

Discussion

The present study confirmed the existence of LVF superiority in the perception of the emotional content in the chimeric faces.  Consistent with our hypotheses, the entire study sample displayed an overall LVF superiority in their judgments of the chimeric faces, with females found to show this to a greater extent over males. The perception of female faces was found to elicit a significantly higher level of LVF superiority compared to male faces, and right-handers, compared to non-right-handers, exhibited a greater LVF superiority. Contrary to our hypotheses however, mood was shown to play no significant role in the strength of LVF superiority. Instead, it strongly influenced how happy the participants judged the chimeric faces to be. This LVF superiority can be seen to indicate a RH bias for the processing of facial emotional expressions. 

Our finding that females display a greater LVF superiority than males supports the common theory that the RH bias is stronger in females for emotional perception (and expression), whereas males display a more pronounced RH bias for visuo-spatial tasks (Crucian & Berenbaum, 1998; Ladavas *et al.*, 1980).  Several explanations have been put forward for these gender-based differences.  Levy & Heller (1992) propose that these sex differences in emotional processing and spatial ability are the result of the displacement of one set of abilities by the other due to limited cerebral capacity within the right hemisphere, the person's sex determining which ability is to be preserved. Alternatively, Sanz-Martin & Loyo (2001) suggest that these gender differences derive from the influence of sex hormones. Crucian & Berenbaum (1998), by contrast, have argued that the noted sex differences in emotional perception could

in fact be attributed to gender differences in the development of the temporal cortex, suggesting it matures faster in females, promoting earlier and better emotional perception. They also make the proposition that these gender differences could result from social factors, as girls are encouraged more than boys to express their emotions, acknowledge others' emotional states, and participate in non-verbal communication. Our study could investigate this possible role of social factors by conducting it cross-culturally, to see if the strength of the LVF superiority varies relative to different socio-cultural contexts.

Our finding that a greater LVF superiority is elicited when judging female chimeric faces compared to male faces not only suggests that the greater expressive ability of females makes it easier for the right hemisphere to identify and process emotional facial expressions, but also supports the view that females display a greater overall ability when perceiving and expressing emotions. Thus, it could be said that the prominent RH bias seen in females gives them an advantage in non-verbal communication. However, the fact that all seven pairs of the female chimeric faces were presented after the seven pairs of male chimeric faces raises the possibility that this stronger LVF superiority may in fact be due to the practice effects of the study procedures, rather than any effect of the faces' gender. A simple way to eliminate this possible confounding factor would be to present the chimeric faces in an ABAB pattern, alternating between male and female faces.

The stronger LVF superiority found in right-handers is consistent with the findings of studies such as Karev (2000). However, it contradicts that of Alony (1998), who found that the perceptual biases of right-handers and non-right-handers

were actually opposing; that is, while right-handers displayed a RH bias, left-handers actually displayed a LH bias, rather than simply a weaker RH bias. However, these results arose from data based on the judgments of chimeric faces that were composed of mirror images of the left and right side of the same face, rather than happy-neutral chimeric faces. This debate surrounding the nature of the differences in the perceptual asymmetries of right- and non-right-handers highlights the necessity for further research in this area.  Several studies (e.g. Luh, Redl, & Levy, 1994) suggest that these differences in perceptual asymmetry are the result of differing patterns of brain organisation and hemispheric specialisation between right- and left-handers. However, such findings have not been validated to a great extent, and need to be further investigated.

While our findings on the effects of mood went against our own predictions, they are consistent with that of David (1989), who also found that while mood influences the perception of emotional intensity, the magnitude of the RH bias remains unchanged. The fact that mood does not appear to influence the extent of LVF superiority suggests, according to Harris & Snyder (1992), that the RH bias for emotional perception is robust enough to transcend any fluctuations or differences in mood.

However, several methodological issues have raised concerns as to how accurately the study was able to measure RH bias. The chimeric faces task really only measures LVF superiority, and it is from this that we infer a RH bias in the perception of emotion.  While this inference has been found to be valid in numerous studies (e.g. Kucharska-Pietura & David, 2003; Schwartz & Smith, 1980), these studies were

based on more direct measurements of RH involvement. The fact that this was a free-viewing chimeric faces task means we did not isolate RH contribution, or control the level of LH contribution in the participants' judgments of the faces. This leaves our study vulnerable to alternative explanations as to the existence of this LVF superiority. For example, Phillips & David (1997) suggest that the dominance of the LVF when judging emotion can be explained relative to the role of visual scanning paths. They propose that our 'normal' visual tracking paths draw us to view the left side of the face first, and with more scrutiny than when viewing the right side. Thus, these researchers suggest that LVF superiority may be the result of our scanning strategies, rather than any superior perceptual capabilities within the right hemisphere. 

