Age-related Differences in Processing Face Configuration: The Importance of the Eye Region

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Objectives. Recent research suggests that older adults have difficulties with aspects of configural face processing. The present study examined whether age-related declines in sensitivity to configural face information are dependent on the face region in which configural changes occur.

Method. Younger and older adults completed a face-matching task that required the detection of configural manipulations to either the eye or the mouth regions of target faces.

Results. Age-related declines in the ability to detect configural changes were found when the eye region of the face was modified. Importantly, no age-related differences were evident when perceiving similar changes to the mouth region.

Discussion. Taken together, these findings suggest that age-related differences in sensitivity to configural information are specific to the eye region of the face. The potential implications of these findings for age-related difficulties in interpreting social cues from the eyes are discussed.

Key Words: Aging—Configural processing—Face features.

INTRODUCTION

Faces provide perceivers with a wealth of socially relevant information about another person’s identity, age range, sex, emotion, and direction of attention. Despite their social importance there is evidence of adult age-related declines in many aspects of face processing, including face detection (Norton, Mc Bain, & Chen, 2009) and identification (Searcy, Bartlett, & Memon, 1999). Older adults also have problems decoding facial cues to emotion (Richter, Dietzel, & Kunzmann, 2011; Sullivan, Ruffman, & Hutton, 2007), eye-gaze direction (Slessor, Laird, Phillips, Bull, & Filippou, 2010; Slessor, Phillips, & Bull, 2008) and threat (Ruffman, Sullivan, & Edge, 2006).

The ability to extract configural information from faces (i.e., the position of facial features and the relational distance between them) has been linked to successful face recognition (Gauthier & Tarr, 1997, but see also Konar, Bennett, & Sekuler, 2010) and decoding of emotional expressions and eye-gaze direction (Chambon, Baudouin & Franck, 2006; Senju, Kikuchi, Hasegawa, Tojo, & Osanai, 2008). Murray, Halberstadt and Ruffman (2010) assessed adult age-related differences in processing the global configuration of faces using the Thatcher Illusion, in which only the eyes and mouth are inverted in an otherwise upright face. This image appears bizarre when presented in upright orientation but once inverted looks “normal” as configural processing is disrupted. Compared with younger participants, older adults rated upright and inverted Thatcherized faces as looking less bizarre, indicating a decline in sensitivity to configural information in faces with age.

In Murray and colleagues (2010) configuration of both the eyes and the mouth were manipulated simultaneously. However, for several aspects of face processing, such as decoding identity, locus of attention, and many emotions, the eyes of the face may be more salient and important than the mouth (see Itier & Batty, 2009). To explore feature use and salience, further research has modified the configuration of the eyes and the mouth independently, by either changing the spacing between the eyes or the position of the mouth (Ribi, Doherty-Sneddon, & Bruce, 2009; Rutherford, Clements, & Sekuler, 2007). When completing a same/different face-matching task using these stimuli individuals with autism were found to have specific difficulties detecting configural manipulations made to the eye region. This finding is consistent with suggestions that individuals with autism avoid eye contact with others and have problems decoding social cues from the eyes (Ribi & Doherty, 2009).

Intriguingly, there is evidence to suggest that the propensity to direct one’s attention to the eye region of a face is something that might also vary with age. Older adults focus less than younger participants on the eyes when viewing faces and have particular difficulties detecting communicative cues from the eye region (Slessor et al., 2012; Sullivan et al., 2007). Therefore age differences in decoding configural information may be most pronounced for eye region of the face.

Interestingly, Chaby, Narme, and George (2011) found that older adults had difficulties detecting configural manipulations (changing the distance between the eyes) to the eye region but no problems when modifications were...
made to both the eyes and mouth (moving these closer together or further apart). However, this task involved matching two faces, presented one after the other for a limited time period and thus relied on working memory and processing speed, which are known to decline with age (Phillips & Henry, 2008). Furthermore, as both the eyes and mouth were manipulated simultaneously in one condition, it was not possible to assess whether age-related declines in configural processing were specific to the eye region.

The aim of the current study was to examine whether age-related differences in the ability to process second-order configural information (distance between facial features) from faces vary between the eye and the mouth region of the face. Participants were required to detect configural modifications made separately to either the eye or the mouth regions by completing a face-matching task (Riba et al., 2009). To reduce working memory and processing speed demands, the faces were presented side by side for an unlimited period of time. We predicted that adult age-related differences in this task would be greatest when detecting configural manipulations made to the eye region of the face.

**Method**

**Participants**
Forty young adults (35 women) aged 18–31 ($M = 20.75$, $SD = 2.69$), and 36 older adults (30 women) aged 60–88 ($M = 73.36$, $SD = 7.08$) were recruited. Both younger and older participants had normal or corrected to normal vision. All older adults had normal mental status, achieving a score of 42 or greater ($M = 47.25$) on the “Test Your Memory” assessment (Brown, Pengas, Dawson, Brown, & Clatworthy, 2009).

**Stimuli and Procedure**
The stimuli comprised colored images ($11° \times 11°$) of the faces of four unfamiliar people (two women). Copies of each face identity were digitally manipulated to create additional images that differed in the configuration of the eye or mouth regions. In the eye condition, configural manipulations were made by moving the eyes closer together or further apart by $0.4°$, whereas in the mouth condition, the mouth was moved higher or lower by $0.26°$ (for more detailed information on stimuli creation, see Riby et al., 2009).

