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Keep a Left Profile, Baby! The Left-Cradling Bias is Associated with a Preference for Left-Facing Profiles of Human Babies

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Abstract: The left-cradling bias (LCB) refers to the (typically female) preference to hold an infant on the left side of one's own body. Among the three main accounts proposed for such a phenomenon, namely the "handedness", "heartbeat" and "hemispheric asymmetry" hypotheses, the latter has met with the greatest empirical success. Accordingly, the LCB would facilitate the communication of socio-emotional information through the right hemisphere of both the cradled and the cradling individual, and should emerge mainly in face-to-face interactions. In this regard, it should be noticed that when the infant's body is oriented toward the cradler, the left or right side of their face is relatively more visible to left- and right-cradlers, respectively. Therefore, we hypothesized that the LCB might also be associated with a preference for left-facing profiles (i.e., those showing the left, and more expressive, hemiface/cheek) of human babies. In order to test our hypothesis, we assessed the cradling-side preferences of female participants, as well as their preference for the left- or right-facing profile of a human infant depicted in a drawing. Left-cradlers exhibited a significantly larger preference for the left-facing version of the drawing compared with right-cradlers, a finding further corroborating the right-hemisphere hypothesis.

Keywords: behavioral asymmetries; mother–infant interaction; left-cradling bias; infant face; face profile

1. Introduction

Population-level asymmetries in cerebral/behavioral lateralization—among which the preference for the right hand is only the most apparent instance—have probably been shaped by evolutionary pressures, due to their advantages in terms of brain efficiency and process optimization [1,2]. Accordingly, atypical cerebral and/or behavioral lateralization has been often hypothesized as a cue of possible deficits in several cognitive domains [3,4], as well as of mental disorders [5] (e.g., Autism Spectrum Disorders [6], schizophrenia [7], etc.), likely reflecting a potentially dysfunctional brain organization.

The term "left-cradling bias" (LCB) indicates a behavioral asymmetry consisting of holding an infant on the left side of one's own body for non-feeding purposes, which is observed in over 65% of women and occasionally—albeit to a weaker degree—in men [8,9]. Lee Salk, who first resurrected the scientific discussion on such a directional asymmetry in 1960, firmly ruled out the common sense idea that the bias could be due to the cradling individual's handedness, according to which holding an infant with the non-dominant arm would imply the advantage of keeping the dominant arm free to simultaneously perform other tasks, showing that also left-handed mothers exhibited a leftward

cradling comparable with that of right-handed ones [10]. Salk then hypothesized that mothers hold their infants on the left, thus exposing them more closely to their heartbeat sound, in order to obtain a mutual satisfaction by both supplying to and receiving from the newborn soothing sensations [11]. However, whereas it has never received the necessary supporting evidence, the heartbeat hypothesis has been seriously questioned by Todd and Butterworth's study showing a typical left-cradling asymmetry also in a mother with dextrocardia [12]. On the contrary, much research (ranging from pioneering studies started in the nineties to ongoing investigations) seems to suggest that leftward cradling would facilitate the communication of socio-emotional information through the right hemisphere of both the cradling and the cradled individuals. Manning and Chamberlain [13] were the first to test such a hemispheric asymmetry hypothesis by occluding girls' and mothers' left or right eye during a doll- or infant-holding task. They found that only the left-visual field occlusion could disrupt or reduce the LCB, which was attributed to the right-hemisphere/left visual hemifield advantage for emotional processing, especially in terms of facial expression recognition [14,15]. In this regard, it should be noticed that this hemispheric asymmetry seems to be stronger for faces expressing negative emotions such as anger, fear and sadness [16] and for faces of crying infants [17]. Using mostly the Chimeric Faces Task [18], several studies confirmed the relationship between the LCB and the right hemisphere dominance for processing emotional characteristics from faces [19–23] (albeit some research has yielded inconsistent results [24,25]). Moreover, Huggenberger et al. [26] found that, compared with nulliparous non-left-cradling women, left-cradling ones exhibited a lower response bias to erroneously judge neutral baby faces presented in the left visual hemifield as emotional (and vice versa for stimuli presented in the right visual hemifield), concluding that women's cradling side preferences might have evolved for saving cognitive resources when monitoring emotional signals from baby faces. Although the cradling literature is rich of several different assessment methodologies and is not yet able to provide a congruent and conclusive explanatory model of the LCB, it is plausible that—as suggested by recent comparative research [27,28]—such an asymmetry stems from deeply rooted preferences in mammalian mothers to choose a posture fostering the transmission of emotional information via their right cerebral hemisphere in order to recognize more efficiently potential cues of distress in the infant (see [29] for consistent findings and considerations).

