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REPORT

When left means right: an explanation of the left cradling bias in terms of right hemisphere specializations

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Abstract

Previous research has indicated that 70–85% of women and girls show a bias to hold infants, or dolls, to the left side of their body. This bias is not matched in males (e.g. deChateau, Holmberg & Winberg, 1978; Todd, 1995). This study tests an explanation of cradling preferences in terms of hemispheric specialization for the perception of facial emotional expression. Thirty-two right-handed participants were given a behavioural test of lateralization and a cradling task. Females, but not males, who cradled a doll on the left side were found to have significantly higher laterality quotients than right cradlers. Results indicate that women cradle on the side of the body that is contralateral to the hemisphere dominant for face and emotion processing and suggest a possible explanation of gender differences in the incidence of cradling.

Introduction

Approximately 70–85% of women show a bias to hold infants on the left rather than right side of the body (e.g. deChateau, 1983; Salk, 1960). The bias appears prior to maternity and is demonstrated early in ontogeny; even pre-school-age girls show a clear left preference when holding a doll the size and weight of a newborn baby (Todd, 1995). A preference for the left side has been found when fathers hold their own infants (Bogren, 1984; deChateau, 1983) but there are indications that this bias is absent or weaker in males who are not parents (e.g. deChateau, 1983; Turnbull & Lucas, 1990).

Mothers often rationalize the left cradling bias in terms of hand preference (Salk, 1973). Right-handed women, for instance, suggest that they hold their baby on the left side so that the dominant right hand is free to perform other tasks whereas left-handed mothers say they prefer to hold their infant in their stronger left arm. Large-scale studies, where handedness measures were made by self-report, showed that a significant majority of left-handed women also cradled on the left side (Salk, 1960), yet there is some evidence that the percentage who do so is lower than that observed in right-handed women (Dagenbach, Harris & Fitzgerald, 1988). Tests with a control object indicate that there is no general bias to the left side for holding objects of similar weight and dimensions to a baby (Todd, 1995, 2001).

Attempts to establish the origins of the bias have been made from a variety of diverse standpoints but none fit the available data precisely and the issue remains unresolved. For example, proposed explanations in terms of proximity of the infant to the maternal heartbeat (Salk, 1960) or as a response to young infants' own right head turning bias, have been considered but have not been supported empirically (Dagenbach *et al.*, 1988; Todd, 2001; Todd & Butterworth, 1998).

Another explanation of the left cradling bias implicates the specialization of the right hemisphere for the perception of emotion. When infants are held on the mother's left side, the infant's face is positioned at the extreme left of her visual field and close to her left ear and it has been suggested that emotionally laden visual (Manning & Chamberlain, 1991) and auditory (Sieratzki & Woll, 1996) information is therefore directed to the specialized right hemisphere for processing. Consequently left holding may facilitate affective interactions in mothers with typical brain organization.

Mothers do not necessarily attend to infant well-being solely through emotional expression; more generalized mechanisms involving right hemisphere specialization may be implicated. The right hemisphere has been identified as superior to the left hemisphere on tasks of externally

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directed, sustained attention (Heilman, Watson & Valenstein, 1985) and Turnbull and Lucas (1996) suggest that cradling infants on the left side therefore advantages a mother in directing attentional resources to her baby.

Patterns of lateralization are relatively consistent across the population with visuospatial processing, including face and emotion processing, typically lateralized to the right hemisphere. However, these patterns are not universal and behavioural measures, such as handedness, have traditionally been used to identify patterns of typical and atypical lateralization. Everheart, Harrison and Crewes (1996) found that left and right handers show distinct patterns of face lateralization and other studies have demonstrated that hand preference is predictive of lateralization of face processing (Ida, 1998). More sophisticated methodologies have also supported the relationship between handedness and lateralization with an fMRI study by Pujol, Deus, Losilla and Capdevila (1999) finding that 96% of right-handed participants have face processing lateralized to the right hemisphere.

Levy, Heller, Banich and Burton (1983) devised a task that could predict lateralization of face processing independently of handedness. They suggest that in the chimeric faces task vertically split chimeric faces are formed with one-half showing a positive expression and the other half a neutral expression. Participants are presented with the chimera and its mirror image and have to decide which face they think looks happiest. According to Levy *et al.* (1983) individuals who are right hemisphere dominant for face processing should show a bias towards choosing the chimera with the positive expression in their left visual field. Consistent with research investigating the relationship between handedness and lateralization, Levy *et al.* (1983) found a distinction between left and right handers, with right-handed people showing a left visual field bias indicating right hemisphere dominance for face processing, whereas biases for left handers were inconsistent. The chimeric faces task has been used in many studies to reveal patterns of hemispheric asymmetry with much consistency (e.g. Kim & Levine, 1991).

