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Infant holding biases and their relations to hemispheric specializations for perceiving facial emotions

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Abstract

Since Salk [Salk, L. (1960). The effects of the normal heartbeat sound on the behavior of the new-born infant: implications for mental health. *World Mental Health 12*, 168–175] reported a left-side preference for cradling an infant, several studies have attempted to elucidate the origin of this bias. Sex and handedness were the first variables tested but none of them is sufficient for explaining this bias. Manning and Chamberlain [Manning, J. T., & Chamberlain, A. T. (1991). Left-side cradling and brain lateralization. *Ethology and Sociobiology, 12*, 237–244] proposed that the explanation had to do with hemispheric specialization of emotions and suggested that the mother could better monitor her infant's emotional state when holding on the left side than on the right side. Moreover, the infant could monitor its mother's emotional state, since the most expressive side of mother's face (the left) is visible to the infant. We used two Chimeric Figures Tasks in order to assess (1) the preferred visual field for perceiving an emotion and (2) the most expressive side of the face. Holding biases were measured in a concrete situation using an infant doll. Our main objective was to assess the relation between the asymmetric visual perception and the holding direction in a large sample of university students. We replicated a left-holding preference (66%) in our sample and found an effect of participants' holding posture and a limited effect of laterality but no effect of sex. The most significant finding concerns the links between the preferred visual field and the preferred holding side. This effect was observed in the sample of women, in right-handers, and in the sub-group of participants with care-giving skills. These findings suggest a leading role for the right hemisphere for side of holding.

Keywords: Hand preferences; Holding postures; Cradling; Emotion processing; Brain lateralization

1. Introduction

Since the first report of a leftward bias for holding a baby (Salk, 1960), several studies have confirmed this phenomenon (e.g., De Château & Andersson, 1976; Harris, Almerigi, & Kirsch, 2000; Saling & Tyson, 1981). It has also been shown that this left holding is independent of the method used to measure it (e.g., imagined situation: Harris, Almerigi, Carbary, & Fogel, 2001; concrete situation: Manning & Chamberlain, 1991; photographic survey: Harris & Fitzgerald, 1985). Several explanations have been proposed to explain this bias.

First, Salk (1960) proposed a hypothesis based on heartbeat. This author showed that babies exposed to recordings of heartbeats had a more important gain of weight and cried less than non exposed babies. The fact that maternal heartbeat is more audible on the left side than on the right side led Salk to suggest that the infant would be more reassured when cradled on the left side. Salk (1960) referred also to handedness to explain the observed biases, and this hypothesis was supported by Huheey (1977). In addition, this latter author saw an evolutionary advantage in holding infants with the left hand as this behavior led the preferred hand free for performing other activities. According to the handedness hypothesis, left-handers should exhibit a right-holding bias. However, right-holding biases have never been found in sample of left hand users (Harris et al., 2000; Manning & Chamberlain, 1991; Salk, 1960), and in some studies, holding side and

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handedness were totally independent (e.g., De Château, Holmberg, & Winberg, 1978; Saling & Tyson, 1981).

It is unlikely that a single factor can determine the direction of holding, and, as concerns the factors of sex and handedness and footedness, we agree with the suggestion by Almerigi, Carbary, and Harris (2002) that these can only be secondary factors, not main factors. This is why it is important to explore other possible contributions to the bias. The present study examined the relations between holding biases and hemispheric specialization for processing the visual perception of emotions.

1.1. The emotional monitoring hypothesis

The right hemisphere has been clearly established for the perception of emotions (e.g., Campbell, 1982; Leventhal & Tomarken, 1986) but is more controversial where their production is concerned (Habib, 1998). This implication consequently favors a direct communication between the right hemisphere and the left side of the body. In his initial studies, Gainotti (1969, 1972) showed (1) that affective indifference induced by right hemispheric lesions led to an inappropriate behavior, thus proving the specialization of the right hemisphere for controlling specifics process of human emotional functioning when (2) catastrophic reaction characterized by anguish and depression and induced by left hemisphere lesions could be considered as a normal and appropriate reaction for a patient conscious of his/her motor and linguistic deficiency. Based on this evidence, we can consider that emotions (independently from their valence) are mainly controlled by the right hemisphere; that, of course, does not exclude a lesser and limited control by the left hemisphere.

