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Searching for Faces of Different Ages: Evidence for an Experienced-Based Own-Age Detection Advantage in Adults

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Previous studies have shown that attention deployment in visual search tasks is modulated by face race and emotional expression, with a search asymmetry in favor of those faces that are less efficiently discriminated and recognized at the individual level (i.e., other-race faces and angry faces). Face age is another dimension affecting how faces are remembered, as it has been widely reported that young adults show significant deficits in recognizing other-age faces. By comparing adults' search efficiency for own- and other-age faces in a visual search task in which face age was the target feature we explored whether the mirror pattern of detection and recognition effects found for race biases generalizes to age biases, and whether search efficiency for adult and nonadult faces is modulated by experience accumulated with nonadult faces. Search efficiency was greater for adult faces than for infant (Experiment 1) or child faces (Experiment 2) in adults with limited experience with infants or children, whereas there was no sign of search asymmetry in preschool teachers who have had extensive recent experience with children (Experiment 2). Results indicate that the influence of age on attention deployment parallels the effects that this face attribute has on face recognition, and that both effects are experience-based.

Keywords: face age, own-age bias, visual search, experience, selective attention

Our visual environment contains an enormous amount of information and our cognitive system is limited, whereby not all information can be processed simultaneously. It is crucial for adaptive behavior that we focus attention on critical elements and features of the visual scene while ignoring distracting information, so that the critical elements are processed first. For example, rapid detection of stimuli that have high biological significance for members of a species is crucial for survival and advantageous for our social interactions.

Accordingly, multiple lines of research suggest that, in humans, faces are a class of stimuli that receives high priority from attention (see review by Palermo & Rhodes, 2007). Developmental studies show that, already from birth, faces preferentially engage and hold attention compared with other stimuli (Johnson & Morton, 1991; Macchi Cassia, Simion, & Umiltà, 2001). In adults, behavioral studies show that faces capture attention more readily than other objects and participants attend to faces even when faces are not relevant for the task or when they distract from the task at hand (e.g., Langton, Law, Burton, & Schweinberger, 2008; Suzuki & Cavanagh, 1995). Electrophysiological evidence indicates that faces are detected and categorized faster than many other stimuli (e.g., Rousselet, Macé, & Fabre-Thorpe, 2003; Yamamoto & Kashikura, 1999).

This attentional advantage of faces over nonface stimuli is typically interpreted as originating from the special status that faces have, being the most biologically and socially significant visual stimuli in the human environment. In line with this interpretation there is evidence showing that nonface stimuli that, like faces, may be crucial for the individual's survival—such as snakes, spiders, and other threatening animals—preferentially engage selective attention in adults (e.g., Brosch & Sharma, 2005; Lipp & Derakshan, 2005; Öhman, Flykt, & Esteves, 2001), as well as in children (LoBue & DeLoache, 2008; LoBue & Larson, 2010) and preverbal infants (LoBue & DeLoache, 2010). However, faces are also objects for which humans naturally develop the greatest perceptual expertise. Since various behavioral and neural effects observed for faces were found also for other homogeneous categories of expertise (see review by Bukach, Gauthier, & Tarr, 2006; but see McKone, Kanwisher, & Duchaine, 2007), some researchers have also argued that the face attentional advantage may stem from human facial expertise. This hypothesis is indirectly supported by evidence showing that bird and car experts had a search advantage for faces and targets of expertise over novice targets in a visual search task in which they searched for face, car, or bird photographs in heterogeneous displays comprised of photographs of real objects (Hershler & Hochstein, 2009). This effect of expertise on visual category search was interpreted as an example of top-down influence on attentional control generated by stimulus familiarity.

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Irrespective of the specific contribution of biological saliency and/or perceptual expertise on the preferential processing of faces over other objects present in a visual scene, it is known that deployment of attention can be modulated by specific face traits. For example, a wide range of studies across various experimental paradigms suggests that, compared with neutral or happy faces, angry faces more readily capture or hold attention and distract from other stimuli. In visual search tasks, both adults and children show a search asymmetry in favor of angry faces, whereby searching for angry faces among neutral or happy faces is faster and more accurate than the reverse (e.g., Hansen & Hansen, 1988; LoBue, 2009; Mather & Knight, 2006; Öhman, Lundqvist, & Esteves, 2001). This search asymmetry is often explained from an evolutionary standpoint as being of adaptive value to preferentially detect and quickly respond to potentially harmful stimuli, which may include threatening facial expressions as well as threatening animals (e.g., LeDoux, 1996; Öhman, 1993; see also LoBue, 2013).

Another facial attribute that appears to modulate the extent to which faces engage mechanisms of selective attention is race. In a series of visual search studies, Levin (1996, 2000; Levin & Angelone, 2001) showed that Caucasian participants were faster to search for the face of a male African American among multiple images of a male Caucasian face than vice versa, suggesting the presence of a search asymmetry in favor of other-race faces. Although the search asymmetry favoring other-race faces was not always found (Levin & Angelone, 2001; Lipp et al., 2009) and did not extend to non-Caucasian participants (Chiao, Heck, Nakayama, & Ambady, 2006; Levin, 1996), it suggested that race-specifying information may function as a visual feature. Specifically, in his feature-selection model Levin (1996, 2000) proposed that subjects code other-race faces as outliers within a representational space based around own-race faces, and thus having race-specifying features that own-race faces lack. Because feature-present targets are detected more quickly than feature-absent targets in a search display (Treisman & Gormican, 1988), when the feature is the membership in a contrasting race, other-race face targets are detected more efficiently than own-race face targets.

Overall, there is evidence suggesting that both emotional expressions and face race can modulate attention deployment, as measured in visual search tasks. For both these face traits, the items that more readily capture attention—that is, angry faces and other-race faces—when compared with their within-category counterparts—that is, happy/neutral faces and own-race faces—are those that are less efficiently discriminated and recognized at the individual level. In fact, the "angry-face detection advantage" contrasts with the widely reported facilitating effect of positive emotional expressions on face recognition memory and familiarity ratings (e.g., Baudouin, Gilibert, Sansone, & Tiberghien, 2000; Gallegos, & Tranel, 2005; Lander & Metcalfe, 2007). Similarly, the "other-race detection advantage" contrasts with the well-known own-race recognition advantage, whereby own-race faces are discriminated and recognized faster and more accurately than other-race faces (e.g., Brigham & Malpass, 1985; Chiroro & Valentine, 1995; Valentine, 1991; see review by Meissner & Brigham, 2001). This mirror pattern in participants' performance for own-race/other-race face processing in visual search tasks and recognition memory tasks has been interpreted as resulting from the processing differences involved in detecting categorical facial information versus recognizing individual facial information in own-race and other-race faces (Ge et al., 2009; Levin, 2000; Susa, Meissner, & de Heer, 2010; Zhao & Bentin, 2008). To detect an own-race face among other-race faces, one must rely on race-specifying information, that is, information diagnostic of the race category. In contrast, to discriminate and recognize a face among other same-race faces, one must rely on identity-specifying information, that is, information diagnostic of the individuality of each face. It is known that, when participants are asked to explicitly categorize faces by their race, they respond faster to other-race faces than to own-race faces, showing the so-called other-race categorization advantage (e.g., Caldara, Rossion, Bovet, & Hauert, 2004; Ge et al., 2009; Zhao & Bentin, 2008). Based on the assumption that a race-based categorization task and a visual search task in which face race is the target feature tap comparable perceptual processes, some researchers claimed that the other-race categorization advantage can explain the search asymmetry in favor of other-race faces (e.g., Levin, 2000).

