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Examining the Relationship Between Degree of Handedness and Degree of Cerebral Lateralization for Processing Facial Emotion

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This paper examines the relationship between degree of handedness and degree of cerebral lateralization on a task of processing positive facial emotion in right-handed individuals. Three hundred and thirteen right-handed participants (157 women) were given two behavioral tests of lateralization: a handedness questionnaire and a chimeric faces test. Two further handedness measures were taken: familial left-handedness and writing posture. Regression analysis showed that both degree of handedness and sex were predictive of degree of lateralization. Individuals who were strongly right-handed were also more strongly lateralized to the right hemisphere for the task. Men were more strongly lateralized than women. Data were reanalyzed for men and women separately. The relationship between handedness and lateralization remained for men only. Neither familial left-handedness nor writing posture were associated with cerebral lateralization for men or women. The results suggest a positive relationship between degree of handedness and degree of cerebral lateralization, and further that there is a sex difference in this relationship.

Keywords: cerebral dominance, face processing, emotion processing, sex differences, familial left-handedness

Differences between left- and right-handers in terms of cerebral lateralization are relatively well-documented. However, more subtle variations in lateralization within handedness groups are less understood. This paper examines variability in lateralization for processing positive facial emotion for right-handed individuals in relation to three measures of handedness: degree of handedness, writing posture, and familial left-handedness.

The motor cortex is perhaps the part of the brain where effects of handedness and hand usage are most apparent (see Hammond, 2002, for a review). However, much of the research examining the association between handedness and lateralized brain organization has considered the lateralization of particular cognitive tasks. A considerable amount of this work has concentrated on lateralization of language function, which is typically lateralized to the left hemisphere. This work has mainly concentrated on comparing discreet groups of participants, classified according to their handedness; however, a wide variety of neuropsychological methods have been used.

A functional MRI (fMRI) experiment (Pujol, Deu, Losilla, & Capdevila, 1999) compared brain activation during silent word generation in left- and right-handed individuals. They found the typical pattern of left-hemisphere dominance in 96% of the right-handed participants, but this reduced to 76% in left-handed participants. This finding suggests that patterns of language lateralization are more variable in left-handers than right-handers. This finding is also supported by two functional transcranial Doppler (fTCD) ultrasonography studies conducted on left- and right-handed participants during a word generation task (Flöel, Buyx, Breitenstein, Lohmann, & Knecht, 2005; Knecht, Drager, et al, 2006b). Both studies found language to be lateralized to the left hemisphere in around 95% of right-handed participants and 74% of left-handed individuals. These figures are comparable to those of Pujol et al.'s (1999) fMRI study providing strong support for these patterns of lateralization across left- and right-handed individuals.

Differences in lateralization of language according to handedness have also been identified with behavioral neuropsychological methods. Bryden, Brown, Roy, & Rohr (2006a) classified hemispheric dominance for language processing using a dichotic listening task and found that 80% of right-handers were lateralized to the left hemisphere, whereas this reduced to around 70% in left-handers. Lavidor, Hayes, and Bailey (2003) examined lateralized biases for language processing in left- and right-handers using both a dichotic listening task and a divided visual field task. They found greater accuracy for stimuli presented to the left ear/visual field, indicating a right-hemisphere advantage for left-handers, but increased accuracy for stimuli presented to the right ear/visual field, indicating a left-hemisphere advantage for right-handers. A further study also examined language lateralization using a divided visual field lexical-decision task (Krach, Chen, & Hartje, 2006) measuring both handedness and lateralization on a continuum. Measuring handedness on a continuum, rather than dichotomously, has significant advantages as it is able to potentially reveal more subtle relationships between handedness and cerebral lateralization. By treating handedness as a continuous variable it is possible that a more detailed and in-depth understanding of handedness and its relationship with other variables may be achieved. Krach et al. (2006) found a significant relationship between degree of handedness and asymmetric accuracy when making lexical decisions based on stimuli presented to the left and right visual fields. This finding suggests a continuous relationship between handedness

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and lateralization, rather than there being absolute differences in brain organization between handedness groups.