Previous studies have confirmed the role of the right hemisphere in the processing of emotions. Sackeim, Gur, and Saucy (1978) have shown that emotions are expressed more strongly on the left side of the face, and Ley and Bryden (1982) have shown that emotion recognition is also more accurate in the left visual field (right hemisphere). The latter findings were confirmed with the use of the Chimeric Faces Task (Levy, Heller, Banich, & Burton, 1983). In this task, chimeric faces are created by pairing a smiling hemiface with a neutral hemiface. The smiling hemiface is presented either in the left visual field or in the right visual field.

As concerns the relation between holding and emotions, Manning and Chamberlain (1991) proposed that hemispheric asymmetries could explain the left-holding bias. These authors suggested that (1) the mother is able to monitor her infant's well-being better in her left visual field (and perhaps with her left ear) and (2) the infant is able to monitor the mother's emotional condition, since the more expressive, left side of her face is more visible to the infant. Consequently, the mother can monitor the infant's emotional state via two main modalities. The visual communication would be the main factor in the choice of holding side, but auditory communication could represent a complementary support or an alternative resource when visual communication is impossible. According to Sieratzki and Woll (1996), left-side holding facilitates both the auditory and visual communication between mother and infant and serves as a channel for somato-affective feedback.

1.2. The current study

The main objective of our research was to assess the relation between holding biases and hemispheric asymmetry in the processing of emotions displayed in faces. For that purpose, we used two kinds of Chimeric Figures Tasks (hereafter called CFT). The function of the first test (Mirror CFT), based on evidence that emotions are more clearly expressed on the left than on the right side of the human face (Sackeim et al., 1978), was to check our participants' abilities to evaluate facial expressions via the perception of left-mirror composites. The second task (Happy/Neutral CFT) is based on previous studies (Harris et al., 2001; Levy et al., 1983); it will enable us to determine which is the preferred visual field for perceiving an emotion.

Holding biases were evaluated with an infant doll task. The same kind of tasks has already been used in other studies (Bundy, 1979; De Château & Andersson, 1976; Lucas, Turnbull, & Kaplan-Solms, 1993; Saling & Bonert, 1983; Souza-Godeli, 1996). In addition to the two perceptual tasks and the measure of holding biases, our participants (university students) were asked to answer a handedness and footedness questionnaire.

Harris et al. (2001) assessed handedness in their study with an eight-item questionnaire. They called left-holders those who preferred to hold an infant on the left side and consequently they called right-holders, participants who preferred to hold an infant on the right side. In our study, we made three distinctions: (1) using a laterality questionnaire including both handedness and footedness measures, we categorized participants as right-users, left-users or mixed-users, (2) using the doll-holding task, we categorized participants as left-holders if they held the doll on the left side, and as right-holders if they held the doll on the right side and (3), we further categorized participants as arm-holders if they held the doll in arms, and as shoulder-holders if they held the doll on their shoulder. Our main predictions were the following. On the CFT, Harris et al. (2001) found a stronger left visual field bias for right-handers than for left-handers. This may mean either that (1) proportionately more left-handers than right-handers showed a right visual field bias or (2) that the mean left visual bias was weaker for left-handers than right-handers. We support the first possibility and believe that the sample of left-handers represents an opportunity to show a right visual field preference for right-holders. Thus our distinction between left-handers and right-handers can be understood as a distinction between a group showing less variability in hemispheric specialization (right-handers) and a group showing more variability in hemispheric specialization (left-handers). Consequently, we expected the left-holding bias to be stronger for right-handers than for left-handers. For the Happy/Neutral CFT (1), we therefore expected right-handers

to show a stronger left visual field bias than left-handers and (2) left-holders to show a stronger left visual field bias than right-holders. For the mirror CFT, based on the hypothesis that left-side holding is related to hemispheric specialization for dealing with emotions, we expected left-holders to perceive the left face composite as more expressive more often than right-holders. Finally, efficacy of visual and auditory communications should vary according to the holding posture. As both visual and auditory interactions are facilitated in the arm-holding position, we predicted a stronger left-holding bias for arm-holders than for shoulder-holders.