Face images (and their components) were presented in an upright orientation and in face pairs. In the “same trial” condition the face pairs were identical (i.e., same identity, same face configuration). In the “different trial” conditions the face pairs differed in their configuration (i.e., same identity, different face configuration). Each pair of faces was presented side by side on the computer in a random order, remaining onscreen until a response was made. For “different trials” location of the modified face was counterbalanced. There were 64 “same” and 64 “different” trials in total. Participants were asked to indicate, with a key press, as quickly and accurately as possible whether these two photos were identical or different.

**Results**
Hit and false alarm rates were calculated for the eye and mouth region conditions (hits were defined as correctly categorizing face pairs as different; false alarms were defined as identifying same face pairs as different) and used to calculate estimates of sensitivity to discriminate between same and different pairs and response bias for each age group. Two mixed-design analyses of variance with one within-subjects factor, feature condition (eyes vs. mouth), and one between-subjects factor, age group (young vs. older), were carried out separately for estimates of sensitivity and response bias. Analysis of estimates of sensitivity (see Figure 1A) revealed a main effect of feature condition, $F(1, 74) = 22.84$, $p < .001$, $\eta^2_p = 0.24$, such that overall performance was significantly better in the mouth ($d' = 2.20$) than in the eyes condition ($d' = 1.61$). There was also a significant main effect of age group, $F(1, 74) = 11.54$, $p < .001$, $\eta^2_p = 0.14$, with younger adults...
(d’ = 2.27) outperforming older participants (d’ = 1.53) on the task. These results were qualified by a significant feature condition × age group interaction, F(1, 74) = 31.50, p < .001, ηp2 = 0.30.

Independent samples t tests revealed that older adults were less sensitive than younger adults at detecting when configurational differences had been made to the eye region, t(74) = 5.89, p < .001, d = 1.37. In contrast, there was no significant age difference in the mouth condition, t(74) < 1, d = 0.05. Paired samples t tests revealed that older adults were significantly more accurate at detecting configurational changes made to the mouth than those made to the eyes, t(35) = 6.02, p < .001, d = 1.00. However, no significant difference was found between younger adults’ estimates of sensitivity in the two feature conditions, t(39) < 1, d = 0.12.

For estimates of response bias (see Figure 1B), there was a significant main effect of feature condition, F(1, 74) = 20.65, p < .001, ηp2 = 0.22, with participants having a greater bias towards responding “different” in the mouth (B’D = –0.40) than eye (B’D = –0.12) condition. There was no main effect of age group, F(1, 74) = 3.29, p = .07, ηp2 = 0.04, but a significant feature condition × age group interaction was found, F(1, 74) = 29.74, p < .001, ηp2 = 0.29. Independent samples t tests revealed that older adults showed a greater bias towards responding “same” than younger participants in the eye-region condition, t(74) = 4.13, p < .001, d = 0.96. However there were no significant age differences in response bias in the mouth condition, t(74) = 1.30, p = .20, d = 0.30.

**Discussion**

Older adults were significantly less sensitive than younger participants to variations in the configuration of the eye region. This was also reflected in an age-related increase in the bias towards responding “same” in the eye-region condition. Importantly, no such age differences were evident when perceiving similar changes in the mouth. Furthermore, older adults found it significantly easier to detect configurational manipulations in the mouth than in the eyes. Therefore age-related differences in sensitivity to configurational information seem to be specific to the eye region.

Previous research investigating age-related differences in the use of information from the eyes has concentrated on the interpretation of communicative cues (Slessor et al., 2011; Sullivan & Ruffman, 2007). The current study contributes to this growing body of literature by finding evidence of specific age-related deficits in extracting meaningful cues from the eyes when completing a face-matching task that is not reliant on social cue decoding. Decoding information from the eyes is central for recognizing and identifying others (Itier & Batty, 2009). Age-related difficulties in extracting this information could thus have implications for older adults’ ability to recognize individuals, a skill that is crucial in situations such as eye witness identification.

Unlike previous findings in children (Riby et al., 2009), younger participants did not show an advantage for detecting configurational manipulations made to the eyes (vs. the mouth). However, younger participants performed extremely well in both conditions and therefore the task may have lacked sensitivity to detect subtle differences in their ability to extract information from different face regions. Nevertheless, the finding of large age-related differences in encoding configurational information from the eye region suggests that in later life the eyes become a less salient facial feature and older adults have problems decoding information from this region. This finding may relate to age-related deterioration in the Superior Temporal Sulcus and the amygdala (Allen, Bruss, Brown, & Damasio, 2005), known to be involved in decoding information from the eyes (Itier & Batty, 2009).

However, in the current study, vertical configurational modifications were made to the mouth, whereas the configuration of the eye region was manipulated horizontally. Consequently, it could be argued, as in Chaby and colleagues (2011), that older adults have specific problems detecting horizontal configurational manipulations, perhaps related to age-related declines in making horizontal, but not vertical, saccades. However, accuracy in making relatively small (<15°) vertical or horizontal saccades, such as those required to detect modifications in the present study, remains intact with age (Warabi, Kase, & Kato, 1984; Yang & Kapoula, 2008). Therefore, it seems more likely that the present findings are linked to age-related declines in extracting important information from the eyes. However in order to fully address this issue future research should investigate age-related differences in detecting vertical and horizontal configurational modifications made to the mouth and eyes, respectively.

Processing configurational facial information, and in particular the configuration of the eye region, has been argued to be important for interpreting a number of social cues from the face. For example, Jenkins and Langton (2003) found that processing the configuration of the eyes in relation to the rest of the face was particularly important for younger adults’ successful gaze perception. Therefore the effects of aging on interpreting communicative cues from the eye region, such as gaze and emotional expression, may be explained by these age-related deficits in the ability to process the configuration of the eyes in relation to the whole face. Further research including tasks assessing both social cognitive skills and configurational processing in the same sample of younger and older adults is required to directly address this issue.

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References