Differential Attentional Allocation and Subsequent Recognition for Young and Older Adult Faces

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Abstract

Studies examining own-age recognition biases report inconsistent results and often utilize paradigms that present faces individually and in isolation. We investigated young and older adults' attention towards young and older faces during learning and whether differential attention influences recognition. Participants viewed complex scenes while their eye movements were recorded; each scene contained two young and two older faces. Half of participants formed scene impressions and half prepared for a memory test. Participants then completed an old/new face recognition task. Both age groups looked longer at young than older faces; however, only young adults showed an own-age recognition advantage. Participants in the memory condition looked longer at faces but did not show enhanced recognition relative to the impressions condition. Overall, attention during learning did not influence recognition. Our results provide evidence for a young adult face bias in attentional allocation but suggest that longer looking does not necessarily indicate deeper encoding.

Keywords: face recognition; own-age bias; attention; task instructions; complex scenes

Adults are experts in face recognition (Maurer, Le Grand, & Mondloch, 2002); however, this expertise is limited to the face categories with which they have the most experience (e.g., Rhodes, Hayward, & Winkler, 2006). Numerous studies have investigated the own-race bias (i.e., the other-race effect) whereby other-race faces are categorized more quickly (e.g., Ge et al., 2009) but recognized less accurately (e.g., Hancock & Rhodes, 2008) than own-race faces. This effect has been attributed to differential expertise (e.g., differential sensitivity to differences among faces in the shape of features or the spacing between them; Hayward, Rhodes, & Schwaninger, 2008; Mondloch et al., 2010) and to social cognitive factors (e.g., categorizing out-group members versus individuating in-group members; Hugenberg, Young, Bernstein, & Sacco, 2010; Sporer, 2001).

Given the growing population of older adults and the retirement of the baby boomer generation, it is important to understand how face perception varies not only as a function of race but also as a function of participant and face age. Although a wealth of research has investigated the own-race recognition bias and its implications for daily social interactions, the own-age recognition bias is inherently more complex and has received much less attention (for a recent review, see Wiese, Komes, & Schweinberger, 2013). Better recognition of own-age faces in young adults is a robust phenomenon (Rhodes & Anastasi, 2012). However, the findings for children and older adults are less consistent, with some studies reporting better recognition for own- relative to other-age faces across all participant age groups (e.g., Anastasi & Rhodes, 2005; Perfect & Harris, 2003; for a recent meta-analysis, see Rhodes & Anastasi, 2012), and other studies reporting comparable recognition for young adult faces relative to own-age faces among children and older adults (e.g., Fulton & Bartlett, 1991; Wallis, Lipp, & Vanman, 2012; Wiese, Schweinberger, & Hansen, 2008; Wolff, Wiese, & Schweinberger, 2012).

Several factors contribute to the increased complexity of the own-age recognition bias. First, whereas face race is a stable characteristic, age, and hence the age of faces to which one is exposed, changes across the lifespan; young adults report more exposure to young adult faces whereas senior citizens report more exposure to older adult faces (He, Ebner, & Johnson, 2011). Although recent experience may influence perception (e.g., Wiese, Komes, & Schweinberger, 2012), some theorists (Macchi Cassia, 2011) have argued that abundant experience with young adult faces early in life (Rennels & Davis, 2008) sets up a life-long perceptual bias for young adult faces. Second, whereas studies investigating the own-race recognition bias rarely report a main effect of participant race (e.g., Megreya, White, & Burton, 2011), children and older adults typically perform worse than young adults in tests of face recognition (Bartlett & Leslie, 1986; Bowles et al., 2009; Hills & Lewis, 2011). In particular, older adults tend to exhibit a high false alarm rate relative to young adults (e.g., Bartlett & Memon, 2007). It is possible that floor effects may account for any failures to detect recognition biases in young children and older adults (Wiese, 2012; see McKone & Boyer, 2006 for a discussion of floor effects in children). Overall differences in accuracy may be attributable to general cognitive factors (e.g., Salthouse, 2004) as well as differential scanning strategies. For example, Firestone, Turk-Browne, and Ryan (2007) found that for both young and older faces, young adults spend more time than older adults looking at the eyes whereas older adults spend more time than young adults looking at the mouth and nose.

Although some studies (e.g., Havard & Memon, 2009; Wright & Stroud, 2002) have asked participants to view mock crime scene videos and later identify the culprit in a lineup, in most studies investigating own-race and own-age face biases, faces are learned in isolation rather than within a naturalistic context (e.g., Anastasi & Rhodes, 2005; Harrison & Hole, 2009;

Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008). Such methods fail to mimic how faces are encountered in the real world where multiple faces are encountered simultaneously and compete for attention with each other and with other stimuli (e.g., bodies, objects). The presentation of each face in isolation during learning minimizes participants' opportunity to selectively allocate their attention to one particular category of face (e.g., own-age faces), making it difficult to determine the extent to which age biases affect recognition in everyday life.

The primary goal of the current study was to enrich our understanding of own-age biases by presenting young and older adult faces in the context of busy social scenes (e.g., parks and outdoor shopping centers) and examining both allocation of attention to young versus older faces during learning and the relationship between attentional allocation and subsequent recognition. We tested both young and older adult participants; in our sample, all participants reported significantly more recent contact with own- than other-age individuals. Thus our older adult participants were comparable to the high-contact older adults tested by Wiese et al. (2012) who showed an own-age recognition bias.

During the learning phase, young and older adults' eye movements were recorded as they viewed eight images of scenes, each of which included two young and two older adults. We hypothesized that young adults would allocate more attention to own- relative to other-age faces, based on studies showing preferential looking towards own-age faces in young adults even when faces are presented in isolation (as shown through overall longer gaze times across all trials to individually presented young relative to older adult faces; see Ebner, He, & Johnson, 2011b; Firestone et al., 2007; He et al., 2011) and on studies showing an attentional advantage for own-race relative to other-race faces when faces are presented in scenes (change-blindness paradigm;

Humphreys, Hodsoll, & Campbell, 2005) or in pairs comprising an own- and other-race face (Lovén et al., 2012).