2. Method

2.1. Participants

Participants were 210 university undergraduates (91 males, 119 females), most of them psychology students. The mean age was 22.4 years (S.D. = 4.92) for the men, 21.9 years (S.D. = 4.42) for the women. As shown in Table 1, the majority of participants were under 25 years of age. Only 11 reported being parents. Given the small size of this sub-group, this factor will not be taken into account in the analyses. For all participants, handedness and footedness were assessed by a questionnaire. Participants also were classified in one of two categories of "child-care" skill based on their answer to the question whether they had children of their own or had cared for sisters, brothers, or other infants. Those answering yes to any of these items were classified as having child-care skills; those answering no to all items were placed in the no-skill category.

2.2. Material

2.2.1. Laterality questionnaire

All participants completed an eight-item laterality questionnaire. Handedness was assessed by five items from the Edinburgh Handedness Inventory (Oldfield, 1971) that included the hand used to write, to hold a hammer, to brush teeth, to throw a ball, to open a jam pot. Footedness was assessed by three items from the Waterloo Footedness Questionnaire-Revised (Elias, Bryden, & Bulman-Fleming, 1998). We took care to select non-repetitive items and to retain representative items from a range of lateralized activities. Thus, the precision gesture was assessed by the question, "If you wanted to pick up a marble with your toes, which foot would you use?" and the automatic gesture was assessed by the question "Which foot would you use to stomp on a fast-moving bug?" The third item was "If you had to stand on one foot, which foot would it be?"

Laterality data were scored as follows: a "++" score if one limb was exclusively used, "+" if one limb was preferentially used, and "+" if both limbs were equally used. Thus, three laterality classes were established: we considered that participants were lateralized when their scores were beyond three standard errors from 0. Participants with scores higher than 0.10 were classified as right-users; those with scores lower than −0.10 were classified as left-users. The remaining participants were classified as mixed-users.

Table 1
Distribution of participants according to age class and sex

	Age class (years)			Total
	≤20	20–25	≥25	
Females	55	54	10	119
Males	23	55	13	91
Total	78	109	23	210

2.2.2. The doll

The doll weighed 2.8 kg and was 45 cm tall, which roughly corresponds to the weight and length of a newborn. To more realistically mimic the distribution of weight of a real newborn, the doll was loaded with two heavy metal balls in the body and pieces of metal in the head.

2.2.3. Happy/Neutral CFT

For the Chimeric Face Task, we used stimuli designed by Carbary, Almerigi, and Harris (2001). From the 38 pairs in their set, we randomly chose 18 pairs and prepared two booklets to counterbalance the position of the faces. Participants were shown two faces one above the other for each trial. A face resulted from the combination of one smiling hemiface and one neutral hemiface. On each page, the smile for one happy neutral chimeric face was displayed in the left visual field whereas the other face was displayed in the right visual field. Participants were asked to indicate orally or by pointing with a finger the face that looked happier. If the left happy neutral face was on the top of a page in the first booklet, the same face was at the bottom of the page of the second booklet. Each face was also presented in both positions. Across the 18 trials, a left-side, or left visual field, bias was assumed to reflect a greater right hemisphere role in the task. The degree of visual field bias could range from 0 to 18, where one point was assigned each time the left happy neutral face was judged to be happier. Scores below 9 indicate a right visual field bias; scores above 9 indicate a left visual field bias; a score of 9 indicates no bias.

2.2.4. Mirror CFT

The second CFT was nearly identical to the first one. As in the previous task, each of the 18 pages presented two faces one above the other but the construction of the faces was different from the previous task. Participants were shown pairs of left- and right-mirror image chimeric faces. Following the procedure used by Sackeim et al. (1978), the left composite face resulted from the combination of the left side of the face and of its mirror image. The same procedure was used for the right face. We prepared two booklets to control for a possible order effect of face presentation. One point was assigned each time the left composite face was rated as the more expressive.

Scores could spread from 0 to 18 points. The goal of the task was (1) to reveal whether left-holders had higher scores in emotional recognition than right-holders and (2) to confirm that the left side of the presented faces was more expressive than the right side.

2.3. Procedure

The experiment was organized in two phases. The first phase consisted in measuring holding biases whereas the second phase consisted in presenting the two Chimeric Faces Tasks. Half of the participants were first requested to hold the doll and then half of this sample was tested on one of the two CFT tasks and the other half on the other task. We decided to present only one task to each participant because presenting the Happy/Neutral CFT could have allowed the participant to figure out how the stimuli had been constructed. The reverse order was used for the remaining half of the participants. This procedure allowed us to control for a possible phase effect. All the participants concluded the experience by filling out the laterality questionnaire.