There seems to be a reasonable amount of evidence that suggests a relationship between language lateralization and handedness, with right-handers typically lateralized to the left hemisphere for a language task and left-handers having more varied patterns of lateralization. While language is a well-documented lateralized cognitive function, other cognitive functions exist that are also lateralized to either the left or right hemispheres. Rather less work has considered the possible relationship between handedness and lateralization of these other cognitive processes, especially those located in the right hemisphere.

Line bisection and the landmark task are both used as tests of spatial attention, which is lateralized to the right hemisphere (Fink, Marshall, Weiss, & Zilles, 2001). Right-handers have been found to show a greater leftward bias when completing the line bisection task, which is interpreted as showing that right-handers are more strongly lateralized (Brodie & Dunn, 2005; see Jewell & McCourt, 2000, for a review and meta-analysis). A fTCD ultrasonography study conducted on left- and right-handers while they were completing a landmark task found that 95% of right-handers were lateralized to the right hemisphere for the task, whereas this reduced to 74% in left-handers (Flöel et al., 2005). These patterns of right hemisphere lateralization for left- and right-handed participants are roughly comparable to those already discussed for left-hemisphere processing of language.

Studies have also compared lateralized biases in left- and right-handed participants using the chimeric faces test, which provides an estimate of lateralization for processing facial emotion. The processing and recognition of faces is a complex and multifaceted cognitive task. Processing and recognition of emotion from faces has been found to occur automatically (Vuilleumier & Schwartz, 2001) within 100 ms of being presented with a face (Batty & Taylor, 2003). A great deal of research has examined the processing of facial emotion in the brain and typically a right-hemisphere dominance is found (e.g., Nakamura et al., 1999). Performance on emotional versions of the chimeric faces test is thought to reflect this right-hemisphere processing as a left visual field bias is typically found (e.g., Bourne, 2005; Christman & Hackworth, 1993). The right-hemisphere dominance is also supported by a reduced left visual field bias in individuals with unilateral right-hemisphere brain lesions (Bava, Ballantyne, May, & Trauner, 2005; Kucharska-Pietura, & David, 2003). Previous research using the chimeric faces test has shown that both left- and right-handers have a left visual field bias, indicating right-hemisphere dominance for the task; however this bias is significantly reduced in left-handers (Harris, Almerigi, Carbary, & Fogel, 2001; Hellige et al., 1994; Luh, 1995). This finding again indicates that degree of lateralization is reduced in left-handed individuals.

There seems to be considerable support for there being differences in lateralized brain organization between left- and right-handed individuals. This seems to be apparent for both left-hemisphere and right-hemisphere tasks. These studies show quite consistent patterns of "typical" lateralization for right-handers, but greater variability in lateralization for left-handers. One limitation of the studies discussed is the tendency to classify participants into handedness groups. The one study that considered handedness as a continuous measure by recording degree of lateralization suggested a linear relationship between handedness and lateralization for language processing (Krach et al., 2006). Variability in language lateralization has also been demonstrated in a sample of right-handed participants (Knecht, Deppe, et al., 2000a). It therefore seems plausible to suggest that there may be a continuous linear relationship between cerebral lateralization and degree of handedness. The present study provides a detailed examination of this relationship, specifically considering lateralization of processing positive facial emotion by using the chimeric faces test.

When examining handedness it is important to consider the method of measurement and the possible theoretical implications of that method. One of the first questionnaire measures of handedness was the Edinburgh Handedness Inventory (Oldfield, 1971), however it has subsequently been criticized for treating handedness as dichotomous (Bishop, Ross, Daniels, & Bright, 1996). Other researchers have suggested that handedness should be considered on a continuum (Annett, 1985); more recently developed handedness questionnaires have measured handedness in this way (e.g., Dorthe, Blumenthal, Jason, & Lantz, 1995). Measurement of handedness on a continuum is particularly relevant in light of evidence that the degree of handedness may be related to the magnitude of asymmetric electroencephalographic alpha activity, particularly in dorsolateral frontal and central areas of the brain (Papousek & Schulter, 1999). Further, an MRI study examining the association between handedness and primary motor cortex in chimpanzees (Dadda, Cantalupo, & Hopkins, 2006) found significant associations between handedness and asymmetry in the precentral gyrus when handedness was measured on a continuum.