In the present study, we aimed to extend the available evidence on the effects of face race and emotional expressions on the deployment of selective visual attention to a different facial attribute, namely age. Like race and emotional expressions, age is known to affect how faces are processed and remembered. Research using eyewitness paradigms (e.g., Wright & Stroud, 2002), intentional or incidental old/new recognition memory tasks (e.g., Anastasi & Rhodes, 2005) and forced-choice perceptual recognition tasks (e.g., Kuefner, Macchi Cassia, Picozzi, & Bricolo, 2008) has shown that the impact of age information on adults' face recognition memory depends on both the observer's age and the age of the target face, with faces of the observer's own-age group recognized better than other-age faces (see reviews by Rhodes & Anastasi, 2012 and Wiese, Komes, & Schweinberger, 2013). This evidence has led researchers to propose the existence of an own-age bias (OAB) in adults' face recognition memory (Perfect & Moon, 2005; Wright & Stroud, 2002), which would parallel other in-group biases such as that for own-race faces or for faces of our own species. Recent evidence has also shown that adults rely more heavily on expert configural/holistic strategies when processing own-age faces compared with infant faces (Macchi Cassia, Kuefner, Picozzi, & Vescovo, 2009), child faces (Kuefner et al., 2008; Kuefner, Macchi Cassia, Vescovo, & Picozzi, 2010), and elderly adult faces (Proietti, Pisacane, & Macchi Cassia, 2013; Wiese, Kachel, & Schweinberger, 2013), and that these effects are mitigated or eliminated when extensive exposure to infants, children, or elderly adults occurs as part of the individual's social and/or working experience, indicating that perceptual experience plays a crucial role in shaping the magnitude and direction of the age-related face processing bias (e.g., de Heering & Rossion, 2008; Harrison & Hole, 2009; Kuefner et al., 2010; Macchi Cassia, Kuefner, et al., 2009; Macchi Cassia, Picozzi, Kuefner, & Casati, 2009; Proietti et al., 2013; see Wiese, Komes, & Schweinberger, 2012 for similar findings in older adults).

Although many studies have been published on how face age modulates face perception and recognition memory, little is known about whether and how age affects attentional responses to faces. There are studies investigating how face age affects the automatic orienting of attention toward nonface stimuli (Brosch, Sander, & Scherer, 2007; Ebner & Johnson, 2010; Hodsoll, Quinn, & Hodsoll, 2010; Proverbio, De Gabriele, Manfredi, & Adorni, 2011). In these studies, adult participants were tested in face-unrelated tasks, and the extent to which task-irrelevant adult and nonadult faces modulated participants' performance was measured. In most cases, adult and baby faces were used as stimuli, and results showed greater attention capturing effects for baby faces. For example, adults had shorter response times to lateralized targets preceded by a baby face compared with those preceded by an adult face (e.g., Brosch et al., 2007; Hodsoll et al., 2010; Proverbio et al., 2011) or longer response times to a target visual feature within a search display composed of baby faces compared with one composed of adult faces (Thompson-Booth et al., 2014). This bias toward baby faces in the automatic allocation of attention was interpreted as a universal and inborn response driven by the high biological relevance of infants for adult members of a species ("baby schema" effect; Lorenz, 1971), in line with other evidence of attentional prioritization of biologically significant stimuli.

The only study that did not use infant faces as stimuli reported a larger attentional interference from own- as compared wth other-age faces in young adult participants, as indicated by longer response times to report the identity of a target number when young as compared with older faces appeared in the background (Ebner & Johnson, 2010). The authors interpreted these findings in line with those showing a recognition advantage for young versus older adult faces in young adults (e.g., Proietti et al., 2013), as due to participants' greater expertise at processing peer faces as compared with nonpeer faces. Of note, however, is the fact that not even in this study was the age of the face relevant to the task. Thus, the results remain uninformative as to whether an attentional bias exists in tasks involving group categorization along the face age dimension, and whether the bias parallels or mirrors the OAB observed in other aspects of face processing (i.e., perceptual discrimination and recognition). Moreover, in none of the aforementioned studies was the amount of participants' current/previous experience with other-age individuals measured or manipulated, this variable being sometimes confounded with parental status (Thompson-Booth et al., 2014). Thus, available evidence also remains uninformative regarding the impact of experience accumulated with different face age groups on attentional responses to face age.

In the current study, we sought to explore these questions by using a visual search task with own- and other-age faces, in which face age (i.e., adult, infant, or child) was the target feature, and participants were explicitly required to process age-specifying information in order to provide their responses. In order to compare search efficiency for own- and other-age faces, in Experiment 1 adults searched for an adult face among infant faces or for an infant face among adult faces, whereas in Experiment 2 they searched for an adult face among child faces or the reverse. The influence of experience with other-age faces was controlled in Experiment 1 by selecting participants for having null or limited *direct* contact with infants (i.e., infant novices), whereas it was investigated in Experiment 2 by contrasting search efficiency for adult and child faces in a group of adults with null or limited contact with children (i.e., child novices) and a group of experienced adults working full time as preschool teachers (i.e., child experts). Previous research has shown that preschool teachers recognize child faces more accurately than child novices (Harrison & Hole, 2009), have no discrimination or recognition advantage for adult faces compared with child faces (Harrison & Hole, 2009; Kuefner et al., 2008) and rely, to the same extent, on configural/holistic strategies to process both face types (de Heering & Rossion, 2008; Kuefner et al., 2008, 2010).