2.3.1. Phase 1

The doll was presented to the mid-line of the standing participant. As Turnbull and Bryson (2001) did, we offered participants the opportunity to hold the doll on both sides. Two observations related to the way the doll was held, one on each side, were made to allow us to confirm that spontaneous doll holding was strongly correlated with the preferred side. The following instruction was given: "Here is a doll, imagine it is a baby. Now can you hold it as if it were your own baby?" The holding posture was recorded as the spontaneous position. Then the participant was requested to hold the doll on the opposite side of the previous holding position. After having compared both holding sides, the participant was requested to indicate his/her favorite side for holding the doll. This answer was recorded as the favorite position. Beyond the holding side (left, right or middle), the experimenter also recorded the doll's position (arm-holding or shoulder-holding). Indeed, preliminary observations of holding postures allowed us to distinguish two main holding behaviors: arm-holding and shoulder-holding. Arm-holding refers to the fact that the doll was carried in arms on a horizontal plane. Shoulder-holding means that the doll was held against the chest, the doll's head being placed on the participant's shoulder on a vertical plane.

According to Manning and Chamberlain (1991), visual communication between the mother and her baby is restricted on a shoulder-holding position, whereas arm-holding allows for better visual and auditory communications.

2.3.2. Phase 2

The participants were individually tested. The whole experience lasted about 20 min per participant. There was no pause between phases 1 and 2. Both the experimenter and the participant sat down during phase 2. The booklet with the experimental stimuli was put on the table in front of the participant. In order to control for a possible effect of the experimenter's position on the participant's choices, the experimenter sat down to the left of the participant for half of the sample, and to the right for the other half of the sample. After looking at the first pair of faces, the participant was requested to indicate to the experimenter which face (A or B) looked happier (Happy/Neutral CFT) or which face was emotionally more expressive (Mirror CFT). Faces were presented until the participant answered but the response latency never exceeded 10 s. The experimenter recorded each response (A or B).

3. Results

3.1. Laterality questionnaire

As hand and foot preferences correlated well with each other in our sample of students ($r = 0.68$, $P < 0.001$), we decided to only describe handedness results. Table 2 reports the numbers and percentages of the three classes of laterality we considered among the participants: left-handers, right-handers and mixed-handers. It is clear from Table 2 that only four participants were weakly left- or-right-handed. Given this very small number, we decided not to include the data from these participants in further analyses.

We observe that the proportions of right- and left-handers of our sample correspond to those reported in the literature (e.g., Annett, 1985).

3.2. Holding biases

We used chi-square and Student *t*-tests for the statistical analyses and set significance level at a *P*-value of 0.01; a *P*-value between 0.01 and 0.05 is considered as being close to significance. For the doll-holding task, 66% of the 210 participants showed a left bias ($\chi^2(1) = 24.12$, $P < 0.001$). The men's percentages (70% left-holding) and women's percentages (64% left-holding) were comparable ($\chi^2(1) = 1.58$, $P < 0.21$).

3.3. Holding scores for spontaneous and preferred sides

We calculated a holding score to measure holding side preferences for the two measures of spontaneous and preferred holding postures. A negative score indicates a left-

Table 2
Distribution of participants according to laterality and sex

Laterality	Males	Females	%
Left-handers	18	12	14
Right-handers	70	106	84
Mixed-handers	3	1	2
Total	91	119	100

Table 3
Percentages of left and right holding according to laterality measures

Laterality	Side of holding	
	Left	Right
Left-handers (n = 30)	60	40
Right-handers (n = 176)	69	31

side hold, a positive score indicates a right-side hold. We assigned one point for the spontaneous holding measure and one point for the preferred measure. The scores varied from −2 (left spontaneous holding and left preferred side) to +2 (right spontaneous holding and right preferred side). Intermediate values were −1 (one left holding and one middle holding), 1 (one right holding and one middle holding) and 0 (one left holding and one right holding). The overall mean holding score (−0.66) was significantly biased toward the left side ($t(209) = 5.49$; $P < 0.001$). The mean score for the right-handers (−0.76) indicates a significant preference for the left side ($t(175) = 5.88$; $P < 0.001$); however, the mean score of the left-handers does not reveal any side preference (mean score −0.3; $t(29) = 0.92$; $P < 0.18$).