Although a measure of degree of handedness is likely to provide much important information about an individual's handedness, other variables can be measured, such as familial handedness and writing posture. Annett's right shift theory of handedness (Annett, 1985) proposed that handedness is influenced by genetics. It might therefore be predicted that individuals with familial left-handedness might show more variable patterns of lateralization. This possibility is supported by functional neuroimaging evidence showing that 4% of right-handed participants have "atypical" lateralization for language processing (i.e., language lateralized to the right hemisphere), whereas this rises to 10% in right-handed participants with a familial history of left-handedness (Knecht et al., 2000b). It has been suggested that writing posture may also be a useful tool for predicting lateralization, particularly in left-handed individuals (Levy & Reid, 1978): people who write with the typical noninverted writing posture tend to have language lateralized to the hemisphere contralateral to writing hand, whereas those who write with an inverted posture have language lateralized to the ipsilateral hemisphere.

Although there may be individual differences in degree of cerebral lateralization according to handedness or degree of handedness, there are other possible predictors of variability in degree of lateralization, such as sex differences. Previous studies have shown that men are more strongly lateralized than women, for both language processing in the left hemisphere (e.g., Baxter et al., 2003; Kansaku, Yamaura, & Kitazawa, 2000) and face processing in the right hemisphere (e.g., Bourne, 2005; Proverbio, Brignone, Matarazzo, Del Zotto, & Zani, 2006). It is therefore possible that there may be a sex difference in the magnitude of the relationship between handedness and cerebral lateralization. This possibility is supported by studies that have explicitly considered the interaction between handedness and sex. Hagmann, Cammoun, Martuzzi, Maeder, Clarke, et al. (2006) examined lateralization of language processing in left- and right-handed participants of both sexes. They found that male right-handers were lateralized to the left hemisphere for language processing, but male left-handers showed reduced lateralization. In contrast, women of both handedness types showed comparable levels of bilateral activation. Therefore, it appears that the relationship between handedness and cerebral lateralization may vary according to sex.

This paper examines the relationship between degree of handedness and lateralization of processing positive facial emotion in right-handed individuals using the chimeric faces test (Levy, Heller, Banich, & Burton, 1983). This task quantifies lateralization of facial emotion processing ability by presenting vertically split chimeric faces, formed with one half showing a neutral expression and the other half showing a positive expression. When presented with the chimera and its mirror image immediately below it, participants were asked to decide which face looks happiest (see Figure 1). Using this test, individuals who choose the face that has the positive expression in their left visual field have processing of positive facial emotion lateralized to the right hemisphere, whereas those who choose the face that has the positive expression in their right visual field have processing of positive facial emotion lateralized to the left hemisphere. Further, the stronger the visual field bias the more lateralized they are.

The chimeric faces test has been validated as a test of lateralization for processing facial emotion in studies comparing performance of patients with unilateral right-hemisphere lesions, unilateral left-hemisphere lesions, and nonclinical control participants (Bava et al., 2005; Kucharska-Pietura, & David, 2003). These studies have found that both control participants and patients with unilateral left-hemisphere lesions show the typical leftward bias when completing the chimeric faces test. In contrast, patients with unilateral right-hemisphere lesions showed a significant reduction in leftward bias, with some participants even showing a slight rightward bias. Bava et al. (2005) found an interesting negative association between the size of the right-hemisphere lesion and the magnitude of the leftward bias reduction: the larger the lesion, the smaller the leftward bias. These findings provide support for the chimeric faces test as a behavioral estimator of right-hemisphere processing of positive facial emotion.

