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Lateralised processing of positive facial emotion: sex differences in strength of hemispheric dominance

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Abstract

Sex differences in lateralisation have been examined frequently, but have found varying and contradictory results. The experiment presented in this paper examines the lateralisation of processing positive facial emotion in 276 right handed undergraduates (138 males, 138 females). All participants completed two behavioural tests of lateralisation: a handedness preference questionnaire and a chimeric faces emotion judgement task, which measured strength of lateralisation for the perception of positive facial emotion. A highly significant difference was found for the chimeric faces task only: males were more strongly lateralised than females, although both males and females tended to be right hemisphere dominant. The results suggest that females are more bilaterally distributed and hence have greater access to mechanisms located in each hemisphere.

Keywords: Emotion processing; Hemispheric specialisation; Cerebral dominance; Gender differences; Asymmetry; Interhemispheric cooperation

1. Introduction

Patterns of lateralisation are relatively consistent across the population. For most individuals language function is typically lateralised to the left hemisphere (LH) and visuospatial processing typically lateralised to the right hemisphere (RH; e.g. Puce, Allison, Asgari, Gore, & McCarthy, 1996). However, this pattern of lateralisation is not universal and variation of lateralisation has been attributed to a number of factors. A frequently examined factor is that of sex differences in the brain. One method that has been used is to examine the incidence of neuropsychological disorders following unilateral brain injury, as the symptoms reveal which hemisphere is specialised for the disordered processing and the extent of the disorder reveals the strength of lateralisation. Such studies have found evidence that males are more strongly lateralised than females (e.g. Inglis & Lawson, 1981; McGlone, 1977). More recently research has examined patterns of lateralisation in non-clinical populations using both behavioural and neuroimaging techniques for a wide range of cognitive functions.

Research examining sex differences in the lateralisation of language function has suggested that males are more strongly lateralised than females. For example, Kansaku, Yamaura, and Kitazawa (2000) conducted an fMRI examination of language processing and found that males were typically left lateralised, whereas females were more bilateral in terms of posterior temporal lobe activation. However much research into lateralisation of language functioning has provided unclear, and even contradictory findings. A number of fMRI studies examining varying aspects of language processing have found no sex differences (e.g. Hund-Georgiadis, Lex, Friederici, & von Cramon, 2002) and an MEG study found that females were more strongly lateralised to the LH for a vowel processing task (Obleser, Eulitz, Lahiri, & Elbert, 2001). Further, Kimura (1983) has suggested that evidence for females being bilaterally distributed for language processing may be an artefact of the organisation of language across the two hemispheres, rather than a distinct sex difference.

While research examining the lateralisation of language has provided largely contradictory findings, research

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examining sex differences in lateralisation of visuospatial processing has typically provided more cohesive evidence in support of sex differences. It has been found that males tend to be RH lateralised, whereas females tend to be more bilaterally distributed on a number of visuospatial tasks, including mental rotation (Johnson, McKenzie, & Hamm, 2002) and geometric illusions (Rasmjou, Hausmann, & Gunturkun, 1999). Further to this an fMRI study examining patterns of activation during an object construction task found that, not only were males RH lateralised for the task, but also that females showed the opposite pattern of lateralisation for the task with LH dominance (Georgopoulos, 2001). The experiment presented in the present paper examines sex differences in lateralisation of face processing. An incidental finding of a previous paper (Bourne and Todd, 2004) suggested that males are more strongly lateralised for face processing than females; however, the sample was unbalanced with more females than males, and as there were only 12 males included in the experiment, this possibility could not be explored fully.

In this experiment participants were given two behavioural tests of lateralisation: a handedness questionnaire and a chimeric faces test. The handedness measure was included as a result of evidence that handedness is predictive of lateralisation of face processing (Ida, 1998). The handedness questionnaire used measured handedness on a continuum as it has been suggested that degree of handedness may be related to magnitude of lateralisation (Papousek & Schulter, 1999). The chimeric faces test (Levy, Heller, Banich, & Burton, 1983) measures lateralisation of processing positive facial emotion by presenting vertically split chimeric faces, formed with one half showing a neutral expression and the other half showing a positive expression. According to the logic of Levy et al. (1983) individuals who have face processing lateralised to the RH should perceive the face that has the positive expression in their left visual field as happier, whereas those who are LH lateralised should choose the face that has the positive expression in their right visual field as happier.

2. Methods

2.1. Participants

Two hundred and seventy-six students from the University of Sussex (138 males, 138 females) participated. Mean age 22.9 years (S.D. = 4.7). All participants were right handed by self-report, had normal or corrected to normal eyesight, were neurologically healthy and were paid £ 5 for participating.

2.2. Stimuli and procedure

All participants completed two behavioural tests of lateralisation: a handedness questionnaire and a chimeric faces test. The handedness questionnaire (adapted from Dorthe, Blumenthal, Jason, & Lantz, 1995) comprised 14 items, each measured on a seven point Likert scale from −3 (always with the left hand) to +3 (always with the right hand). The scores were used to calculate a handedness quotient (HQ) ranging from −1 (strongly left handed) to +1 (strongly right handed). The handedness questionnaire also included questions about writing posture and familial handedness, however these were not included in the analyses.