A comparison between the *spontaneous* holding condition and the *preferred* holding condition reveals no difference between the two situations. Left-side preferences for the two measures were comparable (67% of left holding for the spontaneous side versus 65% of left holding for the preferred side and did correlate ($r = 0.69$, $P < 0.001$).

3.4. Holding biases and laterality questionnaire

Only right-handers showed a significant left-holding (for right-handers: $\chi^2(1) = 24.75$, $P < 0.001$; for left-handers: $\chi^2(1) = 1.20$, $P < 0.27$: see Table 3).

3.5. Holding biases and holding postures

Concerning the holders' postures, we found that arm-holding represented the majority of the measures. In effect, more participants showed arm-holding (86%) than shoulder-holding (14%; $\chi^2(1) = 100.60$, $P < 0.001$). Arm-holders significantly preferred to hold the doll on their left side (69.5% of left holding and a mean score of −0.7119; $t(176) = 5.54$; $P < 0.01$) than on their right side ($\chi^2(1) = 26.90$, $P < 0.01$). By contrast, shoulder-holders showed no holding side bias (51.3% of left holding; $\chi^2(1) = 0.290$, $P < 0.59$ and a mean score of −0.4375; $t(31) = 1.33$; $P < 0.10$). It should be noted that sometimes the doll was carried in the middle of the holder's body, but this behavior represented less than 2% of the total observations.

3.6. CFT

In the Happy/Neutral CFT, we observed a mean score of 10.93 that represents a significant preference of 60.72% in favor of the left visual field preference ($t(103) = 4.15$, $P < 0.01$). This was true only for left-holders ($\chi^2(1) = 108.4$, $P < 0.01$), as right-holders showed no visual field preference ($\chi^2(1) = 0.90$, $P < 0.54$; see Table 4).

Table 4
Percentages of left and right visual field preference according to the preferred side of holding

Preferred holding side	Preferred visual field	
	Left	Right
Left-holders (n = 125)	64.2	35.8
Right-holders (n = 55)	52.1	47.9

The analysis of the link between handedness and preferred visual field showed that the right-handers choose more often the left visual field as the field where the face was the most smiling (68% of left visual field preference; $\chi^2(1) = 11.05$, $P < 0.001$; mean CFT score 11.14, S.D. = 4.56; $t(89) = 4.43$, $P = 0.001$). By contrast, left-handers showed no significant visual field preference (46% of left visual field preference; $\chi^2(1) = 0.077$, $P < 0.78$; mean CFT score 9, S.D. = 5.55; $t(12) = 0$, $P = 0.50$).

3.7. Visual field preferences and holding biases

For those participants with a left visual field preference, a left-holding side preference was found (mean score −0.9848; $t(65) = 5.11$, $P < 0.01$). However, participants that showed a right visual field preference did not demonstrate any holding bias (mean score −0.4; $t(34) = 1.29$, $P < 0.11$).

3.8. Visual field preferences and holding postures

Arm-holders showed a left visual field preference (mean score 11.22; $t(85) = 4.27$, $P < 0.001$) whereas shoulder-holders did not show any visual field preference (mean score 9.56; $t(17) = 0.53$, $P < 0.30$).

3.9. Mirror Chimeric Faces Task

Participants in the Mirror Chimeric Faces Task showed a preference for the left composite compared to the right composite ($t(105) = 8.35$, $P < 0.01$) as the more emotionally expressive. But this task failed to distinguish left-holders from right-holders ($t(103) = -0.61$, $P < 0.54$) or left-handers from right-handers ($t(102) = -0.95$, $P < 0.34$).

Several potential effects were controlled for in both chimeric tasks. Neither effect of booklets' presentation order (Mirror CFT: $t(104) = -0.935$, $P < 0.35$; Happy/Neutral CFT: $t(102) = -1.77$, $P < 0.08$), nor effect of the sequence of phases (Mirror CFT: $t(104) = -1.41$, $P < 0.17$; Happy/Neutral CFT: $t(102) = 0.930$, $P < 0.36$) were observed: see Table 5). Table 6 summarizes all the possible comparisons between holding scores and other measures: laterality biases, visual field biases and holding postures.