On the basis of existing evidence, different predictions can be made. If the mirror pattern of recognition and categorization effects observed for happy versus angry faces and for own-versus other-race faces is a manifestation of a broader phenomenon which holds for different face attributes, including age, novice participants in Experiment 1 and 2 should manifest a visual search asymmetry in favor of infant and/or child faces, whereby the efficiency of the search would be greater for these faces than for adult faces. This prediction applies in particular to Experiment 1 if the so-called "baby schema" effect in the automatic allocation of attention (Brosch et al., 2007; Hodsoll et al., 2010) generalizes also to the deployment of selective attention to faces of different ages. Alternatively, if the influence of face age on attention deployment parallels the effects that this face attribute has on face recognition, we would expect to find a search asymmetry in favor of own-age adult faces in novice participants in Experiments 1 and 2, but not in the teachers in Experiment 2. The comparison between performance of novice and experienced participants in Experiment 2 will allow us to determine whether perceptual expertise has any impact on the extent to which face age engages mechanisms of selective attention.

Experiment 1

The aim of Experiment 1 was to investigate whether adults' efficiency in searching for an own-age adult face among infant faces differed from efficiency of the search for an infant face among adult faces. To this end, adults with limited experience with infants were tested in a visual search task with adult and infant faces.

Method

Participants. The final sample included 20 young adults (15 females; *M* age = 21.75 years, *SD* = 2.79 years). One participant was excluded from the sample because he or she manifested extremely low ($<$70%) search accuracy in one of the experimental conditions. Participants were either undergraduate or graduate university students receiving course credits or recruited from the community by word of mouth on a voluntary basis. They were asked to participate if they had no offspring and had not acquired extensive experience with infants (i.e., 2 years or younger). To this end, potential participants were screened prior to testing via a questionnaire that included specific inquiries aimed at assessing whether, in the past five years, they had had nieces or nephews, contact with infants of friends or acquaintances, and/or a job (full-time or otherwise) that put them in contact with infants. Inclusion criteria were modeled after Kuefner et al. (2008) (i.e., less than 520 hr of experience per year in the past 5 years). All participants had normal or corrected-to-normal vision.

All procedures used in the current study complied with the Ethics Standards outlined by the Declaration of Helsinki (BMJ 1991; 302: 1194) and were approved by the Ethics Committee of the University of Milano-Bicocca. All participants signed an informed consent before testing.

Stimuli. Six gray scale photographs of three adult (20–30-year-old) female faces and three newborn infant faces displaying a full-front neutral expression with open eyes served as stimulus materials. Stimuli were selected from the same pool of adult and infant faces employed in previous studies showing an OAB in adults' recognition (e.g., Kuefner et al., 2008; Macchi Cassia, Kuefner, et al., 2009, Macchi Cassia, Picozzi, et al., 2009). Faces were equalized for luminance and contrast using Photoshop, they were cropped in a standard oval subtending a visual angle of 4.8°

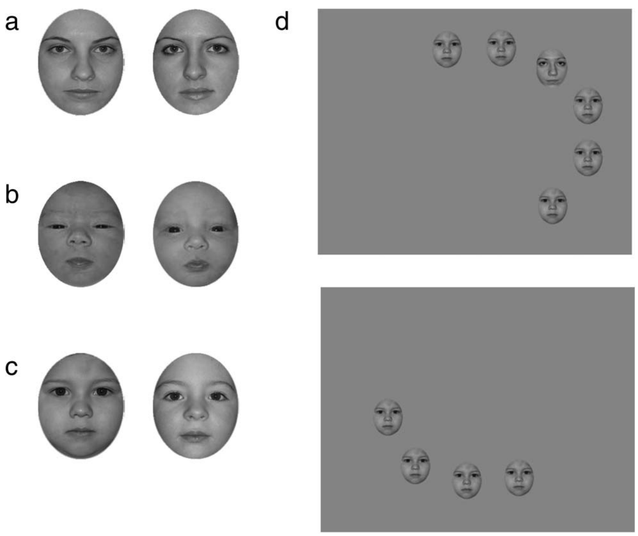

Figure 1. (a) Examples of the adult face stimuli used in Experiments 1 and 2, (b) the infant face stimuli used in Experiment 1, and (c) the child face stimuli used in Experiment 2. Panel (d) shows an example of a target present search display with six elements (top) and a target absent search display with four elements (bottom). The individuals (or parents of the infants-children) whose faces appear here gave signed consent for their likenesses to be published in this article.

horizontally and 5.7° vertically, and dropped in a gray background (Figure 1). An attempt was made to match faces based on subjective criteria of overall similarity to generate three adult-infant stimulus pairs, one used for practice trials and the other two for test trials, with stimulus pair counterbalanced across participants. Thus, the mapping of stimuli to target and distractors was fixed within the task for each participant. Faces from each pair were presented within arrays composed of 2, 4, 6, or 8 elements located contiguously in one of 12 possible locations, equally spaced (6.7°) along a circle 12.4° in diameter centered on the fixation cross (see Figure 1). For each set size there were four possible arrays, two displaying only the adult or the infant face (i.e., target absent), and the other two displaying the infant face as background and the adult face as the target or the reverse (i.e., target present). The target was equally likely to appear in each location within the target present arrays.

Apparatus and procedure. Participants were tested individually in a quiet, darkened room while seated 60 cm from a 15.4-in. Toshiba color LCD monitor that was used to display the stimuli. Viewing distance was controlled at the beginning of the experiment and checked at the beginning of each block of trials. The task was implemented using E-Prime 2.0 software. Participants were instructed to determine whether an adult or infant face was present as quickly as possible without sacrificing accuracy. Then they saw an instruction screen indicating which face was the target and which was the distractor for the upcoming block of trials. Each trial began with a black fixation cross (0.6° × 0.6°) that appeared in the center of the screen and remained visible throughout the trial. Participants were instructed to keep their eyes focused on the cross until the stimulus array appeared, 500 ms after the cross. The search display remained on the screen until the subject pressed one of two possible keys on the keyboard to indicate whether the target was present or absent. After giving each response, the subjects received feedback in the form of a 330-ms green screen for correct responses and a 330-ms red screen for incorrect responses. The intertrial interval was 1,000 ms.

Participants completed two blocks of trials, one with the adult face as the target and one with the infant face as the target. The order of the blocks was counterbalanced between subjects. There were 96 trials in each block, for a total of 192 experimental trials. In addition, the subjects completed 24 practice trials before beginning each block. On each trial, either the stimulus pair, the presence or absence of the target and the set size of the display were chosen randomly, with a 50% probability of either Stimulus Pair 1 or 2 and a target absent or a target present trial and a 25% probability of a display with 2, 4, 6, or 8 items. Only data from experimental trials were analyzed.