The primary aim of this paper is to examine the association between *degree* of handedness and *degree* of lateralization for processing positive facial emotion. As with many papers in the area of lateralization, the sample in this study was restricted to self-reported right-handers only. As described earlier, patterns of lateralization are rather more consistent for right-handers than left-handers and the large majority of right-handers show the "typical" pattern of lateralization. Consequently, linear relationships between degree of lateralization and other variables should be more easily identifiable (if indeed they exist) in right-handers than left-handers. Typically previous studies examining the association between handedness and cerebral lateralization have not measured both of these variables in a continuous manner. For example, handedness has been clustered into either two groups (left- or right-handed; e.g., Hellige et al., 1994; Luh, 1995) or three groups (left-handed, ambidexterous, or right-handed; e.g., Basic, Hajnsek, Poljakovic, Basic, Culic, et al., 2004; Knecht et al., 2000b). Given that both handedness and cerebral lateralization exist on a continuum, rather than as subgroups, it is anticipated that this study will provide a more detailed insight into the relationship between handedness and lateralization.

Figure 1. Example of chimeric face stimuli. In the example, the top face is expressing positive emotion in the left visual field and the bottom face is expressing positive emotion in the right visual field.

Method

Participants

Three hundred and thirteen undergraduate students participated (156 men, 157 women; mean age = 22.7 years, *SD* = 4.8, range 18–53 years). All participants were right-handed by self-report, had normal or corrected-to-normal eyesight, and reported no prior neurological damage.

Stimuli and Procedure

Each participant completed two behavioral tests of lateralization: a handedness questionnaire and a chimeric faces test. The

Table 1
Descriptive Statistics (Means and Standard Deviations) and Frequencies of Handedness and Cerebral Lateralization Measures as a Function of Sex

	Total (N = 313)	Men (N = 156)	Women (N = 157)	Analysis of sex differences
Familial left-handedness (%)	26	30	22	$\chi^2(1) = 2.5$, $p = .121$, $\varphi = .09$
Inverted writing posture (%)	18	21	14	$\chi^2(1) = 2.8$, $p = .104$, $\varphi = .09$
Handedness score (mean and *SD*)	28.6 (9.6)	29.7 (8.9)	27.5 (10.2)	$t(311) = 2.0$, $p = .046$, d = .23
Laterality quotient (mean and *SD*)	.30 (.4)	.36 (.4)	.25 (.4)	$t(311) = 2.4$, $p = .018$, d = .27

handedness questionnaire (adapted from Dorthe et al., 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 summed to calculate a handedness score ranging from −42 (strongly left-handed) to + 42 (strongly right-handed). The questionnaire also asked whether the participants' mother, father, or any siblings were left-handed. This was recorded as a dichotomous variable (familial left-handedness vs. no familial left-handedness). Writing posture was also assessed within the questionnaire. Inverted and noninverted writing postures were shown graphically and described. Participants were asked to indicate which posture best described their typical writing position.

The chimeric faces test is a measure of lateralization for processing positive facial emotion (Levy et al., 1983). In this test, vertically split chimeric faces were presented. These faces were formed with one half showing a neutral expression and the other half showing a positive expression. Participants were seated centrally to the computer and completed a 20-item, computerized version of the chimeric faces test (Bourne, 2005). Prior to each trial a "get ready" prompt was presented centrally to ensure central fixation. Eye movements were not controlled or recorded. All faces were male and presented in grayscale and subtended approximately 7° vertically and 5° horizontally at a viewing distance of 57 cm. In each trial a chimera was presented with its mirror image immediately below it (see Figure 1). Participants were asked to decide which face they thought looked happiest by pressing a button. Faces remained on the screen until participants responded and there were no limits on reaction times (which were not recorded). Laterality quotients were calculated in the standard way[1] and produced scores ranging from −1 (always choosing the face with the positive expression in the right visual field, indicating left-hemisphere dominance for the task) to +1 (always choosing the face with the positive expression in the left visual field, indicating right-hemisphere dominance for the task).