The lateralization hypothesis, like other theories that aim to clarify the origins of the left cradling bias, though inherently plausible, has not yet been clearly demonstrated (see Turnbull & Lucas, 2000). The most promising evidence to date comes from Harris, Almerigi, Carbary and Fogel (2001) who used a version of the chimeric faces task, presented in booklet format, to investigate this hypothesis. They found that the majority of participants showed a left visual field bias for choosing faces showing a 'happy' expression. Participants also reported a left bias in the side which they imagined holding a baby. The authors found that the left visual field bias showed a higher correlation with imagined left rather than imagined right holding. However, their results were only significant among right-handed males.

The present experiment tests two possible explanations of the left cradling bias with participants being asked to pick up and hold a life-like baby doll rather than to imagine holding an infant. Primarily, the experiment adopts a computerized and more controlled version of the chimeric faces task in order to test the lateralization hypothesis. Secondly the possible influence of handedness is tested with participants given a handedness questionnaire that measures handedness on a continuum rather than as a dichotomous variable. Consideration of hand preference as continuous may be particularly effective in the light of evidence showing degree of handedness to be related to magnitude of lateralization (Papousek & Schulter, 1999).

Method

Participants

Thirty-two right-handed students from the University of Sussex participated in the study (mean age 24 years, SD = 6). Of these, 59.4% held the doll on the left. Chi squared analysis showed no association between gender and cradling preference ($\chi^2(1) = .4$, $p = .5$).

All participants were right handed by self-report. They also completed a handedness questionnaire (adapted from Dorthe, Blumenthal, Jason & Lantz, 1995) containing 14 items relating to handedness each marked on a 7-point Likert scale from −3 (always with left hand) to +3 (always with right hand). Handedness laterality quotients (H-LQ) were calculated giving scores of −1 (strongly left handed) to +1 (strongly right handed). Participants also reported whether they thought their writing style was best represented by inverted or not inverted writing posture and were asked to report (if known) their parents' and siblings' handedness.

Participants completed a version of the chimeric faces task (Levy *et al.*, 1983) as a test of cerebral asymmetry to determine which side of the brain is typically used for processing facial emotion. Stimuli for the chimeric faces task were produced from vertically split chimeric faces of which one half is neutral and the other half smiling

Table 1 *Frequency of left and right cradling preference for males and females* (N)

	Left	Right
Male	66.7% (8)	33.3% (4)
Female	55% (11)	45% (9)

Figure 1 *Example trial from the chimeric faces task.*

with the mirror image presented either directly above or below (see Figure 1). The chimeric faces task was computerized and presentation controlled and randomized in Superlab. Participants were seated centrally to the computer and presented with 20 pairs of faces (formed from ten initial images) and had to decide which face looked happiest. Chimeric face task laterality quotients (CFT-LQ) were calculated giving scores of −1 (always choosing the face with the positive expression in the right visual field which indicates left hemisphere dominance for the task) to +1 (always choosing the face with the positive expression in the left visual field which indicates right hemisphere dominance for the task).

The stimulus doll was a training instrument for nurses/midwives and was designed to look like a newborn baby. It was the approximate size and weight of a neonate (length 50 cm, weight 3.5 kg). The doll had a metal lining to the head so that this was heavier than the body and the weight was distributed like that of a real infant. Participants were asked to pick up the doll from a tabletop in a small room; they were free to choose the side from which to approach the stimulus.

Results

A 2 (left/right cradle) × 2 (male/female) independent measures ANOVA was conducted with CFT-LQ as the DV. A significant main effect of cradling was found ($F(1, 28) = 5.1$, $p = .032$) with people who left cradle having a significantly higher CFT-LQ (mean = .5) than those who right cradle (mean = .2). This suggests that, although the scores for both groups indicate that face processing is lateralized to the right hemisphere, people who left cradle are significantly more strongly lateralized.

A significant main effect of gender was also found ($F(1, 28) = 5.7$, $p = .024$). Means indicate that males are more strongly lateralized for face processing (mean = .5) than females (mean = .2). The interaction between cradling side and gender was also found to be highly significant ($F(1, 28) = 9.2$, $p = .005$) with means indicating that the effect results from differences between female left and right cradlers. Further analysis compared left and right cradling for males and females separately.