Results

Since in our paradigm the search display remained visible until the response was given, the dependent variable of choice are reaction times (RTs; Wolfe, 1998). Analyses of accuracies are included for completeness. Median RTs for correct responses (Figure 2) and mean accuracy (proportions correct) (Figure 3) were calculated for each subject separately for target-absent and target-present trials of each face age condition as a function of set-size.

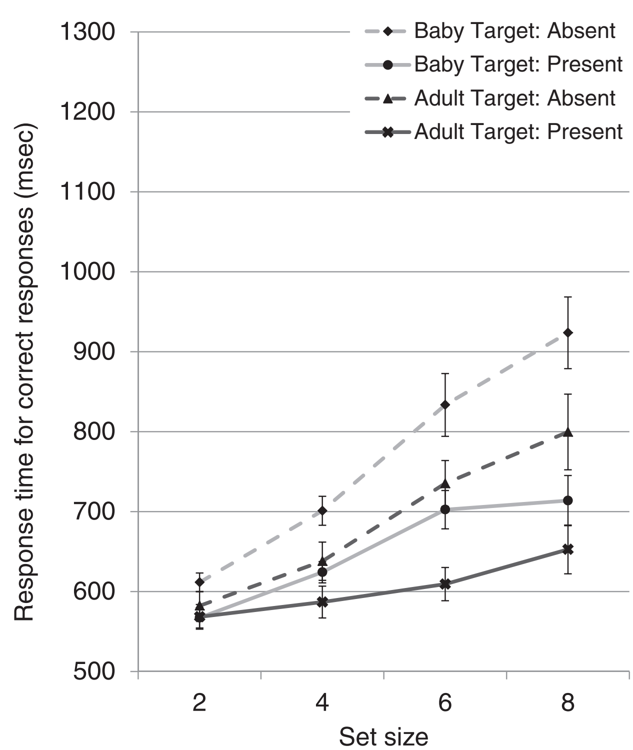

Figure 2. Median reaction times (RTs) as a function of set size describing participants' search for an adult face among infant faces, or vice versa, in the target present and target absent conditions of Experiment 1. Note that statistical analyses were performed on the slopes of RT × Set Size function calculated for each participant in each condition. Error bars represent standard errors of the means.

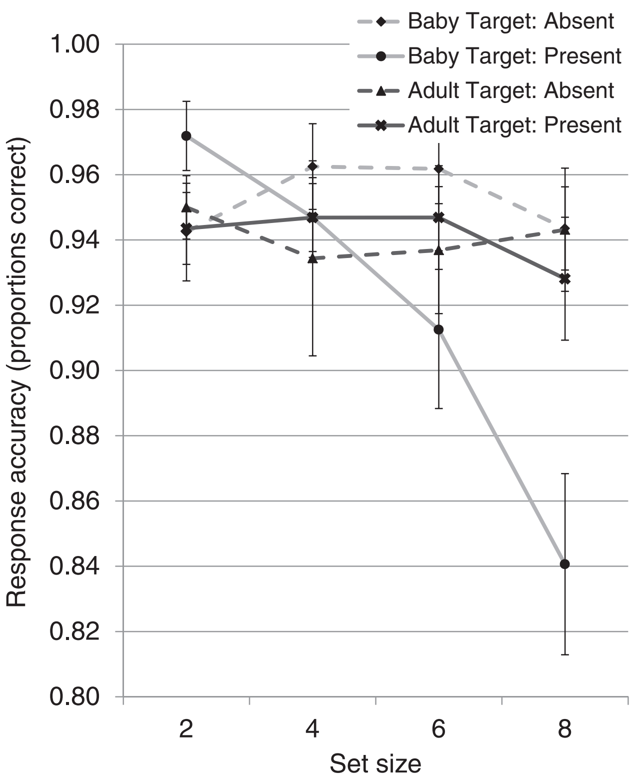

Figure 3. Mean accuracy (proportions correct) as a function of set size describing participants' search for an adult face among infant faces, or vice versa, in the target present and target absent conditions of Experiment 1. Note that statistical analyses were performed on the slopes of Accuracy × Set Size function calculated for each participant in each condition. Error bars represent standard errors of the means.

Reaction times. As a measure of search efficiency we computed and analyzed the slope of the RTs × Set Size function, which provides an estimate of the search in terms of items per unit time (i.e., the steeper the slope, the less efficient the search; Wolfe, 1998). After examining the normality of the distribution of the residuals (Kolmogorov–Smirnov one-sample test, $p > .14$), we conducted a preliminary analysis of variance (ANOVA) on search slopes with target presence (present, absent) and target face age (adult, infant) as within-subjects factors and order (adult target first, infant target first) and stimulus pair (Pair 1, Pair 2) as additional between-subjects factors. There were no significant main effects or interactions involving order or stimulus pair ($ps > .32$). Therefore, data were collapsed across these factors in a subsequent two-way ANOVA, which revealed significant main effects of both target presence, $F(1, 19) = 48.291$, $p < .001$, $\eta_p^2 = .718$, and target face age, $F(1, 19) = 32.135$, $p < .001$, $\eta_p^2 = .628$. As shown in Figure 2, search slopes were steeper on target-absent trials ($M = 45.46$ ms/item) than target-present trials ($M = 19.83$ ms/item), irrespectively of the age of the target face, and were steeper for infant targets ($M = 39.67$ ms/item) than for adult targets ($M = 25.62$ ms/item) across both target-present and target-absent trials. The interaction between the two factors was not significant ($p > .55$).

Accuracy. The slopes of the Accuracies (proportions correct) × Set Size function were computed and subsequently analyzed in a preliminary four-way ANOVA with target presence (present, absent) and target face age (adult, infant) as within-subjects factors and order (adult target first, infant target first) and stimulus pair (Pair 1, Pair 2) as additional between-subjects factors. Since there were no significant effects of order and stimulus pair ($ps > .18$), data were collapsed across these factors in a subsequent two-way ANOVA. The analysis revealed significant main effects of target face age, $F(1, 19) = 7.707$, $p = .012$, $\eta_p^2 = .289$, and target presence, $F(1, 19) = 12.682$, $p = .002$, $\eta_p^2 = .400$, as well as a significant Target Face Age × Target Presence interaction, $F(1, 19) = 6.303$, $p = .021$, $\eta_p^2 = .249$, indicating more efficient search for adult targets than infant targets on target present trials, $t(19) = 3.517$, $p = .002$, (see Figure 3).