Results

Descriptive statistics describing the handedness and cerebral lateralization measures are presented in Table 1.

A simultaneous multiple regression was run using handedness score, writing posture, familial left-handedness, and sex as predictors of laterality quotient (see Table 2). The overall model was significant, $F(4, 308) = 3.4$, $p = .010$; $f^2 = .044$. Degree of handedness was a significant predictor of lateralization ($\beta = .006$, $p = .014$), with individuals who were more strongly right-handed being more strongly lateralized to the right hemisphere. Sex was also a significant predictor ($\beta = -.096$, $p = .047$), with men being more strongly lateralized than women. Neither writing posture nor familial left-handedness were significant predictors ($p = .808$ and $p = .256$, respectively).

Given the sex difference identified, the regression analysis was rerun for men and women separately (see Table 3). For men the overall model was significant, $F(3, 152) = 2.8$, $p = .040$; $f^2 = .056$. Handedness was a significant predictor of cerebral lateralization ($\beta = .008$, $p = .021$), again with men who are more strongly right-handed being more strongly lateralized to the right hemisphere. Writing posture and familial left-handedness were not significant predictors ($p = .107$ and $p = .941$, respectively). For women the overall model was not significant, $F(3, 153) = 2.0$, $p = .123$; $f^2 = .038$. Handedness ($p = .141$), writing posture ($p = .182$), and familial left-handedness ($p = .102$) were not significant predictors of cerebral lateralization.

Discussion

This study has demonstrated a positive relationship between degree of handedness and degree of cerebral lateralization on an emotional face processing task in men, but not women. The sex difference in degree of lateralization, with men being more strongly lateralized than women, is consistent with previous research (e.g., Bourne, 2005; Kansaku et al., 2000). A relationship between handedness and lateralization has been reported in a number of previous studies; however, they have tended to compare handedness groups. This study examined degree of handedness measured on a continuum within one handedness group: self-reported right-handers. From these data there appears to be a linear positive relationship between degree of handedness and degree of cerebral lateralization for men. This finding is comparable to that of Hagmann et al. (2006), who found a relationship between lateralization for language processing and handedness, measured dichotomously, for men only.

Although previous research has suggested a relationship between writing posture and lateralization (Levy & Reid, 1978), this study found no significant effects in any of the analyses. Previous research has also suggested that familial left-handedness is predictive of "atypical" lateralization of language (Knecht et al., 2000b). Again, no significant relationship between familial left-handedness and degree of lateralization was found in this study. As inverted writing posture and familial left-handedness were both relatively infrequent in this sample, it may be that a relationship does exist,

[1] (Number of LVF choices − (Total number of trials − Number of LVF choices))/Total number of trials

Table 2
Multiple Regression Analysis Including Both Men and Women

	β	*t*	*p*
Strength of handedness	.006	2.46	.014
Writing posture	−.015	−.24	.808
Familial left handedness	.062	1.14	.256
Sex	−.096	−2.00	.047

but that the groups were so unbalanced and inverted writing posture/familial left-handedness so occasional that the relationship could not be statistically identified. Given that both inverted writing posture and familial left-handedness are more frequent in left-handed individuals than right-handers (Annett, 1985); these factors may be identified as significant variables if the study were to be replicated with left-handed participants. It is also interesting to consider predictions for the relationship between handedness and lateralization if such a replication were to be conducted with both left- and right-handed individuals. As noted in the introduction, lateralization is more variable in left-handers than right-handers. Consequently it may be more difficult to directly replicate the linear relationship found with right-handers without considering "typically" and "atypically" organized left-handers separately.

