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Research report

Effects of aging and exposure duration on perceptual biases in chimeric face processing

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ABSTRACT

Experiments using chimeric faces, where the left and the right hand side of the face are different, have shown that observers tend to bias their responses toward the information on the left. Here we investigate the effects of aging as well as exposure duration on this leftward bias. Forty female and male blended as well as chimeric faces were presented to 24 young and 23 elderly adults in either sub-saccadic 100 msec, 300 msec or free view conditions. We found firstly that an increase in exposure duration resulted in an increase in the degree of leftward perceptual biases, irrespective of age, in line with hypotheses stressing the contribution of scanning to chimeric face processing. Secondly, fundamental differences in the perceptual biases between the groups were found in so far that the younger subjects demonstrated significant perceptual biases to chimeric face stimuli even at sub-saccadic exposure durations, whilst for older adults this was the case for the 300 msec and free view conditions only. This differential perceptual activity can be viewed in terms of either reduced right hemispheric function, or increased bilateral function as a possible consequence of elderly adults experiencing the task as more effortful.

1. Introduction

Since Wolff (1933) first observed that the right side of the human face, that is the side that falls in the *left* visual field during face to face encounters, shows more correspondence to 'the impression caused' by the full face, the finding of a robust *left* perceptual bias for chimeric images has been reported with chimeric stimuli employing emotion (David, 1993; Ferber and Murray, 2005), gender (Luh et al., 1991; Butler et al., 2005), age and attractiveness (Burt and Perrett, 1997). This effect is so robust that it can be demonstrated via the Internet (Rueckert, 2005) and even with inverted stimuli (Butler and Harvey, 2005).

It is generally assumed that these effects are due to a right hemisphere bias for face processing (Dutta and Mandal, 2002; Hugdahl et al., 1993; De Renzi et al., 1994; Rhodes et al., 1993). However, Vaid and Singh (1989) have argued that the finding may not purely reflect a right hemisphere processing advantage but rather an interaction between a long practised directional scanning bias of the participants and cerebral lateralisation. Partial support for this hypothesis comes from a recent study by Butler et al. (2005) in which chimeric faces were presented for 2 sec and subjects' eye movements were recorded. A clear relationship between the chimeric face bias and the eye fixation pattern was reported: on trials where participants showed a left perceptual face bias they produced

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significantly more left saccades and fixated for longer on the left side of the chimeric face.

However, Ferber and Murray (2005) published a prism adaptation study disputing any clear link between chimeric face bias and eye movement patterns: although they found a left eye movement bias with a left chimeric face bias, when eye movements were shifted to the right (using prism adaptation), they failed to observe a concurrent shift in the chimeric face judgements. From this finding, the authors argue that overt motor responses such as eye movements are not required in order to produce perceptual biases in chimeric face judgements.

Following their argument, if we were to exclude eye movements completely from the behaviour of our subjects, the perceptual bias should still be present and indeed David (1993), who employed stimuli that required an emotional judgement, reported a left field perceptual bias with chimeric face drawings exposed for 120 msec. Interestingly, Butler and Harvey (2006) have provided evidence that leftward perceptual biases to gender based chimeric images were significantly reduced when eye movements were not possible, compared to the bias obtained in the study in which exposure duration was 2 sec (Butler et al., 2005).

Therefore, in contrast to Ferber and Murray (2005), what we propose instead is that a systematic increase in presentation time should lead to a systematic increase in the left chimeric face bias provided the stimuli are presented long enough to allow eye movements. Thus in the present study we will address the influence of variable presentation durations, in order to examine the proposed modulation this will have on the degree of leftward perceptual biases obtained from chimeric face stimuli.

Secondly, the presented paradigm lends itself well to addressing the effects of healthy aging on face perception per se, and on perceptual biases to chimeric faces in particular, as there is converging evidence that tasks that selectively engage the right hemisphere may be executed in a different fashion in an elderly compared to a younger sample of subjects. Goldstein and Shelly (1981), studying a large, multiple age group population of medical and neuropsychiatric patients with a neuropsychological test battery, reported an increase in dysfunction of the right hemisphere with age, although they also reported evidence for a less robust pattern of results for the left hemisphere in the same direction. This theoretical point of view has been latterly described as the differential aging hypothesis. It has also been argued that the right hemisphere may in fact be more sensitive to the aging process. McDowell et al. (1994) conducted a study with older and younger adults requiring them to identify positive, negative and neutral emotional faces. Findings revealed that overall the younger subjects were more accurate, but that older adults were equally accurate for positive affect but impaired for negative and neutral affective facial expressions. Such a finding, if a lateralised benefit for valence processing is accepted, is very much in keeping with selective right hemisphere deterioration in older adults. However, less support was found in the second experiment using tachistoscopic, and lateralised, exposures of the same stimuli as this revealed that the older adults' performance was in keeping with a valence hypothesis, i.e., faster responses to angry faces in the left visual field and the opposite pattern for happy faces.

Cabeza (2002) has proposed an alternative account of the effect of the aging process on the brain, the hemispheric asymmetry reduction in older adults (HAROLD) model. The model primarily hypothesises that prefrontal cortex activity in older adults becomes less lateralised, possibly due to a combination of reduction in cognitive resources, cognitive speed, or a reduction in inhibitory control in older adults. The model differs from selective right hemisphere aging by also encompassing situations where older adults may display increased left or right hemispheric activity compared to younger adults in tasks that tend to be more lateralised in younger adults.

So far evidence for age related differences in paradigms involving chimeric faces has not been strong: Levine and Levy (1986) conducted a free vision smiling–neutral chimeric faces task with multiple age groups. They reported significant leftward perceptual biases across all groups, and no evidence of an effect of aging with the older adults on the degree of left perceptual bias obtained. Such findings are clearly not in keeping with a hypothesis of selective right hemisphere aging. Further, Moreno et al. (1990) proposed that older adults, when compared to younger adults, should display reduced perceptual biases to free view chimeric stimuli. Their results, however, indicated no age related difference in the degree of left perceptual bias in a chimeric faces test. More recently, Cherry et al. (1995) exposed older and younger adults to a free vision happy–neutral chimeric faces task. Both groups displayed a significant left perceptual bias, and although the bias of the older adults was smaller this difference was not statistically significant.

Finally though, Failla et al. (2003), who conducted a free view chimeric faces task with happy–neutral stimuli, with participants ranging in age from 5 to 70, reported that all groups, with exception of the oldest (60–70 years old) group, displayed a significant left bias in the task. The authors related this to possible reductions in the function of the right hemisphere. So, although so far only Failla et al.'s (2003) study elucidates possible age related changes in performance in chimeric face tasks, it is of note that all four studies cited employed spliced photographs, which may not properly ensure that participants engage in normal face perception mechanisms. Therefore the present study seeks to explore age related changes in perceptual biases in a chimeric face task with more realistic stimuli (such as those employed in Butler et al., 2005).

We had three exposure durations, one at a sub-saccadic 100 msec and one at free viewing (as employed in the above four papers), additionally we had a third exposure duration of 300 msec. These durations were chosen deliberately to manipulate the number of possible eye movements which should be none at 100 msec, very few (i.e., 2) at 300 msec and a considerable number in the free view condition. If our view is correct, then the degree of bias seen should systematically increase over these three presentation times. Finally, regarding the effect of aging on perceptual biases, both the HAROLD and differential aging hypotheses accommodate a reduction in right hemisphere dominance for this task for older adults relative to younger adults and we would expect to see reduced left biases in this population in particular for the short presentation conditions.