Discussion

Results showed that search efficiency, as measured by the slope of RTs per set size function, varied as a function of the age of the target face, suggesting the presence of a search asymmetry driven by face age. Specifically, although in both the adult target and baby target conditions searches depended on the number of distractors, the slopes were less steep for the search of an adult face among baby faces than vice versa, indicating that search asymmetry was in favor of adult faces. This was true on target-present trials as well as on target-absent trials, indicating that participants were not only faster at detecting an adult face among baby faces (on adult present trials) than vice versa, but also faster to disengage attention from baby face distractors while searching for an adult target (on adult absent trials) than from adult face distractors while searching for a baby target. Importantly, because our experimental procedure maximizes distractors and target homogeneity and holds distractors and target similarity constant by using a single exemplar of each age category across trials, the observed difference in search time for adult and baby target faces reflects a true search asymmetry (Duncan & Humphreys, 1989), which is indicative of preferential detection of own-age faces.

Although accuracy rate was not the measure of interest in our visual search task due to the extended presentation duration of the search display, which makes RTs the variable of choice (Wolfe, 1998), the analyses performed on the slopes of the Accuracies × Set Size function confirmed the effects obtained for RTs, since participants were more accurate at searching for adult targets than infant targets on target present trials.

The finding of a search advantage for own-age faces is at odds with the other-race detection advantage found in studies investigating adults' search asymmetries for faces of different races (e.g., Levin, 1996, 2000; Levin & Angelone, 2001; Lipp et al., 2009). Unlike race, face age appears to influence attention deployment in the same way that it affects identity discrimination and recognition, own-age faces being more easily detected and more difficultly rejected than other-age faces during visual search.

The current demonstration of a search advantage for own-age faces in participants selected for having very limited experience with other-age faces converges with earlier demonstration of a search advantage for objects of expertise in bird and car experts (Hershler & Hochstein, 2009). When considered together, these findings suggest that participants' familiarity with the search target may influence the deployment of attention, in the form of an enhanced attentional response toward the more familiar target compared with the less familiar one. Crucially, in the study with bird and car experts the two participants' groups searched exactly the same displays but reacted differently according to their prior experience with exemplars of the target versus distractor category. Accordingly, more critical to the role of stimulus familiarity in the search advantage for own-age faces observed in Experiment 1 would be evidence from adult individuals differing in the amount of experience accumulated with nonadult faces.

To this end, in Experiment 2 we compared the efficiency of the search for an adult face among child faces with that for a child face among adult faces in a group of adults with limited experience with children (i.e., novice group) and a group of preschool teachers (i.e., experienced group) working full time with young children. If experience and stimulus familiarity contribute to the search advantage for own-age faces, we expected to find a search advantage for adult faces over child faces in novice participants, but no search advantage in preschool teachers. If, on the contrary, preschool teachers maintain a search advantage for adult faces, it could be claimed that such an advantage relies on low-level stimulus properties that differentiate adult from child faces.

Experiment 2

Method

Participants. Subjects included 40 adult women of Caucasian origins, 20 in the *experienced* group (M age = 46.8 years, SD = 10.97 years) and 20 in the *novice* group (M age = 31.2 years, SD = 15.22 years). Three additional participants were tested but excluded from the analyses because they manifested extremely low (<70%) search accuracy in one of the experimental conditions. The experienced group consisted of teachers recruited from a local preschool. They were asked to volunteer if they worked full time in school and were selected on the basis of their reports of having been in contact with children between the ages of one and six years in their current work environment for about 25 hours per week (M = 24.74 hours, range = 12.5–25.0 hours) for at least two years (M = 25.3 years, range = 2–40 years), according to the same criteria previously used by Kuefner et al. (2010). Fifteen teachers had at least one child of their own, who, in three cases, was 6-years-old or less. Women in the novice group were either undergraduate or graduate university students receiving course credits or recruited from the community by word of mouth on a voluntary basis. They were selected for having limited experience with children (i.e., 1–6 years) according to the same criteria used in Experiment 1 (Kuefner et al., 2008). Participants in both groups had normal or corrected-to-normal vision.

Stimuli. Stimulus material consisted of six gray scale photographs of three adult (20–30-year-old) female faces, and three child (3–4-year-old) faces displaying a full-front neutral expression with open eyes, taken from the same pool of adult and child face stimuli employed in previous studies showing an OAB in adults' recognition (e.g., Kuefner et al., 2008; Macchi Cassia, Pisacane, & Gava, 2012) (see Figure 1). Adult faces were different from those used in Experiment 1. Photographs were manipulated and search arrays were constructed in the same way as in Experiment 1.

Apparatus and procedure. Participants were tested in the same manner as in Experiment 1.

Results

As in Experiment 1, the dependent variable of choice are RTs (Wolfe, 1998) and analyses of accuracies are included for completeness. To this aim, median RTs for correct responses (Figure 4) and mean accuracy (Figure 5) were computed in the same manner as in Experiment 1.

Reaction times. Similarly to Experiment 1, we computed and analyzed the slope of the RTs × Set Size function as a measure of search efficiency. Normality of the distribution of the residuals was examined for each participant group via the Kolmogorov–Smirnov one-sample test ($ps > .08$). A five-way ANOVA with participant group (novice, experienced), order (adult target first, infant target first) and stimulus pair (Pair 1, Pair 2) as between-subjects factors and target presence (present, absent) and target face age (adult, child) as within-subjects factors revealed significant main effects of both target presence, $F(1, 32) = 102.995$, $p < .001$, $\eta_p^2 = .763$, and participant group, $F(1, 32) = 6.872$, $p = .013$, $\eta_p^2 = .177$, suggesting that search slopes were steeper on target-absent trials (M = 155.20 ms/item) than on target-present trials (M = 71.38 ms/item), and were steeper for participants in the experienced group (M = 134,22 ms/item) than for subjects in the novice group (M = 93,36 ms/item). The factor stimulus pair showed significant interactions with target face age, $F(1, 32) = 6.475$, $p = .016$, $\eta_p^2 = .168$, and with target face age, order, and target presence, $F(1, 32) = 5.819$, $p = .022$, $\eta_p^2 = .154$. Post hoc Bonferroni corrected t tests revealed that participants who were tested with Stimulus Pair 1 and viewed child target trials first, showed higher search efficiency for adult compared with child target faces on target absent trials, $t(11) = 4.128$, $p = .002$. No other comparison attained statistical significance ($ps > .16$). Importantly, there were also two significant interactions involving the factor participant group: Target Presence × Participant Group, $F(1, 32) = 4.228$, $p = .048$, $\eta_p^2 = .117$, and Target Face Age × Target Presence × Participant Group, $F(1, 32) = 7.006$, $p = .012$, $\eta_p^2 = .180$, suggesting that face age affected search efficiency differently for the novice and the experienced participants. To follow up on these interactions, we performed two separate four-way ANOVAs, one for each participant group. Like in Experiment 1, for the novice group there were significant main effects of target presence, $F(1, 16) = 32.300$, $p < .001$, $\eta_p^2 = .669$, and target face age, $F(1, 16) = 5.843$, $p = .028$, $\eta_p^2 = .267$, indicating that novices' search was overall more efficient on target present trials (M = 58.94 ms/item) compared with target absent trials (M = 125.78 ms/item), as well as for adult targets (M = 84.38 ms/item) compared with child targets (M = 100.35 ms/item) (see Figure 3). For the experienced group, there was a main effect of target presence, $F(1, 16) = 77.276$, $p < .001$, $\eta_p^2 = .828$, confirming that for these participants visual search was also more efficient on target-present trials (M = 83.81 ms/item) than on target-absent trials (M = 184.62 ms/item). There were also three significant interactions involving the factor target face age: Target Face Age × Stimulus Pair, $F(1, 16) = 6.419$, $p = .022$, $\eta_p^2 = .286$, Target Face Age × Stimulus Pair × Target Presence, $F(1, 16) = 5.266$, $p = .036$, $\eta_p^2 = .248$, Target Face Age × Stimulus Pair × Target Presence × Order, $F(1, 16) = 8.351$, $p = .011$, $\eta_p^2 = .343$. All post hoc comparisons (Bonferroni corrected) failed to reach significance ($ps > .36$). Nevertheless, since our primary question concerned the effects of face age on teachers' performance, it is