We did not make predictions for the allocation of attention among older adults because previous results for older adults are less consistent. Although older adults were more distracted by task-irrelevant older than young adult faces in a multi-source interference task (Ebner & Johnson, 2010) and looked longer at own-age faces than young adult faces in two studies involving a passive viewing task (Ebner et al., 2011b; He et al., 2011), they looked longer at young adult faces when asked to judge the age of individual faces and rate the quality of the images prior to completing a surprise memory task (Firestone et al., 2007). These inconsistent findings for older adults likely reflect the influence of two factors: Whereas older faces may receive preferential attention by virtue of their belonging to a social in-group (Rodin, 1987), young faces may draw attention because they are perceived to be more positive than older faces (as shown by both implicit attributions and explicit age stereotypes; He et al., 2011). Indeed, whereas young and young middle-aged adults perceive themselves as being more closely connected to young than older adults, older adults do not differ with regard to perceived closeness to young and older adults (Wolff et al., 2012).

Following the learning phase, participants completed an old/new recognition task that assessed their memory for the young and older faces in the scenes. We hypothesized that young adults would be more accurate in recognizing own- relative to other-age faces. The own-age bias is quite robust in young adults and has been consistently demonstrated across a wide range of studies (e.g., Harrison & Hole, 2009; Rhodes & Anastasi, 2012). In contrast, evidence for the own-age bias is less consistent in older adults and even when found, is often weaker than that observed in young adults (Rhodes & Anastasi, 2012); thus we made no specific predictions as to whether older adults would show an own-age bias in recognition.

We also examined whether differences in attentional allocation during learning influence the magnitude of the own-age bias in recognition. Ebner et al. (2011b) found that longer looking at own- relative to other-age faces was correlated with improved emotional expression identification for own-age faces. Likewise, He et al. (2011) reported that the own-age bias in the visual inspection of individually presented faces was correlated with the magnitude of the own-age bias in recognition. However, not all studies have found evidence for this correlation; Firestone et al. (2007) found that visual scan patterns on own- and other-age faces were not associated with performance on a subsequent old/new recognition task, and Neumann, End, Luttmann, Schweinberger, and Wiese (in press) recently reported that the magnitude of the own-age bias in recognition was comparable during focused versus divided attention tasks. In the current study, young and older faces were simultaneously presented and thus we expected that the longer the participants looked at own-age faces, the less time they had to extract the relevant identifying information from other-age faces. This lack of knowledge about the other-age faces presented in the scenes would make these faces more difficult to recognize in the subsequent memory task. Thus we hypothesized that looking time for young and older faces and the magnitude of an own-age bias in looking time would correlate with accuracy for young and older faces and the magnitude of an own-age bias in recognition memory, respectively.

The second goal of the current study was to systematically examine whether participants' goals during learning influence scanning strategies and affect subsequent recognition. Scene perception involves both bottom-up and top-down processing, and task knowledge appears to influence both scan patterns over a scene and gaze duration (reviewed in Henderson, 2011).

There is evidence that goals influence the allocation of attention. For example, Kaakinen, Hyönä, and Viljanen (2011) showed participants scenes of interior home settings and asked them to examine the images from the perspective of a homeowner, a burglar, or in preparation for a memory test. Participants in the homeowner and burglar conditions looked longer and more frequently at perspective-relevant items whereas those in the memory condition looked longer and more frequently at the most salient items in each setting. Likewise, allocation of attention when viewing a painting of several people in a room varies by task instructions (DeAngelus & Pelz, 2009; Yarbus, 1967). Although Rhodes and Anastasi (2012) report that intentional versus incidental encoding at learning does not moderate the magnitude of the own-age bias in recognition when faces are presented individually, we hypothesized that both recognition and allocation of attention when faces are presented in complex scenes may be influenced by participants' goals. To this end, half of the participants were instructed to simply form a general impression of the people in each scene and half were explicitly told that they would be asked to recognize the people they viewed in each scene. The impressions condition was designed to draw participants' attention to the people in the scenes without alerting them to the subsequent memory task (i.e., an incidental learning condition), whereas the memory condition was designed to encourage participants to rely on specific memory strategies to aid in recognition (i.e., an intentional learning condition). Thus whereas the memory condition taps more directly into face recognition ability when participants are motivated to remember, the impressions condition may better represent how faces are naturally viewed in everyday life.

We hypothesized that providing participants with the knowledge that they would later be asked to recognize the people in the scenes would increase motivation to attend to all faces in each image; thus we expected that regardless of participant and face age, participants in the memory condition would spend more time looking at faces than those in the impressions condition. We also expected that participants in the impressions condition would spend more time looking at the bodies and scene context than those in the memory condition because forming an impression of a person involves not only examining the person him or herself, but also surveying the activity in which the person is engaged, the items he or she is holding, and the relationship of the person to the complete scene (see DeAngelus & Pelz, 2009). Lastly, we expected that regardless of participant age, participants in the memory condition would be more accurate in recognizing faces and show a smaller own-age bias than those in the impressions condition. If identity is encoded more automatically for own- than other-age faces, as suggested by evidence that in-group faces are processed at the individual level whereas out-group faces are processed at the categorical level (e.g., Hugenberg et al., 2010), encouraging participants to memorize faces may reduce differences in the accuracy with which own- and other-age faces are recognized.