From the cradling individual's perspective, the left posture facilitates the monitoring of their infant's wellbeing cues through their left visual (and possibly auditory [30]) hemifield, projecting more directly to the right hemisphere. Vice versa, from the cradled individual's point of view, the leftward positioning exposes their right hemisphere—during vis à vis interactions—to the side of the mother's face which is more expressive (i.e., the left hemiface [31]). In this regard, we point out that individuals who had been cradled on the right during infancy—i.e., during a critical period of brain development—showed a significant decrease in the typical perceptual bias for the left half of emotional faces compared with individuals who had been cradled on the left [32]. Possibly, this phenomenon has its roots in the infants' bias for face-like stimuli supported by an early subcortical pathway [33] and the fact that the right-hemispheric advantage underlying the left-face bias yields stronger effects in the case of female faces [34,35]. Therefore, atypical exposure to information from faces during infanthood (due to the less frequent right-sided holding position) might have crucial outcomes for the ability to perceive facial emotions later in life and for the related development of socio-emotional abilities. Indeed, since the very beginning of postnatal life, the LCB might be beneficial to the social cognition functions of the infant by means of a facilitation of the processing of social and emotional stimuli, and it might represent a crucial epigenetic factor for the development of socio-communicative and emotional abilities [36–38].

Several researchers have also examined which brain and mental dysfunctions might be associated with the reversal of the typical cradling asymmetry, usually ascribing them to potential anomalies in mothers' cerebral organization (in terms of brain functional asymmetries). In particular, an atypical—or a reduction in the typical—pattern of lateralization in cradling asymmetries has been associated with depression [39–42], stress [43], non-optimal attachment styles [44], reduced social abilities [45], prejudiced attitudes [46], lack of empathy [39] and autistic traits [47,48], and has also

been observed in uncomfortable situations such as postpartum separations of at least 24 h [11] or living in hazardous environments [41,49]. Generally, it has been suggested that cradling lateral asymmetry is part of a more complex system involving the organization of the caregiver–infant relationship, with the typical (i.e., leftward) lateral preference representing a natural index of the emotional connection between the cradling and the cradled individuals, as well as a facilitator of such a bonding (e.g., [50,51]). On the other hand, a right positioning might be a cue of the presence of a disturbance within the dyadic relationship. In summary, it could be hypothesized that females showing a typical cerebral organization (also in terms of a right-hemispheric dominance for face processing) should more likely show a typical left-positioning bias during cradling interactions.

It should be noticed that, differently from the experimental manipulations used insofar in studies indicating an attentional and perceptual advantage of the left visual hemifield for baby faces [26,29], the cradling individual is usually exposed to only a portion of the cradled individual's face. In particular, although in daily life cradling situations—irrespective of whether the infant is positioned more vertically over the shoulder or more horizontally in the arms—the cradling and the cradled individuals are rarely engaged in a fully frontal face-to-face interaction, when the infant's body is oriented toward the cradler, her/his left or right cheek is relatively more visible to left- and right-cradlers, respectively (interestingly, this particular positioning should not affect the mother's capabilities to correctly judge the infant's emotional expression [52]). Therefore, in the present study, we hypothesized that the LCB might also be associated with a preference for left-facing profiles (i.e., those showing the left—and more expressive—hemiface/cheek, especially with regard to negative emotions [53–58]) of human babies. In this regard, research showed that—even when only one profile is shown—the left hemiface is generally perceived as more expressive [59] (see also [54,55]) and its emotional valence is identified more accurately [60] compared with the right hemiface, especially when a negative emotion is displayed. In order to test our hypothesis, we assessed the cradling-side preferences of female participants in relation to their preference for the left- or right-facing profile depicted in the drawing of a human infant.

2. Materials and Methods

2.1. Sample Size Determination

Following the recommendations of Simmons et al. [61], we clearly report how we determined the sample size, all data exclusions and all measures in the present study. Given that no existing study on cradling lateral preferences has assessed the present topic, we did not have previous data (e.g., effect size) according to which we could determine a specific sample size. Moreover, to the best of our knowledge, no previous study defined a priori a comparison between groups of left- and right-cradlers of equal numerosity, and we decided to do so. Knowing from one of our previous studies [44] that left-cradlers, right-cradlers and unbiased cradlers are distributed in the female population approximately with a proportion of 5:3:2 (or, in other words, that right-cradlers account for the 30% of the total), we arbitrarily established to test a sample of 80 left-cradlers (40 allotted to version A and 40 to version B of the stimulus sheet; see below) and 80 right-cradlers (40 allotted to version A and 40 to version B of the stimulus sheet), which demanded for an estimated total sample size of at least 266 participants.