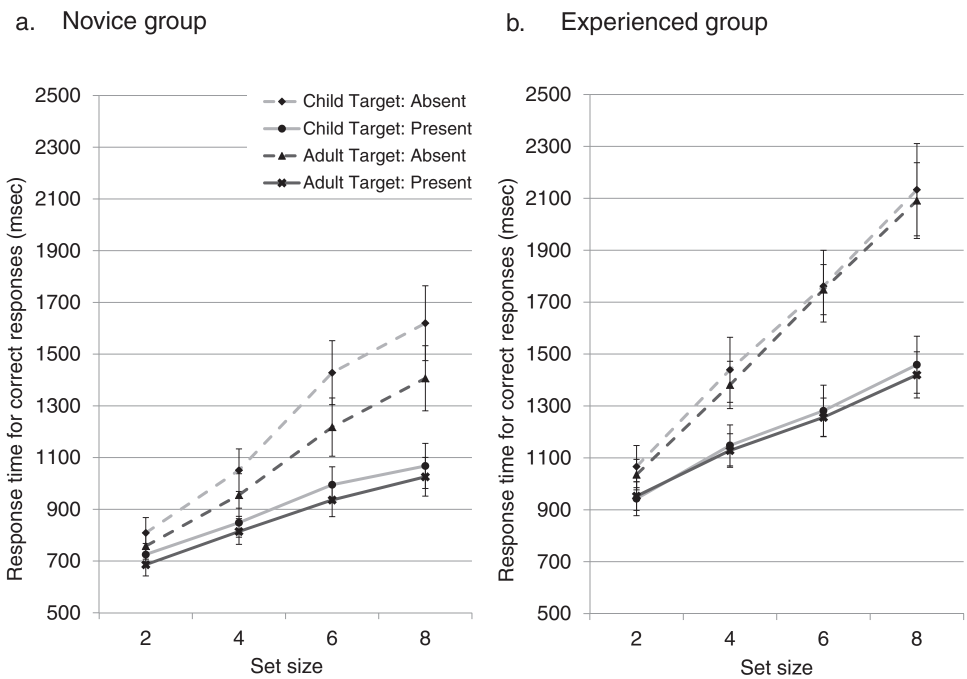

Figure 4. Median reaction times (RTs) as a function of set size for searches for an adult face among child faces, or vice versa, on target present and target absent trials for (a) the novice group and (b) the teachers tested in Experiment 2. Note that statistical analyses were performed on the slopes of RT × Set Size function calculated for each participant in each condition. Error bars represent standard errors of the means.

important to note that if a trend was present in the data, it was in an opposite direction with respect to the novices, since teachers' search on target-present trials was more efficient for child targets (M = 44.80 ms/item) than adult targets (M = 72.86 ms/item), when Stimulus Pair 2 was presented and adult target trials were administered first (p = .18), with no variations in search efficiency as a function of face age in all other conditions (p > .29) (see Figure 4).

Accuracy. Since preliminary analyses revealed no significant main effects or interactions involving order or stimulus pair (ps > .11), the slopes of the Accuracies (proportions correct) × Set Size function were entered into a three-way ANOVA with target presence (present, absent) and target face age (adult, infant) as within-subjects factors and participant group (novice, experienced) as between-subjects factors. The analysis revealed main effects of participant group, $F(1, 38) = 5.453$, $p = .025$, $\eta_p^2 = .126$, and target presence, $F(1, 38) = 25.020$, $p < .001$, $\eta_p^2 = .397$, since slopes were steeper for the novices compared with the teachers and for target-present than for target-absent trials. There was also a Target Face Age × Target Presence interaction, $F(1, 38) = 7.262$, $p = .010$, $\eta_p^2 = .160$, similar to the one found in Experiment 1, which was due to more efficient search for adult targets than child targets on target present trials, $t(39) = 2.107$, $p = .042$. Of note, participant group did not interact with any other factor (ps > .28) (see Figure 5).

Discussion

The goal of Experiment 2 was to provide direct evidence for the impact of experience acquired with individuals from different age groups on visual search efficiency for adult and nonadult faces. The comparison between visual search performance of novices and teachers showed that preschool teachers were overall slower in providing their response in comparison to the novices and showed overall steeper slopes, particularly on target-absent trials. This overall difference in task performance between the two groups is likely due to the teachers being slightly older than the novices (p = .001), since previous work has shown that older adults use a more careful search style compared with younger adults, and their search performance is particularly impaired when the target is absent and the search set size is large (e.g., Ho & Scialfa, 2002; Hommel, Li, & Li, 2004). The presence of a Target Presence × Participant Group interaction confirms that the teachers' search efficiency was particularly impaired as set size increased on target-absent trials, producing steeper search slopes compared with those exhibited by younger participants in the novice group.

More crucially, the presence of a Target Face Age × Target Presence × Participant Group interaction indicates that group differences in experience with children added to the effects of age differences, resulting in a modulation of the visual search asymmetry induced by face age. Results from the novice group replicated and extended those of Experiment 1, showing that slopes were steeper for the search of a child face among adult faces than vice versa, in the same way as they were steeper for the search of a baby face among adult faces than vice versa. Thus, like in Experiment 1, there was a search asymmetry in favor of adult faces, which more easily captured participants' attention on target-present trials and more strongly hold attention on target-absent trials.