The analysis showed no significant difference between male left and right cradlers ($t(10) = -.5$, $p = .6$); however, female left cradlers have significantly higher CFT-LQ than female right cradlers ($t(18) = 4.2$, $p = .001$), indicating that females who left cradle are more strongly lateralized for a face processing task than female right cradlers (Figure 2). Further to this the mean CFT-LQ for female left cradlers is .6, indicating lateralization to the right hemisphere, whereas for female right cradlers the mean CFT-LQ is –.2, indicating lateralization to the left hemisphere. This finding suggests that females cradle a baby to the side that is contralateral to the hemisphere that is dominant for face processing.

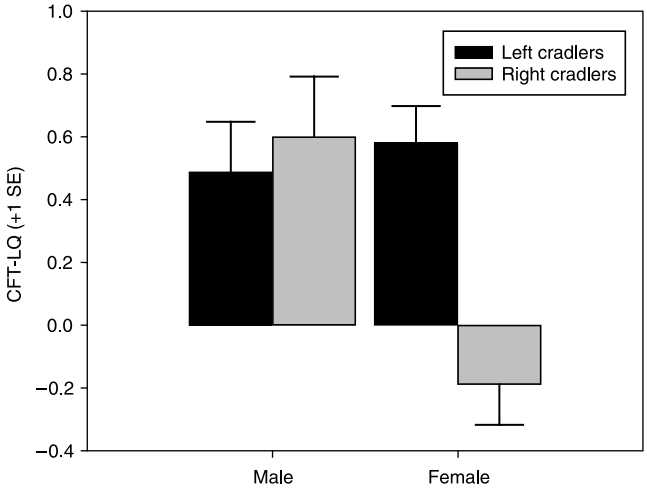

Figure 2 *Mean laterality quotients for left and right cradlers as a function of gender.*

In order to assess whether handedness may account for left cradling bias, corresponding analyses were conducted using H-LQ as the DV. Neither the main effects of cradling side nor gender were significant along with the interaction between them ($F < 1$ for all three). Similarly *t*-tests comparing left and right cradlers were non-significant for both males ($p = .6$) and females ($p = .44$). Further to this a Pearson's correlation between CFT-LQ and H-LQ quotients was also not significant ($r = .19$, $p = .4$), indicating that there is no relationship between the measures.

A logistic regression was conducted using side of cradling as the outcome variable and entering CFT-LQ, and all other behavioural measures of handedness as predictor variables using the forward stepwise likelihood ratio method. Analysis showed that CFT-LQ was the only significant predictor of cradling side ($\chi^2(1) = 8.1$, $p = .004$).

Equivalent analysis was conducted for males and females independently. For male participants no behavioural measures were predictive of cradling side; however, for the females CFT-LQ was the only predictive measure ($\chi^2(1) = 11.7$, $p = .001$). Further to this the slopes differ significantly ($\chi^2(1) = 3.9$, $p = .049$). This analysis suggests that females with higher CFT-LQ, indicating lateralization of face processing to the right hemisphere, have a tendency to left cradle, whereas those with low CFT-LQ have a tendency to right cradle.

Discussion

This study provides evidence for a relationship between lateralization and cradling behaviour. Findings indicate that right-handed women who show a left cradling bias are right hemisphere dominant for the perception of facial emotion. The findings of this study are in line with a lack of relationship between cradling and hand preference (e.g. Salk, 1960; deChateau, 1983). All of the participants in this study were right handed so it is not possible to extrapolate to left-handed individuals; however, measures of handedness bore no relationship to cradling bias.

One group of interest is the female right cradlers for whom there is a slight trend towards left hemisphere specialization. Patterns of lateralization may not adequately account for right cradling bias in right-handed women and therefore further research may consider other factors that may account for cradling behaviour of this group. This finding is compatible with Manning, Trivers, Thornhill, Singh, Denman, Eklo and Anderton's (1997) fluctuating asymmetry hypothesis, which suggests that left cradling bias is correlated with low levels of fluctuating asymmetry, which is said to signify optimal transmission of affective information to the right hemisphere.

Although a clear relationship between lateralization and cradling bias was found for women this relationship was not evident in males. Regardless of cradling preference the patterns of lateralization in male participants consistently revealed right hemisphere dominance, therefore cradling preference in males may be attributable to other factors such as task demands, socialization or brain organization.