Several comparisons were made between visual field preferences and holding biases. These comparisons are summa-

Table 5
Percentages of left preferences for the Mirror CFT (left face composites) and left preferences for the Happy/Neutral CFT (left visual field) as a function of the two booklets and of the two phases' order

	Chimeric Faces Tasks	
	Mirror	Happy/Neutral
Booklet		
Booklet A	59.9	56.2
Booklet B	62.5	65.3
Order		
Phase 1–phase 2	63.1	58.3
Phase 2–phase 1	59.3	63.2

Table 6
Mean holding scores as a function of laterality, Happy/Neutral CFT and holding postures

Samples	Mean holding scores	S.D.	*t*	*p*	dl
Left-handers	−0.23	1.78	0.69	0.25	30
Right-handers	−0.60	1.73	3.10	0.001	81
Left VF	−0.98	1.55	5.11	<0.001	65
Right VF	−0.4	1.80	1.29	0.10	34
Arm-holders	−0.71	1.71	5.54	<0.001	176
Shoulder-holders	−0.44	1.83	1.33	0.10	31

Table 7
Pearson correlations between responses for the Happy/Neutral CFT and holding scores

Samples	Spearman *r*	*p*	*n*
Females	−0.31	0.019	57
Males	0.02	0.915	47
Care-giving skills	−0.37	0.012	45
No care-giving skills	−0.06	0.636	58
Arm-holders	−0.19	0.078	86
Shoulder-holders	−0.12	0.63	18
Left-handers	0.08	0.786	13
Right-handers	−0.22	0.034	91

rized on Table 7. We have obtained three correlations very close to be significant between the preferred side of holding and the preferred visual field for perceiving an emotion: (1) for the sample of females ($r = -0.3109$, $n = 57$, $P = 0.019$), (2) for the sample of participants with infant's care-giving skills ($r = -0.3718$, $n = 45$, $P = 0.012$), and (3) for right-handers ($r = -0.2224$, $n = 91$, $P = 0.034$).

4. Discussion

4.1. Holding biases

One of our main findings was a significant left bias in our sample. Our study therefore adds to the available evidence of left-side preferences for holding babies in human populations. We can observe that our percentage of leftward holders is remarkably close to those reported in the literature, even though different kinds of methods were used (e.g., Harris et al., 2001: 67% with an imagined situation; Manning & Chamberlain, 1991: 66% with an concrete situation; Harris & Fitzgerald, 1985: 63% with a photographic survey).

4.2. Sex effects

We have observed that women's and men's holding biases were comparable (64% and 70%, respectively). This absence of difference between sexes was also found in other researches (e.g., Bogren, 1984; Bundy, 1979; Harris et al., 2000). However, a few studies have reported a sex effect (e.g., Bruser, 1981; Manning, 1991; Turnbull & Lucas, 1991).

As concern Bundy's (1979) and Bogren's (1984) studies, participants of both sexes in these investigations were likely to have equivalent care-giving skills. Thus, it is possible that sex difference might be related to differences in care-giving skills. Given our sample of university students it is unlikely that women and men differed in terms of care-giving skills. Only 11 participants (6 women and 5 men) reported being parents. Our sample being relatively homogenous in terms of experience with infants, this could explain the absence of sex difference in side of holding preferences.

4.3. Holding measures: spontaneous versus preferred

Investigations of infant holding biases have rarely addressed the question of the spontaneous versus the preferred holding side (but see Turnbull & Bryson, 2001). We therefore asked our participants first to express their spontaneous holding, then to hold the doll on the other, non-spontaneous side, and finally to indicate which side they preferred. Our results show a strong similarity between the two measures. This convergence illustrates the reliability of holding measures as only one observation is sufficient to assess participants' choices.

4.4. Visual field preferences: Happy/Neutral CFT

Recall that our Happy/Neutral CFT used the same stimuli as those employed by Harris et al. (2001). We found that our participants showed a left visual field bias for choosing the "happier" face. The same was found by Harris et al. (2001). The left visual field preference obtained in our study can be explained in terms of hemispheric specialization. We suggest that the right hemisphere is more involved in perceiving facial emotions than the left hemisphere, a hypothesis in line with Harris et al.'s (2001) "hemispheric arousal-attentional hypothesis" (Harris, 1983; Harris et al., 2000; see also Turnbull & Lucas, 1996) for interpreting their results.