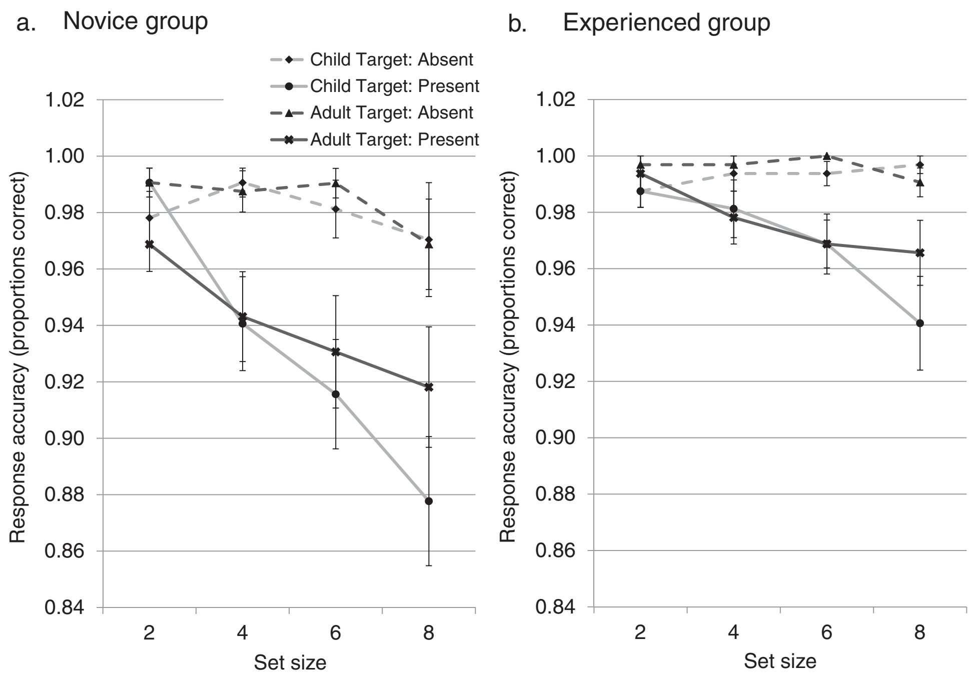

Figure 5. Mean accuracy (proportions correct) as a function of set size for searches for an adult face among child faces, or vice versa, on target present and target absent trials for (a) the novice group and (b) the teachers tested in Experiment 2. Note that statistical analyses were performed on the slopes of Accuracy × Set Size function calculated for each participant in each condition. Error bars represent standard errors of the means.

Results were critically different for the teachers, whose visual search performance was not affected by the target face age. Teachers were as fast when searching through child face distractors as when searching through adult face distractors, and as fast when rejecting child face distractors as when rejecting adult face distractors. Accuracy measures suggested an overall speed–accuracy trade-off in participants' performance, as the overall larger increase in RTs as a function of set size shown by the teachers, as compared with the novices, was paralleled by a larger decrease in accuracy as a function of set size for the novices as compared with the teachers. Nevertheless, such trade-off did not impact on our results since there were no group differences in the effects of face age on search accuracy. This indicates that, as expected based on the specific visual search paradigm we used with unlimited display presentation time, accuracy measures were simply less sensitive than RTs to the effects of experience with children.

Overall, results rule out the possibility that the search advantage for adult faces manifested by novice participants in both Experiments 1 and 2 relied on low-level stimulus properties that differentiate adult from nonadult faces. More importantly, by showing that a quantifiable amount of experience acquired with multiple child faces is capable of attenuating the detection advantage of own-age faces in adults, our findings point to the critical role of contact in modulating attentional responses to face age.

General Discussion

The present study showed, for the first time, that face age can act as an attentional guiding attribute in a visual search task, and that experience accumulated with a specific face age group affects how easily selective visual attention is deployed to those faces.

By comparing search efficiency for adult and baby faces (Experiment 1) and for adult and child faces (Experiment 2) in a visual search task in which face age was the relevant target feature, we provided consistent evidence for a detection advantage in favor of own-age faces in adults. Results from Experiment 1 contrast with earlier demonstrations of greater capturing effects for baby faces compared with adult faces (Brosch et al., 2007; Hodsoll et al., 2010; Proverbio et al., 2011; Thompson-Booth et al., 2014) in the automatic allocation of attention in tasks in which face age was irrelevant to the task and had not to be explicitly processed in order for the task to be performed. Although the biological relevance of baby faces for adult members of the species (e.g., Brosch et al., 2007) may explain these latter findings, it is more likely that the explicit request to process age-specifying information and the use of faces as the relevant, to-be-attended stimuli in our task has opened the gate to top-down influence on attentional control generated by stimulus familiarity and perceptual expertise, which overcame any "baby schema" effect. Such top-down influences may be related to motivational factors. In fact, it has been proposed that motivational mechanisms mediate the relationship between experience and perceptual expertise at processing faces, because people who have more frequent contact and thus are more familiar with individuals from specific groups may become more socially interested and motivated to attend to individuals from these groups to foster their interest (Hugenberg et al., 2010; Rodin, 1987).

The advantage of adult faces over infant and child faces in guiding the deployment of attention in participants selected for having limited experience with infant and children mimics the recognition advantage that participants selected according to analogous criteria exhibited for adult faces compared with infant (e.g., Kuefner et al., 2008; Macchi Cassia, Kuefner, et al., 2009) and child (Kuefner et al., 2008) faces. This similarity suggests that analogous mechanisms may underlie the recognition and the detection effects induced by face age. Although it has been speculated that social–cognitive mechanisms, similar to those contributing to the own-race bias (ORB; see Young, Hugenberg, Bernstein, & Sacco, 2012), may also contribute to the OAB (e.g., Hugenberg, Young, Bernstein, & Sacco, 2010), extant evidence indicates that the age bias is mediated by perceptual learning mechanisms, as reduced contact with other-age faces prevents adults from developing sensitivity to the same configural/featural cues that mediate their efficient recognition of overexperienced peer faces (e.g., Harrison & Hole, 2009; Kuefner et al., 2008).

