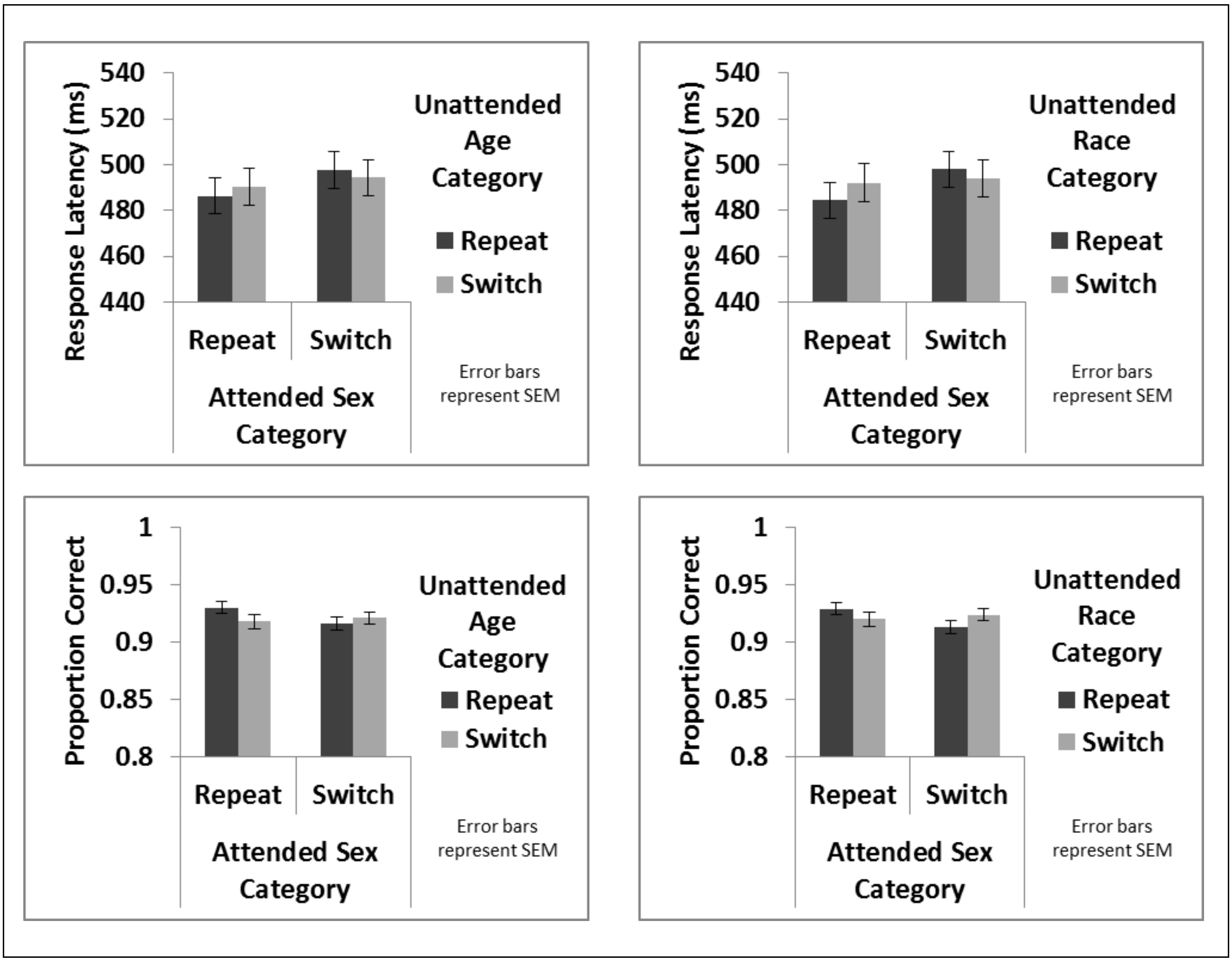

Figure 3. Mean task performance, when sex was the attended category (Expt. 1c), by unattended category; response latency (top panel), proportion correct (bottom panel). Error bars denote standard error.