Method

Participants

Forty Caucasian undergraduate students from Brock University (36 female; *M* = 19.40 years, age range = 18-24) and 40 Caucasian senior citizens living in independent housing in the Niagara region of Ontario (31 female; *M* = 69.53, age range = 57-84) participated in this experiment. Senior citizen participants were all in good health, and 39 of the 40 senior participants had 20/30 visual acuity or better, as shown through performance on a tumbling E chart; the remaining participant had 20/40 acuity. Undergraduates received research credit or a small honorarium and senior citizens received a gift card for their participation in the study. Participants completed a questionnaire assessing their weekly face-to-face contact with young and older adults. Both groups reported spending more time with own-age peers (*M* = 57.00 hours and 46.83 hours per week for young and older adults, respectively) than other-age individuals (*M* = 4.35 and 5.59 hours per week). Furthermore, 90% of the seniors in our sample indicated that they lived alone or with another senior only. An additional 19 participants were tested but excluded from the final data set due to equipment malfunction (n = 3 young adults, 1 older adult) or because participants' (n = 15 older adults) eye movements failed to meet criterion (defined as ≥ 70% of gaze data recorded from both eyes during the learning phase). Eye-tracking technology was designed to work well with individuals with healthy eyes, and thus a large number of older adults may have failed to meet criterion because of underlying medical conditions such as glaucoma or cataracts.

Materials

Learning phase. Stimuli consisted of eight colored photographs of settings such as parks, outdoor shopping centers, and streetscapes. Each photograph was resized such that the width was 1280 pixels and the height was 900 pixels. We used Adobe Photoshop version CS5 to alter the photographs such that faces were superimposed onto same-age bodies of the people in the scenes (Figure 1). Face stimuli were acquired from the Center for Vital Longevity Face Database (Minear & Park, 2004) and resized such that each face realistically fitted the young or older body to which it was attached. Each photograph included two forward-facing young adults (face age range = 19-26 years) and two forward-facing older adults (face age range = 70-85 years); thus there were a total of 32 faces (16 young) that were to be later recognized. Half of the faces in each age category were female. Scenes were presented using Tobii Studio 3.2 and eye movements were recorded by a Tobii T60 XL Eye Tracker (approximately 0.5 degrees of precision, 24 inches, 60 Hz sampling rate, 1440 x 900 pixels resolution). Across all eight scenes, the percentage of the screen occupied by the young adult faces (12%) was identical to the percentage of the screen occupied by the older adult faces (12%). Furthermore, in a pilot test, we validated that young and older adults were viewed as equally central to the scenes by blurring the faces such that all age-identifying facial information was removed. Pilot participants (n = 10 young adults; 4 female) were asked to indicate the two people in each scene who they viewed as most central to the action. Across all eight scenes, there was no difference in the extent to which young and older adult bodies were indicated as central to the scene, $t(7) = -1.73$, $p = .13$.

Test phase. Both familiar and novel test stimuli consisted of colored photographs of Caucasian young (age range = 19-26 years) and older adult (age range = 70-89 years) faces. All stimuli were acquired from the Center for Vital Longevity Face Database (Minear & Park, 2004) and resized such that the distance from hairline to chin was approximately 250 pixels. All background information (e.g., clothing) was digitally removed using Adobe Photoshop version CS5 and faces (including hair) were placed on a white background. Half of the faces (16 from each age category) were previously shown during the learning phase and half were novel; thus 64 faces (32 female) were shown during the test phase. Both familiar and novel faces were previously rated by 12 young adults (8 female) on a 7-point attractiveness scale (1 = not at all attractive, 7 = extremely attractive) and by 13 separate female young adults on a 7-point distinctiveness scale (1 = not at all distinctive, 7 = extremely distinctive). In this rating task, participants were asked to rate the attractiveness of each face with regard to other faces from the same age group and to judge the distinctiveness of each face based on how likely the face would stand out in a crowd. Young adult faces received a mean rating of 3.72 ($SD = .69$) on attractiveness and 3.69 ($SD = .36$) on distinctiveness. Older adult faces received a mean rating of 3.46 ($SD = .54$) on attractiveness and 3.81 ($SD = .48$) on distinctiveness. There were no significant differences between young and older adult faces in either attractiveness, $t(62) = -1.64$, $p = .11$, or distinctiveness, $t(62) = 1.13$, $p = .26$. All faces were presented and responses were recorded in the recognition task using E-Prime software.

Procedure

The procedure received clearance from the Research Ethics Board at Brock University, and participants gave written consent prior to their participation. Upon arrival to the lab, participants were seated approximately 65 cm in front of a 24-inch Tobii Eye Tracker. Before beginning the experiment, participants' eye movements were calibrated using a 5-point fixation procedure. Following the calibration, participants were told one of two sets of instructions before beginning the learning phase. Half of the participants were explicitly told that they would later be asked to identify the people they viewed in the scenes, whereas the other half were told to form an impression of the people shown in the scenes. In both instruction conditions, each scene was shown for 40 seconds and was preceded by a 1-second fixation cross in the center of the screen. We elected to show each scene for 40 seconds based on pilot testing and to be consistent with other work examining attentional allocation to own- and other-race faces presented in complex scenes (Semplonius & Mondloch, under review). The order in which the scenes were presented was randomized across participants.

After viewing the eight scenes, participants were told that they would be shown a series of individual faces and that their task was to indicate whether each face was novel or familiar as quickly and as accurately as possible. Faces were presented on the eye-tracking monitor but eye movements were not recorded. Each trial consisted of a 500-ms fixation cross, followed by a face that remained on the screen until a response was made. Participants indicated their response by pressing the z or m key on a keyboard; for half of the participants, the z key indicated that the face was familiar and the m key indicated that the face was novel, and for the other half, key assignment was reversed. The order in which the faces were presented was fully randomized for each participant, and there were a total of 64 trials in the test phase.