A sex difference was found in this study; the relationship between degree of handedness and degree of lateralization was found for men only. This finding was not unexpected. Sex differences in lateralization for processing facial emotion, with men being more strongly lateralized than women, have already been reported (e.g., Bourne, 2006; Proverbio et al., 2006). Comparable sex differences have also been reported for language processing (e.g., Baxter et al., 2003; Kansaku et al., 2000) and left-handedness is more frequent in men (Annett, 1985). Of noted importance, one other study has examined the interaction between sex and handedness, although measured dichotomously, and also found that the relationship between handedness and lateralization was only evident in men (Hagmann et al., 2006). Taking these sources of evidence together, it seems there is considerable evidence for a sex difference in the lateralization of both brain and behavior, and further, for the relationship between the two. Although such sex differences seem relatively well-established, there is currently no cohesive explanation for their existence. Possible accounts may include fluctuating cerebral asymmetry in women across the menstrual cycle (e.g., Hausmann, 2005), prenatal hormone exposure (e.g., Putz, Gaulin, Sporter, & McBarney, 2004), sex differences in interhemispheric transfer (e.g., Nowicka & Fersten, 2001), or differences in strategies for completing lateralized tasks (Welsh & Elliot, 2001). Future research should attempt to provide an understanding of the source of sex differences in the lateralization of brain and behavior.

One limitation of this research is that only one test of cerebral lateralization was used. The chimeric faces test provides a measure of lateralization for processing positive facial emotion. However, there are a number of other cognitive processes that are also lateralized that could have been included, either in addition to or instead of the present task. Although the present study suggests a relationship between degree of handedness and degree of lateralization for processing positive facial emotion, if this relationship were consistent across many lateralized cognitive processes, this would demonstrate a more fundamental finding about the relationship between handedness and cerebral lateralization. The form of the chimeric faces test used in this study was based on processing of positive facial emotion. However, a number of alternative forms exist that are based on other judgments. Burt and Perrett (1997) contrasted perceptual asymmetries in the processing of chimeric faces with various stimuli and decisions. In addition to the positive emotion form of the chimeric faces test, they also examined lateralization for judgments of gender, age, attractiveness, and lip reading. A leftward bias was found in all conditions other than lip reading. It might therefore be assumed that, if the present study had utilized alternative and/or additional forms of the chimeric faces test, similar relationships would be identified. Versions of the chimeric faces test have also used both positive and negative emotion stimuli. Theories exist regarding the lateralization of positive and negative emotion processing are conflicting (see Borod, Haywood, & Koff, 1997), and the work contrasting positive and negative emotion versions of the chimeric faces test is similarly inconsistent, with some finding a right-hemisphere bias for all emotions (e.g., Christman & Hackworth, 1993; Gooding & Tallent, 2002), and others finding different lateralization patterns across positive and negative emotions (e.g., Adolphs, Jansari, & Tranel, et al., 2001; Indersmitten & Gur, 2003). It is therefore difficult to make specific predictions if both positive and negative versions of the chimeric faces test were to be used in a replication of this study.

Other behavioral measures of right-hemisphere cognitive functions exist which might be used as an alternative to the chimeric faces test. Two obvious possibilities are line bisection (see Jewell & McCourt, 2000) and landmark tests (see Harvey & Olk, 2004). Both of these are tests of visuospatial attention, thought to be lateralized to the right hemisphere. This interpretation is supported by an fMRI study, which showed selective right-hemisphere activation when completing the landmark test (Fink et al., 2001). Few studies have examined both line bisection and the chimeric faces test in combination (e.g., Failla, Sheppard, & Bradshaw, 2003; Luh, 1995; Mattingley, Bradshaw, Nettleton, & Bradshaw, 1994; Yeo, Gangestad, Thoma, Shaw, & Repa, 1997), and these have not all explicitly examined the correlation between these two measures. However, there appears to be no correlation between the two measures (Luh, 1995; Mattingley et al., 1994); consequently, it is possible that if this study were to be replicated using the landmark or line bisection test different results may be found.