4.5. Visual field preferences: Mirror CFT

Biases obtained in the Mirror CFT always showed a preference for the left composite. Our results are congruent with the literature (Sackeim et al., 1978) and to the proposal that the right hemisphere leads in the control of emotions (Gainotti, 2000). The left side of faces was always perceived as being more expressive than the right side. In addition, the mirror CFT performances are independent of laterality and holding measures. As Mirror CFT performances are neither related to holding biases nor to laterality biases, we conclude that

the recognition of emotions as it is evaluated by this task is a stable phenomenon that does not depend on inter-individual variability.

4.6. Holding postures and visual asymmetries

The distinction between the two holding postures (arm-holding versus shoulder-holding) indicates that most of our participants held the doll in their arms. Interestingly, only arm-holding is associated with a significant left visual field preference, whereas shoulder-holders had neither holding biases nor visual field biases.

Beyond the comparison between the two holding sides, it is important to compare the two holding postures with respect to visual field biases. Our results confirm the emotional monitoring hypothesis proposed by Manning and Chamberlain (1991), namely that arm-holding seems to be the most appropriate posture for processing infant's emotions, presumably because visual feedback is important in this behavior. By contrast, the shoulder holding posture did not elicit neither holding nor emotional biases. This is not too surprising given that this position allows for few visual interactions between the holder and the infant.

4.7. Visual field preferences and holding biases

We observed that right-handers in our sample have exhibited a left-hold bias, while left-handers did not show such a bias. The existence of a left holding among right-handers has been widely found (see for a review Damerose & Vauclair, 2002). The absence of a left-hold bias for the subgroup of left-handers has also been found in some studies (e.g., Harris et al., 2000; Manning & Chamberlain, 1991).

In addition, whereas left-holders showed a preference for the left visual field (right hemisphere), right-holders did not show this left visual preference. A similar pattern was described by Harris et al. (2001). Analyses of correlations have confirmed the presence of a link between holding side and visual perception of emotions. These results reinforce the interest of the hypothesis initially proposed by Manning and Chamberlain (1991) according to whom mothers hold their infant on the left side in reason to facilitate communication between the left visual field and the right hemisphere. A recent study (Bourne & Todd, 2004) has reported that right-handed women who were right hemisphere dominant for the perception of facial emotions had a tendency to hold on the left side. By contrast, right-handed women with no hemispheric dominance for perceiving facial emotions had a tendency to hold on the right side.

4.8. Future studies

Three kinds of remarks are in order for further investigating the relations between holding biases and hemispheric specialization.

The first remark concerns the study of left hand users and of their holding patterns. It seems to us that populations of left-handers must be specifically studied because of (a) the variability of hemispheric specialization in this population (Knecht et al., 2000) and (b) the now growing evidence that handedness is not sufficient to explain holding biases. Secondly, it can be stated that the determination of the holding side preference results from several factors. The present study favors the involvement of the asymmetric perception of emotions. In order to examine the role of hemispheric specialization on holding biases in more details, it might be interesting to assess the influence of auditory stimuli, as both visual and auditory communications presumably play a role in holding side preferences, notably for arm-holders. In effect, this latter posture is the most likely to involve a global preference in perceptual field for processing infant's and mother's emotions (Manning & Chamberlain, 1991).

Thirdly, future studies about holding should consider the context in which holding behaviors occur. For example, any carrying does not necessarily involve that the baby is cradled and it could thus be misleading to make the confusion between a holding and a carrying posture (for example with the intent, in the latter case, to feed a baby). It occurs that both attentional and emotional involvements depend on the holder's intents. Thus, Reissland (2000) showed that mothers used different pitches of infant-directed language depending on whether they would attract attention or sooth the infant. This author showed that mothers who cradle on their right side speak with a higher pitch and higher amplitude than mothers who cradle on their left. Moreover, mothers who cradle both left and right speak with a higher pitch and higher amplitude when they cradle on their right side. For Reissland (2000), mothers might, consciously or unconsciously, vary the holding side depending on whether they try to arouse or to soothe the infant.

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