Participants also completed the chimeric faces test, to assess the lateralisation of processing facial emotion. Vertically split chimeric faces, formed with one half showing a neutral expression and the other half showing a positive expression, were created. When presented with the chimera and its mirror image immediately below it participants were asked to decide which face they thought looked happier. Participants were seated centrally to the computer and completed a 20 item, computerised version of the test. From their responses, laterality quotients (LQ) were calculated ranging from −1 (always choosing the face with the positive expression in the right visual field indicating LH dominance for the task) to +1 (always choosing the face with the positive expression in the left visual field indicating RH dominance for the task).

3. Results and discussion

Independent *t*-tests compared quotients for males and females on each behavioural test. For the HQ there was no significant gender effect ($t(274) = .01$, $P = .995$) suggesting that males and females did not differ in terms of strength of handedness. In contrast, as shown in Fig. 1, males scored significantly higher on the LQ measure of perceptual asymmetry than females ($t(274) = 4.21$, $P < .001$, effect size $r = .25$). This suggests males are typically more strongly lateralised for an emotional face processing task than females.

This finding is broadly consistent with the previous research examining sex differences in the lateralisation of

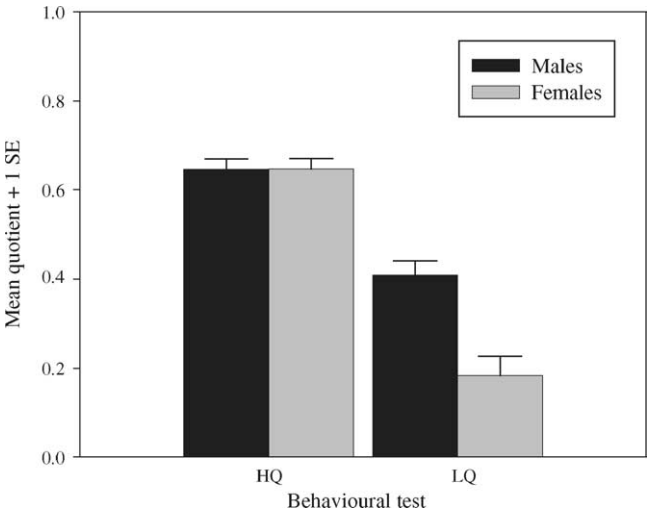

Fig. 1. Mean quotients (+1S.E.) for each behavioural test as a function of sex.

visuospatial processing. The present study found that both males and females were lateralised to the RH for the task, but that males were more strongly lateralised, whereas previous research has frequently found that males are typically RH dominant and females bilaterally distributed (e.g. Johnson et al., 2002; Rasmjou et al., 1999). The difference between these findings may reflect the greater lateralisation of processing positive facial emotion to the RH than the kinds of tasks examined in previous research (e.g. mental rotation and object construction). Two possible explanations of the sex difference identified in this study will be discussed.

First, face processing in males may be more strongly lateralised than in females. Lewin and Herlitz (2002) found that females were significantly better at face recognition than males. It has been suggested that each hemisphere might be differentially involved in face processing (Damasio, Damasio, & VanHosen, 1982) with the RH processing configural facial information and the LH processing featural information (see also Bourne and Hole, submitted for publication). It is possible that females are better at face recognition tasks due to the more bilaterally distributed nature of their face processing mechanisms. If males are strongly RH lateralised they may only have effective access to one processing mechanism, the one located in the RH. Whereas, if females are more bilaterally distributed they may have enhanced access to processing mechanisms located in each hemisphere which would provide some form of advantage when processing a face.

A second possible explanation is that the sex differences identified may also, at least to some extent, reflect a sex difference in interhemispheric transfer of information. According to this idea, there need be no sex differences in the lateralisation of face processing per se. Kansaku and Kitazawa (2001) suggested that the greater bilateral activation during language processing in females might be due to more efficient interhemispheric transfer. Therefore, the more bilateral nature of processing in females might reflect easier access to processing mechanisms in each hemisphere due to interhemispheric transfer. There is evidence that interhemispheric transfer tends to be faster and more symmetric in females than in males (Nowicka & Fersten, 2001). This possibility is, however, not supported by other studies, which indicate interhemispheric facilitation of face recognition (e.g. Compton, 2002), but not for facial emotion perception (Schweinberger et al., 2003).

While the present results may specifically reflect a sex difference in facial emotion processing, it is possible that the findings may arise due to a more generalised sex difference in cognitive processing style. For example, Rizzolatti and Buchtel (1977) also found that males showed a stronger lateralisation effect than females in a face processing task. This difference was attributed to males being field-independent and females being field-dependent. The possibility that the differences identified in this paper are the result of generalised sex differences in cognitive processing style requires further examination.

The research presented in this paper examined sex differences in strength of lateralisation for processing facial emotion. Both males and females were found to be lateralised to the RH, but males were more strongly lateralised than females. The results suggest that females are more bilaterally distributed and hence have access to mechanisms located in each hemisphere.

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