Results

Learning Phase

All eye-tracking data were obtained from the Tobii Studio software. For each scene, we defined four key areas of interest (two young adult face AOIs and two older adult face AOIs). These four AOIs were then collapsed across the eight scenes into two AOI groups: young adult faces and older adult faces. To investigate whether participants' attentional allocation differed for young and older faces, we examined two key variables of interest: total visit duration, which provides a measure of the amount of time participants spent looking at each AOI group summed across all visits, and visit count, which provides a measure of the number of times participants looked at each AOI group. We conducted 2 (face age: young adult, older adult) x 2 (participant age: young adult, older adult) x 2 (instruction type: impressions, memory) mixed ANOVAs to examine whether the amount of time (in seconds) spent visiting young and older faces and the frequency with which each face age was visited varied depending on participant age and instruction type.

Total visit duration. Both age groups spent more time visiting young (M = 68.09, SE = 3.63) than older (M = 57.39, SE = 3.27) adult faces, as shown by a main effect of face age, $F(1, 76) = 56.93$, $p < .001$, $\eta_p^2 = .43$ (see Figure 2). There was also a main effect of participant age, $F(1, 76) = 36.14$, $p < .001$, $\eta_p^2 = .32$; young adults spent more time visiting faces (M = 79.05, SE = 4.54) than older adults (M = 46.43, SE = 3.46). There was a main effect of instruction type,

F(1, 76) = 8.65, p = .004, η_p^2 = .10. Participants in the memory group spent more time visiting faces (M = 70.72, SE = 5.01) than those in the impressions group (M = 54.76, SE = 4.23).

The main effects of face age and instruction type were qualified by a face age by instruction type interaction, F(1, 76) = 6.49, p = .01, η_p^2 = .08. In the memory group, more time was spent visiting young faces (M = 77.88, SE = 5.41) than older faces (M = 63.56, SE = 4.84), t(39) = -6.46, p < .001, Cohen's d = .44. Likewise, in the impressions group, more time was spent visiting young faces (M = 58.31, SE = 4.40) than older faces (M = 51.22, SE= 4.25), t(39) = -3.82, p < .001, Cohen's d = .26. Thus, the same pattern of results was found in the two instruction types, but the effect size was larger for participants in the memory group. All other two- and three-way interactions did not reach significance, ps > .08.

Visit count. Similar to total visit duration, there were more visits to young (M = 79.16, SE = 2.59) than older (M = 73.95, SE = 2.68) faces for both age groups, as shown by a main effect of face age, F(1, 76) = 16.17, p < .001, η_p^2 = .18. There was also a main effect of participant age, F(1, 76) = 13.68, p < .001, η_p^2 = .15; young adults made overall more visits to faces (M = 85.15, SE = 3.04) than older adults (M = 67.96, SE = 3.62). There was a main effect of instruction type, F(1, 76) = 4.71, p = .03, η_p^2 = .06. Participants in the memory group made more visits to faces (M = 81.60, SE = 3.54) than those in the impressions group (M = 71.51, SE = 3.51).

The main effects of face age and instruction type were qualified by a face age by instruction type interaction, F(1, 76) = 4.96, p = .03, η_p^2 = .06. In the memory group, there were more visits to young (M = 85.65, SE = 3.47) than older adult faces (M = 77.55, SE = 3.85), t(39) = -4.22, p < .001, Cohen's d = .35. However, in the impressions groups, the number of visits to young faces (M = 72.68, SE = 3.60) did not differ from the number of visits to older faces (M =

70.35, *SE* = 3.67), *t*(39) = -1.23, *p* = .23, Cohen's *d* = .10. There was also a significant face age by participant age interaction, *F*(1, 76) = 7.77, *p* = .007, η_p^2 = .09. Among young adults, the number of visits to young faces (*M* = 85.95, *SE* = 3.01) did not differ from the number of visits to older faces (*M* = 84.35, *SE* = 3.35), *t*(39) = -.86, *p* = .40, Cohen's *d* = .08. However, among older adults, there were more visits to young (*M* = 72.38, *SE* = 3.96) than to older faces (*M* = 63.55, *SE* = 3.50), *t*(39) = -4.70, *p* < .001, Cohen's *d* = .37. Neither the participant age by instruction type interaction nor the three-way interaction reached significance, *p*s > .57.

First 10 seconds of each scene. To examine whether young adult faces received a large attentional advantage during the initial encoding of the scenes, we analyzed both total visit duration and visit count during the first 10 seconds of each scene. Similar to the full 40 seconds of presentation, both age groups spent more time visiting young (*M* = 2.39, *SE* = .14) than older (*M* = 1.92, *SE* = .13) faces, as shown by a main effect of face age, *F*(1, 76) = 8.73, *p* = .004, η_p^2 = .10. There was a main effect of participant age, *F*(1, 76) = 10.49, *p* = .002, η_p^2 = .12; young adults spent more time visiting faces (*M* = 2.51, *SE* = .15) than older adults (*M* = 1.81, *SE* = .15). There was also a main effect of instruction type, *F*(1, 76) = 6.77, *p* = .01, η_p^2 = .08. Participants in the memory group spent more time visiting faces (*M* = 2.44, *SE* = .15) than those in the impressions group (*M* = 1.87, *SE* = .15). Unlike the full 40 seconds of presentation, there was no face age by instruction type interaction, *p* = .30; however, there was a participant age by instruction type interaction, *F*(1, 76) = 5.74, *p* = .02, η_p^2 = .07. Among young adults, participants in the memory group spent more time visiting faces (*M* = 3.04, *SE* = .20) than those in the impressions group (*M* = 1.97, *SE* = .19), *t*(38) = -3.92, *p* < .001, Cohen's *d* = 1.26. However, among older adults, there was no difference in overall time spent visiting faces across both instruction types (*M* = 1.83, *SE* = .27 and *M* = 1.78, *SE* = .20 for the memory and impressions groups, respectively), $t(38) = -.13$, $p = .89$, Cohen's $d = .05$.