Although it would be interesting to replicate this study with other tests that measure typically right-hemisphere cognitive functions, a more fundamental addition might be to include tests of left-hemisphere lateralized function. Language tends to be lateralized to the left hemisphere (for a meta-analysis of 129 functional

Table 3
Multiple Regression Analyses for Men and Women Separately

	Men			Women		
	β	*t*	*p*	β	*t*	*p*
Strength of handedness	.008	2.34	.021	.005	1.48	.141
Writing posture	−.125	−1.62	.107	.137	1.34	.182
Familial left handedness	−.005	−.08	.941	.141	1.65	.102

neuroimaging studies, see Vigneau et al., 2006). There are two primary behavioral methods for examining lateralization of language function: dichotic listening (e.g., Russell & Voyer, 2004) and divided visual field (e.g., Cousin, Peyrin, & Baciu, 2006). It would be interesting to repeat the present study using multiple tests of lateralized cognitive function, to assess both left- and right-hemisphere functions, and determine whether this finding is specific to lateralization of processing positive facial emotion, or whether the relationship is consistent across various lateralized cognitive functions.

The way in which handedness was measured in this study has possible implications for the findings of this study. First, handedness was measured in this study in terms of *preference*. It has been suggested that handedness questionnaires, such as the one used in this study which measure handedness preference, might provide a somewhat subjective measure, whereas measures of handedness performance are more objective (Bryden, Pryde, & Roy, 2000b). However preference and performance measures have been found to be highly correlated (Brown, Roy, Rohr, & Bryden, 2006). Second, familial left-handedness was treated as a dichotomous variable in this study. Such treatment of this data has been criticized and measures that take into account the number of left-handed family members have been shown to provide a more sensitive measure (Corey & Foundas, 2005). Although the findings of this study may be somewhat limited by these issues, it appears that the measures used in this study are less sensitive than some alternative measures. Hence, while the measures used could be improved upon, it is most likely that such changes would reveal stronger associations than have been found using these less sensitive measures.

The data presented here suggest a relationship between degree of handedness and degree of cerebral lateralization for processing positive facial emotion for men. However, this is not the only possible interpretation of the findings. While laterality quotients close to zero on the chimeric faces task are interpreted as reflecting bilateral processing of stimuli or “weak” lateralization, it might be that such scores instead reflect more effective interhemispheric transfer of information. This possibility is supported by studies of sex differences and interhemispheric transfer time. Nowicka and Fersten (2001) used event-related potentials to examine the speed and asymmetry of interhemispheric transfer in right-handed men and women. They found no difference in speed of transfer of information between the hemispheres in either direction for women. In contrast, men showed significantly faster transfer from the right to the left hemisphere than in the opposite direction. Further, transfer from the right to the left hemisphere in men was of a comparable speed to transfer in both directions in women. It was specifically the transfer from the left to the right hemisphere, being quicker in women, which reflected a sex difference. There is also evidence for a relationship between handedness and interhemispheric transfer, suggesting faster transfer in left-handed individuals than right-handed individuals, which supports this possibility (Cherbuin & Brinkman, 2000a, 2000b). From the data presented in this paper, it is not possible to distinguish whether low laterality quotients are attributable to reduced hemispheric asymmetry or increased interhemispheric transfer. However, further research into the relationship between degree of handedness, degree of lateralization, and effectiveness of interhemispheric transfer of information seems both possible and worthwhile.

The identified relationship between degree of handedness and degree of cerebral lateralization has important methodological implications for the study of lateralized processes. As a result of the reduced consistency of patterns of lateralization in left-handed individuals, behavioral examinations of lateralized processes have typically only included right-handed participants (see Bourne, 2006). The findings presented in this paper suggest that stricter controls may be necessary in order to identify more subtle hemispheric asymmetries. Rather than restricting participants to right-handers, selecting only those that are strongly right-handed may maximize the chances of accurately detecting patterns of asymmetry. It is possible that previous work that has not taken degree of lateralization into account may have underestimated, or even missed, the extent to which various processes are lateralized.

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