A more effective means of measuring actual RH contribution would be to control and measure to a greater extent the level of LH involvement in these judgments. This could be done through the use of commissurotomed patients as participants. These patients have had their corpus callosum severed, eliminating any communication between the left and right hemispheres. Any emotionally expressive stimuli then presented in their LVF would only stimulate the right hemisphere, allowing the more accurate measurement of RH contribution in the perception of emotion. Alternatively, as seen in Schwartz & Smith (1980) the use of a tachistoscope on 'normal' participants to present the chimeric faces on would provide yet another more effective means of measuring hemispheric contributions to perception, as it allows the two visual fields to be split and isolated. The use of PET scans when exposing participants to emotional stimuli could also provide a more accurate measurement of RH and LH involvement in these tasks.

The ability of our study to accurately measure RH bias may also be impeded by the fact that we used only happy and neutral emotional expressions in our chimeric faces. Several studies have demonstrated the possibility that RH involvement changes in conjunction with task difficulty; as task difficulty increases, perceptual biases shift from the usual LVF superiority to a RVF superiority (Carbary, Almerigi, & Harris, 2001; Ladavas *et al.*, 1980). Ladavas *et al.* (1980) make the suggestion that tasks that actually require the participant to discriminate the specific emotional content of different facial expressions may be a more effective means of determining the extent of RH bias than tasks that merely ask participants to judge the intensity of only one emotion comparatively. This suggestion proposes yet another improvement we could make to our study.

Another issue that arises from our use of only happy faces and neutral faces is the fact that in doing so, we have assumed that the LVF and right hemisphere play the prominent role in the processing of all emotions. This theory is known as the “right hemisphere” hypothesis (Workman, Peters, & Taylor, 2000). However, a conflicting theory, known as the “valence hypothesis”, argues that while the right hemisphere plays the major role in the processing of negative emotions, the left hemisphere (or the “verbal hemisphere”, Baron, 2001) has an important role in the perception of positive emotions. Workman *et al.* (2000) suggest that there is a greater degree of LH involvement in the perception of positive and pro-social emotions because such emotional expressions commonly accompany and facilitate verbal communication. Numerous studies have supported this theory, finding the RH bias is more pronounced in the identification of sad expressions (Moretti, Charlton, & Taylor, 1996), and the presence of high LH involvement when judging positive emotional stimuli (Adolphs,

Jansari, & Tranel, 2001; Baron, 2001; Natale, Gur, & Gur, 1983). These research findings suggest we may have been able to more extensively investigate RH bias had we used sadness, or some other negative emotion, instead of happiness in our chimeric faces; conversely, the use of both negative and positive emotional expressions may have revealed differing rates of hemispheric specialisation for the various emotions.

On the other hand, several studies have supported the “right hemisphere” hypothesis, finding no difference in RH bias for the perception of positive and negative emotions (Christman & Hackworth, 1993; Drebing, Federman, Edington, & Terzian, 1997). Such findings suggest that our results using only happy expressions can in fact be generalised to other emotions. However, while Drebing *et al.* (1997) support the hypothesis that different emotions have no function as to the strength of the RH bias, they do suggest that the use of multiple emotions may be a more effective measurement of perceptual asymmetry because it is more representative of the types of judgments made in daily social interactions. Again, this suggests that our study could more accurately investigate RH bias if we were to use a multitude of emotional expressions, even if only to compare to our current findings, to see if there are any significant differences.

The apparent dominance of the right hemisphere in our judgments of emotional facial expressions raises the issue as to whether this RH bias exists when perceiving other forms of emotional body language, such as postures and gestures. However, before we can investigate such possibilities, researchers need to address the validity of presuming RH bias at the presence of LVF superiority. This is particularly

important to address because, as our study highlighted, LVF superiority is strongly influenced by a number of variables, namely gender, handedness, and mood. This could possibly have important implications as to the strength of any RH bias.

Researchers therefore need to devise more effective means of measuring RH bias if we wish to further our knowledge and understanding of this phenomenon.