In terms of visit count, there was only a main effect of participant age, $F(1, 76) = 5.59$, $p = .02$, $\eta_p^2 = .07$; young adults made more visits to faces (*M* = 3.96, *SE* = .24) than older adults (*M* = 3.18, *SE* = .24). There was also a face age by instruction type interaction, $F(1, 76) = 3.96$, $p = .05$, $\eta_p^2 = .05$. However, follow-up t-tests revealed that the number of visits to young faces did not differ from the number of visits to older faces for either instruction type, *p*s > .15.

Total visit duration for non-face items in the scenes. To determine whether any differences in looking time were face-specific, we examined whether there were group differences in how much time was spent looking at young and older adult bodies in the scenes (i.e., bodies aligned with young versus older faces). We conducted a 2 (body age: young adult, older adult) x 2 (participant age: young adult, older adult) x 2 (instruction type: impressions, memory) mixed ANOVA to examine whether the amount of time spent visiting young and older bodies varied as a function of participant age and instruction type. There was a main effect of body age, $F(1, 76) = 18.94$, $p < .001$, $\eta_p^2 = .20$, such that young bodies were looked at longer (*M* = 36.36, *SE* = 1.86) than older bodies (*M* = 32.25, *SE* = 1.68). All other main effects and interactions were not significant, *p*s > .15[1].

We also examined whether there were group differences in the amount of time spent looking at the context of the scene (i.e., entire scene excluding the faces and bodies) to verify that our task instructions were effective (i.e., that the impressions group spent more time than the memory group looking at the background scene) and to ensure that participants remained on-task and that the eye tracker was able to consistently track their eye movements. A 2 (participant age:

[1] We elected to examine only total visit duration for non-face items in the scenes as visit duration was our primary variable of interest and best reflected how much time was spent attending to any given stimulus.

young adult, older adult) x 2 (instruction type: impressions, memory) univariate ANOVA revealed a main effect of participant age, $F(1, 76) = 44.41$, $p < .001$, $\eta_p^2 = .37$; older adults spent more time visiting the scene context ($M = 136.94$, $SE = 6.46$) than young adults ($M = 83.83$, $SE = 5.12$). There was also a main effect of instruction type, $F(1, 76) = 7.41$, $p = .01$, $\eta_p^2 = .09$; participants in the impressions group spent more time visiting the scene context ($M = 121.23$, $SE = 6.93$) than those in the memory group ($M = 99.54$, $SE = 7.08$). The interaction of participant age by instruction type was not significant, $p = .69$.

Test Phase

Recognition accuracy. To provide an unbiased measure of participants' recognition memory for young and older adult faces, we calculated each participant's *d′* for both face ages using Macmillan and Creelman's (1991) method. Our analyses focused on *d′* and criterion (*C*), but hit and false alarm values are presented in Table 1. Single-sample *t*-tests showed that *d′* values for young and older faces were greater than 0 for all combinations of participant age groups and instruction types, all *p*s < .006. We then conducted a 2 (face age: young adult, older adult) x 2 (participant age: young adult, older adult) x 2 (instruction type: impressions, memory) mixed ANOVA to examine whether recognition for young and older faces varied as a function of participant age and instruction type. There was a main effect of face age, $F(1, 76) = 17.21$, $p < .001$, $\eta_p^2 = .19$; young faces ($M = .90$, $SE = .09$) were recognized more accurately than older faces ($M = .54$, $SE = .06$). There was also a main effect of participant age, $F(1, 76) = 24.16$, $p < .001$, $\eta_p^2 = .24$; young adults showed better recognition memory ($M = .99$, $SE = .09$) than older adults ($M = .45$, $SE = .06$) for all faces collapsed across face age. There was no main effect of instruction type, $p = .29$.

Only young adults showed evidence for an own-age recognition advantage. As shown in Figure 3, there was a significant face age by participant age interaction, $F(1, 76) = 10.15$, $p = .002$, $\eta_p^2 = .12$. Among young adults, young faces ($M = 1.31$, $SE = .13$) were recognized more accurately than older faces ($M = .67$, $SE = .10$), $t(39) = -4.76$, $p < .001$, Cohen's $d = .87$. However, among older adults, there was no difference in recognition accuracy for young ($M = .49$, $SE = .09$) and older faces ($M = .40$, $SE = .07$), $t(39) = -.77$, $p = .45$, Cohen's $d = .17$. These results are consistent with young adults making more hits and fewer false alarms for young compared to older faces whereas both hit and false alarm rates were higher for young than older faces among older adults (see Table 1). Neither the face age by instruction type interaction nor the participant age by instruction type interaction reached significance, *p*s > .08. Lastly, there was no significant three-way interaction, $p = .73$.

To ensure that the lack of any face age biases in older adults was not due to their reduced performance on the memory task relative to young adults, we calculated a corrected memory bias score ((d' [young faces] – d' [older faces])/ |(d' [young faces] + d' [older faces])|; see Wiese et al., 2012) for each participant. Young adults showed a significant positive memory bias, $t(39) = 3.23$, $p = .002$, indicating a young adult face recognition advantage. In contrast, older adults did not show a significant memory bias in either direction, $t(39) = .70$, $p = .49$.

Response bias. To examine participants' response biases, we calculated each participant's criterion (*C*) for both young and older faces using Macmillan and Creelman's (1991) method. A 2 (face age: young adult, older adult) x 2 (participant age: young adult, older adult) x 2 (instruction type: impressions, memory) mixed ANOVA revealed a marginally significant main effect of participant age, $F(1, 76) = 3.75$, $p = .06$, $\eta_p^2 = .05$, such that young adults tended to be more conservative in their responses ($M = .04$, $SE = .01$) than older adults (*M*

= .02, *SE* = .01). There was also a marginally significant main effect of instruction type, $F(1, 76) = 3.55$, $p = .06$, $\eta_p^2 = .05$; participants in the impressions group tended to be more conservative in their responses (*M* = .04, *SE* = .01) than participants in the memory group (*M* = .02, *SE* = .01). Although marginally significant, these biases are quite small in absolute terms. There were no other main effects or interactions, all *p*s > .13.