Results from the novice groups tested in Experiments 1 and 2 are in apparent conflict with those obtained in a recent study by Neumann et al. (Neumann, End, Luttmann, Schweinberger, & Wiese, 2015) showing a detection advantage in favor of older adult faces among young adults. The authors tested participants' attentional responses to young and older faces in a variety of behavioral and event-related potential experimental paradigms, and found no evidence for an other-age attentional advantage if not a more accurate visual search for older target than young target faces. A number of important methodological differences between the current study and Neumann et al.'s study (e.g., presentation duration of the search display) may have contributed to the differences in the results. In addition, one may also claim that in-group/out-group boundaries between young and older adult faces are more clearly defined than those between adult and infant or child faces. We consider this possibility unlikely for several reasons. First, young and older adults all belong to the wider category of grown-up individuals, which does not include infants and young children. Second, even in the absence of specific experience, young adults have likely more contact and passive exposure to older people than to infants and young children, so there is no reason to assume that infant and child faces should fit more familiarity-based inclusion criteria for in-group/out-group segregation than older adult faces. Third the literature on the OAB in face recognition does not provide indications that the bias is stronger or more stable when assessed in relation to older adult faces as compared with infant or child faces (see review by Rhodes & Anastasi, 2012; Wiese et al., 2013). On this basis, we do not see specific reasons why adult participants should perceive older adult faces as more of an out-group than infant and child faces. Rather, it is possible that the search advantage for older target faces reported by Neumann et al. (2015) is due to participants' reliance on featural cues inherent to older faces morphology, such as skin texture and wrinkles, which may have enhanced attentional selection in the search for older targets.

The role of perceptual learning mechanisms and stimulus familiarity in the own-age detection bias observed in the current study is confirmed by the finding that the preschool teachers tested in Experiment 2, who accumulated a great deal of recent experience with children, did not show the same search asymmetry in favor of adult faces shown by novice participants. Rather, they were equally good at searching for a child face among adult face distractors as they were at searching for an adult face among child face distractors. Because the two participants' groups viewed exactly the same stimuli and were tested under the same exact conditions, any bottom-up processing effects evoked by stimulus material were identical, with expertise remaining the most plausible source of the observed difference in groups' performance. As an alternative interpretation, one could still argue that, as a result of their job experience, the teachers may be more socially interested in children, or more prone to include children in their social in-group representation, and thus may have a higher motivation to search for child faces compared with the novices. The present findings do not allow us to distinguish between these two possibilities, and further research is required to evaluate the impact of motivational factors and/or in-group/out-group categorization mechanisms on selective attentional responses to faces.

Quite interestingly, our finding of preferential detection of own-age faces in adults contrasts with evidence of preferential detection of other-race faces in visual search tasks (Levin, 1996, 2000; Levin & Angelone, 2001). Recent research has shown that methodological variations related to stimulus presentation, such as the degree of perceptual similarity between own- and other-race faces (Levin & Angelone, 2001) or participants' ethnicity (Chiao et al., 2006), can modulate the search asymmetry, up to the point of eliminating the advantage for other-race faces. In particular, the search asymmetry flips in favor of own-race faces if more than one exemplar is used per category and the nature of target and distractor stimuli varies across trials (Lipp et al., 2009). The procedure used in the present study was modeled on Levin's (2000) original research reporting preferential detection of other-race faces among own-race faces, since it employed a fixed mapping of stimuli to target and distractors by testing each participant with a single exemplar face per age category. Thus, our finding of preferential detection of own-age faces emerged under the same task conditions in which preferential detection of other-race faces is evident.

Levin's findings were interpreted, together with the widely reported other-race advantage in face categorization (e.g., Caldara et al., 2004; Ge et al., 2009), as evidence that race-specifying information is spontaneously coded in other-race faces at the expense of individuating information (Levin, 1996, 2000), thus making race categorization of other-race faces faster than categorization of own-race faces. Our data suggest that a similar feature-selection model cannot be generalized to age biases, because the detection advantage in our visual search task was in favor of own-age faces, and not of other-age faces. We propose that there are important differences in the way race and age information are processed and represented in adults' memory, which may explain the difference between the current findings and those found in race studies.

One important difference relates to the characteristics of race and age experience across the life span. Because one's own age, unlike race, continuously changes, as does the age of faces to which one is primarily exposed, age experience is less stable than race experience across an individual's life span. Indeed, although by the end of the first year of life infants show better discrimination of own-race compared with other-race faces (e.g., Kelly et al., 2007) as well as better discrimination of adult faces compared with infant faces (Macchi Cassia, Bulf, Quadrelli, & Proietti, 2014), by the time they've grown into young adults they typically show a recognition bias favoring peer faces (see review by Rhodes & Anastasi, 2012). In contrast, the direction of the ORB typically remains unchanged from infancy to adulthood (see review by Meissner & Brigham, 2001). This and other evidence (e.g., Hills & Lewis, 2011; Macchi Cassia, Picozzi, et al., 2009) indicates that the individual's face representation constantly adapts to continuous changes in age experience that naturally occur across the life span, whereas, under typical conditions, this does not happen for race experience. As a consequence, it is possible that the proposed difference in perceptual processing strategies for own- and other-race faces (Hugenberg, Miller, & Claypool, 2007, but see Rhodes, Locke, Ewing, & Evangelista, 2009 for an alternative account) does not hold in the same way for own- and other-age faces, and this could explain why other-age faces do not elicit a search advantage as other-race faces do.

A second possible difference in how race and age information are processed relates to the impact of social-cognitive and motivational factors on such processing (Hugenberg et al., 2010; Sporer, 2001). A variety of findings in the social cognition literature converges on the hypothesis that members of social groups distinctly apart from one's own are processed more at the category level than as individuals (e.g., Bernstein, Young, & Hugenberg, 2007). However, although research has shown that social categorization mechanisms play a role in driving the recognition advantage for own-race faces (e.g., Cassidy, Quinn, & Humphreys, 2011; Freeman, Penner, Saperstein, Scheutz, & Ambady, 2011; Lebrecht, Pierce, Tarr, & Tanaka, 2009), there is currently no evidence that these same mechanisms are at play in the case of the OAB. Indeed, it is likely that continuous variations in one's own age and in the age of the faces to which one is primarily exposed change the individual's manner of self-categorization across the life span. Thus, even assuming that age is a facial attribute that induces social categorization, it is likely that in-group/out-group boundaries are less defined and the distance between the members of the two groups smaller when the critical feature is age as opposed to race. Again, within the framework of social-cognitive theories of face processing biases (see review by Young et al., 2012), this could explain why the search advantage for other-race faces does not generalize to other-age faces.

In conclusion, the present study is the first to show that own-age faces enjoy an advantage in driving adults' allocation of selective visual attention as measured by visual search tasks, and that experience acquired with a specific face age group has a critical role in driving this attentional advantage. By showing that the detection advantage is toward own-age faces, rather than other-age faces, our results suggest that the mirror pattern of recognition and categorization effects observed for own-versus other-race faces does not generalize to age biases. A goal for future studies will be to test whether this pattern of results holds when adults' proficiency at categorizing own- and other-age faces is tested more directly in a categorization task.

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