Sex differences in lateralization are widely debated; however, a study conducted using fMRI found that brain activation was strongly lateralized in males whereas activation was bilateral and distributed for females (Shaywitz, Shaywitz, Pugh, Constable, Skudlarski, Fullbright, Bronen, Fletcher, Shankweiler, Katz & Gore, 1995). The sex differences identified in this study are consistent with such evidence. The finding that the laterality effects are only evident for females, despite their being less strongly lateralized than males, is interesting and the sex differences in cradling behaviour warrant further research.

Another issue to consider in relation to the sex difference is that of the task used to determine degree of lateralization. The chimeric faces task requires a decision based upon extraction of emotion from a face. If there are sex differences in emotion perception, or more specifically lateralization of emotion perception, it is possible that the lack of effect in male participants may be attributable to the task administered. Lavadas, Umiltà and Ricci-Bitti (1980) conducted a divided visual field study in which participants were presented with faces expressing differing emotions and had to respond to a target emotion. Overall females responded faster than males; however, a left visual field advantage was found for females that suggested greater lateralization of emotion to the right hemisphere in females than in males. These findings suggest that the sex differences may have resulted from aspects of the chimeric faces task rather than differences in patterns of lateralization or cradling behaviour.

The findings of this study suggest that lateralization can account for the left cradling bias in right-handed females; however, the exact nature of which processes are located within the right hemisphere that provide such an advantage is unclear. The present study demonstrates right hemisphere dominance for an emotion-based face processing task; however, it is not necessarily the lateralization of face or emotion processing that is specifically and uniquely predictive of cradling behaviour. A more plausible explanation is that a number of functions located within the right hemisphere work together to aid

monitoring of a baby. As well as emotion and face processing the right hemisphere is also specialized in auditory perception (Bryden, Free, Gayne & Groff, 1991), the perception of intonation (Ross, 1981), attention (Heilman *et al.*, 1985) and tactile stimulation (Weinstein, 1968).

The location of attention within the right hemisphere is an ability that would be particularly advantageous for the monitoring of a baby held in the contralateral visual field. Evidence taken from patients with visual neglect (Heilman *et al.*, 1985) suggests that both hemispheres contribute to attentional processing, but that the left hemisphere only directs attention to the contralateral visual field whereas the right hemisphere directs attention bilaterally. Further to this a study of patients with right frontal lobe damage demonstrated that such patients were less able to attend to warning signals than patients with comparable left frontal lobe damage (Pardo, Fox & Raichle, 1991). With such evidence in mind it may be that the left cradling bias exists to facilitate the mother's monitoring of the baby thereby providing an evolutionary advantage.

This study provides an explanation and demonstration of the left cradling bias in right-handed women in terms of hemispheric specializations. The exact nature of the right hemisphere functions that provide an advantage to left cradlers is an issue that requires further research as does the lateralization and cradling behaviour of subgroups of the population including males, left-handed individuals and right cradling females.

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References

Bogren, L.Y. (1984). Side preference in women and men when holding their newborn child. *Acta Psychiatrica Scandinavia*, **69**, 13–23.

Bryden, M.P., Free, T., Gagne, S., & Groff, P. (1991). Handedness effects in the detection of dichotically-presented words and emotions. *Cortex*, **27**, 229–235.

Dagenbach, D., Harris, L.J., & Fitzgerald, H.E. (1988). A longitudinal study of lateral biases in parents' cradling and holding of infants. *Infant Mental Health Journal*, **9**, 218–234.

DeChateau, P. (1983). Left-side preference for holding and carrying newborn infants: parental holding during the first week of life. *The Journal of Mental and Nervous Disease*, **171** (4), 241–245.

DeChateau, P., Holmberg, H., & Winberg, J. (1978). Left-side preference in holding and carrying newborn infants. 1. Mothers holding and carrying during the first week of life. *Acta Paediatrica Scandinavia*, **67**, 169–175.

Dorthe, N.J., Blumenthal, T.D., Jason, D.R., & Lantz, P.E. (1995). The use of next-of-kin in assessing handedness. *Perceptual and Motor Skills*, **81** (1), 203–208.

Everheart, D.E., Harrison, D.W., & Crewes, W.D. (1996). Hemispheric asymmetry as a function of handedness: perception of facial affect stimuli. *Perceptual and Motor Skills*, **82** (1), 264–266.

Harris, L.J., Almerigi, J.B., Carbary, T.J., & Fogel, T.G. (2001). Left-side infant holding: a test of hemispheric arousal-attentional hypothesis. *Brain and Cognition*, **43**, 246–252.