Relationship between Looking Time and Recognition

To examine whether there was a relationship between participants' looking time and subsequent recognition memory, we examined whether there was a correlation between total visit duration for own-age faces and *d′* for own-age faces for both young and older adult participants. We also examined whether there was a correlation between total visit duration for other-age faces and *d′* for other-age faces for both participant age groups. Among young adults, there was no relationship between looking time and *d′* for either own-age faces, $r = .27$, $p = .09$, or other-age faces, $r = .08$, $p = .61$. Likewise, among older adults, there was no relationship between looking time and *d′* for either own-age faces, $r = .07$, $p = .66$, or other-age faces, $r = -.12$, $p = .44$.

To further confirm the lack of a relationship between looking time and recognition, we calculated the magnitude of the own-age looking time advantage by subtracting total visit duration on other-age faces from total visit duration on own-age faces for each participant. We then calculated the magnitude of the own-age recognition advantage by subtracting *d′* for other-age faces from *d′* for own-age faces for each participant. A moderated regression was conducted to examine whether the relationship between the own-age looking time advantage (centered) and own-age recognition advantage was moderated by participant age, task instruction, or any of the two- or three-way interactions between the three predictors. Overall, the model was significant, *Adjusted* $R^2 = .13$, $F(7, 72) = 2.66$, $p = .02$. However, the only significant predictor in this model was participant age, $\beta = -.43$, $p = .004$; young adults showed a larger own-age recognition advantage than older adults. All other predictors and interactions between the predictors were not significant, *p*s > .47[2].

Discussion

The primary goal of the present study was to examine the effect of participant age on attentional allocation and subsequent recognition for young and older faces learned within the context of complex scenes. Although our study was not designed to disentangle perceptual expertise and social cognitive accounts of the own-age recognition bias, we briefly discuss our findings with regard to each of these models. A second goal was to determine whether task instructions would influence these effects.

Attentional Allocation for Young and Older Faces

Overall, both young and older adults attended more to young than older faces during the learning phase. This was demonstrated by longer total visit duration and by more visits to young than older faces, although the latter pattern was evident only for older adult participants. Differential attentional allocation to young versus older faces cannot be attributed to differences in the salience or the amount of space occupied by young and older faces. Across all scenes, both face ages occupied the same percentage of the screen and our pilot task revealed that young and older adults were viewed as equally central to the action of the scenes.

The pattern of results for young adult participants is consistent with both social cognitive and perceptual expertise accounts of the own-age bias. Young adults may be motivated to attend

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[2] Given that we found evidence for a young adult looking time advantage for both participant age groups, we conducted this same analysis to examine whether there was a relationship between a young adult looking time advantage and a young adult recognition advantage. The overall model was not significant, *Adjusted* $R^2 = .06$, $F(7, 72) = 1.69$, $p = .13$, but there was a significant predictor of participant age, $\beta = -.32$, $p = .007$; young adults showed a larger young adult recognition advantage than older adults.

more to in-group (i.e., young adult) faces and disregard the faces of out-group (i.e., older adult) members (Rodin, 1987), and for this reason they may develop strategies that are more finely tuned for the processing and recognition of own-age faces. For example, young adults may be more sensitive to subtle differences between young and older adult faces, which may aid them in extracting relevant identifying information that can later be used for recognition. Furthermore, according to social cognitive accounts (e.g., Bernstein, Young, & Hugenberg, 2007; Hugenberg et al., 2010; Sporer, 2001), in-group faces are processed at an individual level whereas out-group faces are processed at the categorical level. Individuation likely requires greater effort than categorization (Ge et al., 2009) and thus the pattern of increased attention to young relative to older adult faces may reflect these differential processing strategies.

Although the evidence for young adults is consistent with the literature, older adults' preferential attention to young relative to older faces is inconsistent with social cognitive accounts of the own-age recognition bias. However, it is important to note that not all researchers have found evidence for older adults attending more to own- relative to other-age faces (e.g., Firestone et al., 2007). One potential explanation that may underlie older adults' longer looking at young relative to older faces is that the older faces were viewed more negatively than the young faces. He and colleagues (2011) found that both young and older adults have more positive implicit associations and explicit stereotypes for young than older adult faces (see also Ebner, 2008). Importantly, however, He et al. (2011) did not find that implicit associations and explicit stereotypes predicted the own-age bias or were related to looking time. Additional research has demonstrated that age-stereotypic attitudes tend to be found more often among young relative to older adult raters (Gluth, Ebner, & Schmiedek, 2010; Kite, Stockdale, Whitley, & Johnson, 2005), indicating that older adults are less likely to hold stereotypes about either young or older adults, perhaps because they were once young adults themselves. Regardless of the mixed evidence in the literature, our results clearly indicate that older adults demonstrate a visual preference for young relative to older faces. Given that we did not measure participants' social attitudes, future work should examine the extent to which the visual preference for young adult faces is mediated by age-stereotypic implicit attitudes (such as through the use of the Implicit Association Task; see Wiese, Wolff, Steffens, & Schweinberger, 2013).

It is important to note that young adults spent more time than older adults looking at faces (collapsed across face age), whereas older adults looked longer at the background context, even when explicitly instructed to memorize the people in the scenes. For the purposes of the current task, older adults' looking strategy was less effective than that of young adults, which may explain their reduced performance on the subsequent recognition task relative to young adults. For example, in the memory condition, older adults may have encoded background items alongside the faces as a cue for recognition; however, such items were not shown in the recognition task and thus would not have benefited participants. There is some evidence that older adults rely more on gist-based memory representations than young adults (Koutstaal & Schacter, 1997). This reliance on gist-based memory may be reflective of a tendency to focus on global contextual cues rather than detailed local cues. Accordingly, in the present task, older adults may have taken a more holistic approach to viewing the scenes, which negatively influenced their recognition for the faces when such contextual cues were removed. Older adults' approach to viewing the scenes may also be reflective of age-related changes in emotional regulation and resource allocation. Older adults tend to allocate greater attention to positive than neutral stimuli (reviewed in Mather & Carstensen, 2005). In the current study, all faces were of a neutral valence, and it is possible that older adults perceived the background context to be more positive and emotionally rewarding than the faces (e.g., several scenes depicted exciting parks or street fairs); thus they may have been more apt to attend to the scene context than to the face stimuli, regardless of task instructions. Older adults may have also spent more time looking at the background scene relative to young adults because of deficits in visual attention. There is some evidence to suggest that older adults are less successful than young adults in avoiding attentional capture by irrelevant distractor items (Colcombe et al., 2003; but see Madden, 2007). Thus even when older adults were told that their task was to remember the people in the scenes, they may have had difficulty ignoring the details of the background context. Future work should examine face recognition when faces at test are presented in the context in which they were learned, which may particularly benefit older adults' recognition.

Recognition Accuracy for Young and Older Faces

Results from the recognition phase support our hypothesis that young adults would be more accurate in recognizing own- relative to other-age faces. This finding is consistent with the results of past studies that have found an own-age recognition advantage among young adults (Bäckman, 1991; Proietti, Pisacane, & Macchi Cassia, 2013) and with studies showing that young adults show greater neural activation in response to young relative to older faces (Ebner, He, Fichtenholtz, McCarthy, & Johnson, 2011a; Wiese et al., 2008). The novelty of this work is that, in contrast to previous studies, faces were displayed within the context of complex scenes, presented with full bodies, and shown in direct competition with another face category. Under these conditions, young adults continued to show enhanced recognition for young relative to older faces, which demonstrates the robustness of the own-age bias in young adults across experimental paradigms.

As in past studies (e.g., Bartlett & Memon, 2007), older adults showed higher false alarm rates (for both face ages) than young adults. In contrast to young adults, older adults did not show a recognition advantage for own-age faces; rather, they showed comparable recognition accuracy for young and older faces. Ours is not the first study to fail to find an own-age recognition advantage in an older adult sample (e.g., Bartlett & Leslie, 1986; Fulton & Bartlett, 1991; Wiese et al., 2008). Although our study was not designed to disentangle the effects of recent versus cumulative life experience, the lack of an own-age recognition advantage in older adults may be related to the early and cumulative experience they have received with young adult faces. Although older adults receive extensive recent experience with individuals belonging to their in-group (i.e., other older adults), they were young adults earlier in development and therefore have gathered substantial experience with young adult faces as well. It may be the case that early and continuous exposure to young adult faces throughout development tunes the perceptual system to the dimensions of young adult faces (Short & Mondloch, 2013) and is sufficient to support the recognition of young faces even in older adulthood when young faces are less frequently encountered and are those of a social out-group. Moreover, even though older adults receive less frequent exposure to young adult faces in their daily social interactions, they may still receive ample exposure to young adult faces in the media, which may further preserve their abilities. Thus, among older adults, recent experience with older faces may enhance recognition abilities for own-age faces; however, the cumulative life experience they have received with young faces still exerts influence and therefore recognition is comparable for the two face ages. Consistent with this is Wiese et al.'s (2008) finding that young adults showed better recognition and a higher-amplitude N250 for own-age than older adult faces, whereas older adults' recognition accuracy and N250 amplitude did not differ as a function of face age.

It is important to note that a recent study (Wiese et al., 2012) found that older adults who report high contact with other older adults show an own-age recognition advantage whereas those who report low contact with older adults do not. The older adults in our study reported more contact with older than young adults yet did not show an own-age recognition advantage, which is inconsistent with Wiese et al.'s (2012) recent finding. One possibility is that the number of different older adults with whom one interacts is more critical than the number of hours spent interacting with individuals in that age group. Although the older adult participants in our sample reported more hours per week spent with older than young adults, it is possible that the time spent with older adults was restricted to a very small number of people (e.g., spouses). This familiarity with only a limited number of older adults may have been insufficient to produce a recognition bias for older adult faces when participants were asked to learn novel faces.

Relationship between Looking Time and Recognition Accuracy

Although both young and older adults looked preferentially towards young adult faces, we did not find any evidence that longer looking times improved recognition. First, older adults did not recognize young adult faces more accurately than older adult faces. Second, there was no relationship between total looking times and recognition accuracy for either young or older faces, and individual differences in the magnitude of the looking time advantage for own-age faces did not predict individual differences in the magnitude of the own-age recognition advantage. Lastly, explicit instructions to remember the faces did not improve recognition performance relative to instructions that simply encouraged participants to form impressions of the scenes.

Our results suggest that memory encoding occurs quite automatically and that longer looking does not necessarily indicate that faces are encoded at a deeper level. It may be that the type of processing we engage in during initial encoding is more important for subsequent recognition than the overall amount of time spent looking at the face. Indeed, our results suggest that what might best distinguish recognition of faces from different age categories is the efficiency with which they are processed. For example, older adult faces may be processed less efficiently than young adult faces because observers are less sensitive to the dimensions of older adult faces and/or process these faces less holistically (see Harrison, Gauthier, Hayward & Richler, 2014, for evidence that own-race and in-group faces are processed more efficiently than other-race and out-group faces). Behaviorally, both young and older adults show evidence for greater holistic processing for young than older faces (Wiese, Kachel, & Schweinberger, 2013), and there is evidence that early electrophysiological components associated with face processing are sensitive to differences in face age. For both young and older adults, the N170 is larger for older versus young adult faces (e.g., Ebner et al., 2011a; Wiese et al., 2008; Wiese et al., 2012) and the P2 is larger for young than older adult faces (Wiese, 2012; Wiese et al., 2008; Wiese et al., 2012). Such differences are suggestive of potentially different encoding strategies for young and older faces.