Heilman, K.M., Watson, R.T., & Valenstein, E. (1985). Neglect and related disorders. In K.M. Heilman & E. Valenstein (Eds.), *Clinical neuropsychology* (pp. 243–293). Oxford: Oxford University Press.

Ida, Y. (1998). Dual associations between hand preference and visual asymmetry in perception of faces. *Perceptual and Motor Skills*, **87** (3), 1035–1041.

Kim, H., & Levine, S.C. (1991). Sources of between-subjects variability in perceptual asymmetries: a meta-analytic review. *Neuropsychologia*, **29** (9), 877–888.

Lavadas, E., Umiltà, C., & Ricci-Bitti, P.E. (1980). Evidence for sex differences in right-hemisphere dominance for emotions. *Neuropsychologia*, **18**, 361–366.

Levy, J., Heller, W., Banich, M.T., & Burton, L.A. (1983). Asymmetry of perception in free viewing of chimeric faces. *Brain and Cognition*, **2**, 404–419.

Manning, J.T., & Chamberlain, A.T. (1991). Left-side cradling and brain lateralisation. *Ethology and Sociobiology*, **12**, 237–244.

Manning, J.T., Trivers, R.I., Thornhill, R., Singh, D., Denman, J., Eklo, M.H., & Anderton, R.H. (1997). Ear asymmetry and left-side cradling. *Evolution and Human Behaviour*, **18**, 327–340.

Papousek, I., & Schulter, G. (1999). EEG correlates of behavioural laterality: right-handedness. *Perceptual and Motor Skills*, **89** (2), 403–411.

Pardo, J.V., Fox, P.T., & Raichle, M.E. (1991). Localisation of a human system for sustained attention by positron emission tomography. *Nature*, **349**, 61–64.

Pujol, J., Deus, J., Losilla, J.M., & Capdevila, A. (1999). Cerebral lateralisation of language in normal left-handed people studied by functional MRI. *Neurology*, **52** (5), 1038–1043.

Ross, E.D. (1981). The aprosodias: functional-anatomic organisation of the affective components of language in the right hemisphere. *Annals of Neurology*, **38**, 561–589.

Salk, L. (1960). The effects of the normal heartbeat sound on the behaviour of the new-born infant: implications for mental health. *World Mental Health*, **12**, 168–175.

Salk, L. (1973). The role of the heartbeat in the relations between mother and infant. *Scientific American*, **228**, 24–29.

Shaywitz, B.A., Shaywitz, S.E., Pugh, K.R., Constable, R.T., Skudlarski, P., Fullbright, R.K., Bronen, R.A., Fletcher, J.M., Shankweiler, D.P., Katz, L., & Gore, J.C. (1995). Sex differences in the functional organisation of the brain for language. *Nature*, **373**, 607–609.

Sieratzki, J.S., & Woll, B. (1996). Why do mothers cradle babies on the left? *Lancet*, **347**, 1746–1748.

Todd, B.K. (1995). Left-side cradling bias in pre-school girls and boys. Poster presented at the British Psychological Society Developmental Section Conference, University of Strathclyde, September.

Todd, B.K. (2001). The origins and functions of the left-cradling preference in human females. Unpublished doctoral thesis, University of Sussex.

Todd, B.K., & Butterworth, G. (1998). Her heart is in the right place: an investigation of the 'heartbeat hypothesis' as an explanation of the left side cradling bias in a mother with dextrocardia. *Early Development and Parenting*, **7**, 229–233.

Turnbull, O.H., & Lucas, M.D. (1990). Lateral cradling preferences in males: the relationship to infant experience. *The Journal of Genetic Psychology*, **152** (3), 375–376.

Turnbull, O.H., & Lucas, M.D. (1996). Is the leftward cradling bias related to lateral asymmetries in attention? *The Journal of Genetic Psychology*, **157** (2), 161–167.

Turnbull, O.H., & Lucas, M.D. (2000). 'Tell me, where is this fancy bred?': the cardiac and cerebral accounts of the lateral cradling bias. In M.K. Mandel, M.B. Fleming & G. Tiwari (Eds.), *Side bias: A neuropsychological perspective* (pp. 267–287). The Netherlands: Kluwer Academic Publishers.

Weinstein, S. (1968). Intensive and extensive aspects of tactile sensitivity as a function of body part, sex, and laterality. In D.R. Kenshalo (Ed.), *The skin senses* (pp. 195–222). Springfield, IL: Thomas.

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