Moreover, recognition can be supported following minimal exposure times and does not require long prolonged visual inspection. The N250r, which is sensitive to face repetition and familiarity, emerges as early as 180 to 220 ms after stimulus onset (reviewed in Schweinberger, 2011; Zheng, Mondloch, & Segalowitz, 2012), and both children and adults can accurately discriminate faces that differ only in the shape of individual features and the spacing among them after a 200-ms presentation time (Mondloch, Dobson, Parsons, & Maurer, 2004; Mondloch, Le Grand, & Maurer, 2002). A significant amount of information can thus be extracted from faces within 1000 milliseconds of exposure; increased looking with no changes in processing strategy may not necessarily provide additional information that benefits recognition. Consistent with this idea is the finding that face recognition is supported by only two fixations at test; more than two fixations does not provide any additional performance benefit (Hsiao & Cottrell, 2008), at least when participants are asked to simply recognize a face in an old/new paradigm.

Effect of Task Instructions

The second goal of the present study was to investigate whether participants' goals during learning influence visual scanning strategies and affect subsequent recognition. Past studies have demonstrated that task instructions can successfully influence participants' allocation of attention (DeAngelus & Pelz, 2009; Kaakinen et al., 2011). Our results are consistent with the literature; participants directed their attention to items in the scenes that were most relevant to their assigned task. For example, participants in the impressions condition took a global approach to examining the scenes and allocated more attention to the scene context relative to those in the memory condition. This may be because forming an impression of a person involves not only examining the person him or herself, but also surveying the activity in which the person is engaged, the items he or she is holding, and the relationship of the person to the scene context. In contrast, participants in the memory group were told they only needed to remember the people in the scenes and thus directed more attention towards faces and less attention towards the background context.

Contrary to our predictions, instructing participants to remember the faces in each scene did not reduce differential allocation of attention to young versus older faces. Rather, participants in the memory group showed larger differences in looking time between young and older faces than participants in the impressions group and only the memory group visited young faces more frequently than older faces. Although greater attention was directed toward faces in the memory condition, memory for faces was not better in the memory group than the impressions group.

Furthermore, participants in the memory condition did not show a smaller own-age bias than those in the impressions condition, indicating that although the task instructions were successful in altering scanning patterns, they did *not* alter participants' recognition accuracy for young and older faces (contrasting Kaakinen et al., 2011). These results are consistent with the results of a recent meta-analysis (Rhodes & Anastasi, 2012) that demonstrated that intentional and incidental encoding at learning did not moderate the magnitude of the own-age bias in recognition. In the current study, our manipulation of task instructions (memory versus impressions) may have more closely mapped onto intentional (memory condition) and incidental (impressions condition) encoding than onto Kaakinen et al.'s strategy of manipulating participants' perspectives during a recognition task. Moreover, our finding that instruction type influenced looking time but not recognition is consistent with our failure to find a relationship between looking time and recognition accuracy; it may be the case that the conditions that affect looking times at learning do not necessarily affect recognition to the same degree.

Conclusions & Future Directions

Using a novel method in which young and older faces were simultaneously presented in complex environments, we are the first to show how young and older adults selectively allocate their attention in the context of everyday scenes and to examine how face recognition varies as a function of participant age and goals. Future studies can utilize the novel method employed in this experiment to examine attentional allocation and recognition for other relevant face categories, such as attractive versus unattractive faces. Furthermore, this method makes it possible to examine the role of social context in face recognition by manipulating the social environment in which the faces appear. For example, older adult faces could be presented in a youthful setting (e.g., a carnival), indicating that the older adult is "young-old" rather than "old-

old" (Neugarten & Hagestad, 1976) and therefore may be perceived as more versus less relatable to a young adult. Lastly, future studies should further examine the effect of task instruction. For example, in our task, we drew participants' attention to the faces in even the impressions condition because we wanted to ensure that participants at least briefly encoded each face. However, future studies should examine participants' recognition following passive viewing of the scenes or following instructions that systematically direct attention to other aspects of the scene and make the faces task-irrelevant (e.g., by asking participants to form an impression of the architecture). Our results have important implications for the way in which faces of different ages are processed in complex situations that contain numerous environmental stimuli that compete for attention. As the population of older adults continues to grow, it will become increasingly important to understand the way in which older adults perceive and are perceived by others in their daily social interactions and everyday life experiences.

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Table 1
Means and SEs of test phase.

	Young adults		Older adults	
	Young faces	Older faces	Young faces	Older faces
Hits	9.28 (0.51)	8.05 (0.38)	8.35 (0.53)	7.60 (0.42)
False alarms	2.62 (0.31)	4.43 (0.41)	5.77 (0.54)	5.45 (0.44)
d'	1.31 (0.13)	0.67 (0.10)	0.49 (0.09)	0.40 (0.07)
C	0.04 (0.01)	0.03 (0.01)	0.02 (0.01)	0.03 (0.01)

Figure Captions

Figure 1. Sample scene shown during the learning phase. Each scene contained two young and two older adult faces.

Figure 2. Mean total visit duration in seconds (+1 SE) for young and older faces for both participant age groups in each instruction condition.

Figure 3. Mean *d′* values (+1 SE) for young and older faces shown in the recognition task for both young and older adult participants. Performance was greater than chance in all conditions, and the asterisk indicates that $p < .001$.