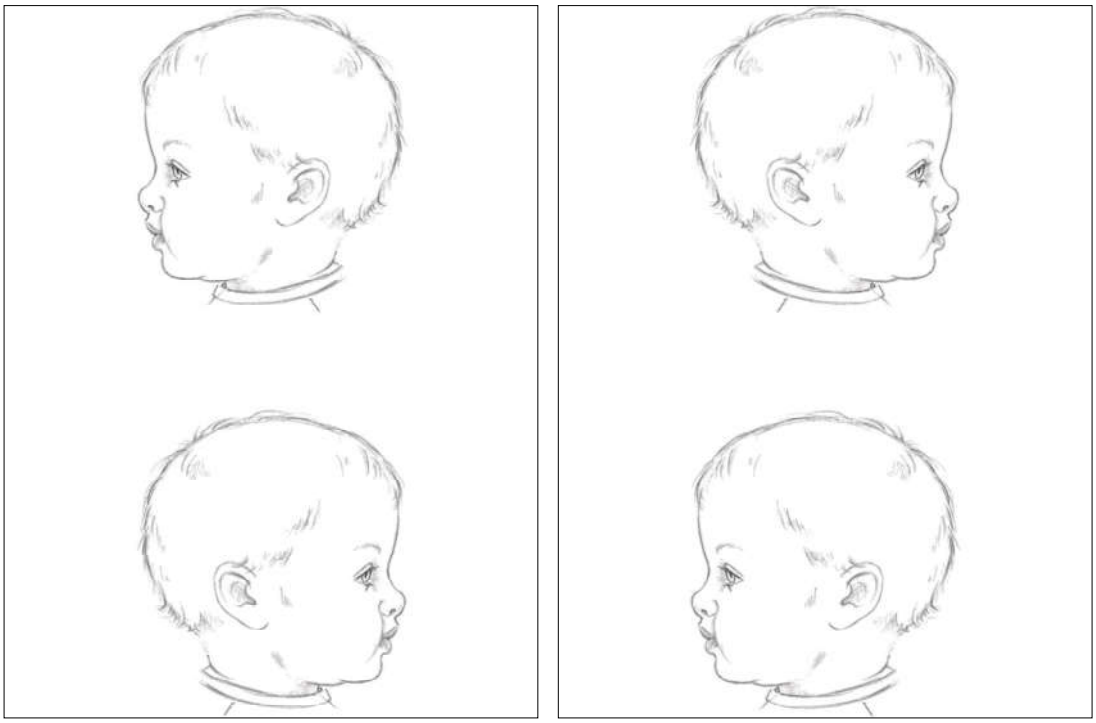
2.2. Participants

A sample of 284 Italian women took part in this study. They were aged from 18 to 34 years (M = 21.6; SD = 2.73) and 16 of them were not right-handed, scoring negatively on the Italian version of the Edinburgh Handedness Inventory [62]. All participants provided written informed consent to participate in the study and signed an authorization form. Neither risky nor invasive procedures were involved, and the data were analyzed anonymously. The study was conducted following the principles of the Declaration of Helsinki and all procedures met the guidelines of the Italian Association of Psychology (Associazione Italiana di Psicologia) Ethical Code.

2.3. Materials and Procedure

Regarding the assessment of participants' cradling-side preference, the same procedure as in [44] was followed. Each participant was tested by the experimenter in a quiet room where she performed the cradling task. A female experimenter, positioned behind an empty table in front of the participant, informed her that she had to perform several trials in which she had to pick up a doll—with the appearance and, approximately, the size (45 cm length) of a baby—positioned on the table. The participant performed six trials, for each of which the same instruction was given by the experimenter: "Imagine that this doll is a real infant who is crying: please take it in your arms and soothe it". Once the participant had held the doll for a time of about 8–10 s, the experimenter said: "Thank you, you can put it back on the table". For each trial, the experimenter set down the doll opposite to the participant, placing it in one of six different positions: supine or prone with the head on the center, on the left or on the right with respect to the participant. The order in which these positions were presented was pseudo-randomly counterbalanced across participants (half of the participants performed the supine-doll trials before the prone-doll trials, and vice versa the other half, with a complete randomization of head lateral positioning). The experimenter discreetly coded the trials in which the participant cradled to the left as −1, the trials in which the participant cradled on the right as +1, and the trials in which the participant cradled on the midline as 0. Therefore, the cradling-side score ranged from −6 (designating an absolute left-cradler) to +6 (designating an absolute right-cradler), with 0 indicating no cradling bias at all (unbiased cradlers). Participants scoring negatively were categorized as left-cradlers and those scoring positively as right-cradlers.

After the cradling task, in order to assess participants' preferences for the left- or right-facing profile of a human baby face, we used the line drawing of an infant face profile with a neutral expression taken from the web. The original drawing and its horizontally flipped version were printed one above the other in black against a white background on a white laminated A4 (29.7 × 21 cm) sheet (see Figure 1). Two versions of the stimulus sheet were created: one (version A) with the left-facing profile at the top and the right-facing profile at the bottom (Figure 1A), and one (version B) with the right-facing profile at the top and the left-facing profile at the bottom (Figure 1B). Participants were required to indicate (on the basis of their first impression) which of the two profiles presented on the sheet they rated as more attractive. The sheet was put centrally at the center of the empty table and could not be handled by participants.



(**A**) (**B**)

Figure 1. The two versions of the stimulus sheet: (**A**) left-facing profile at the top and right-facing profile at the bottom; (**B**) right-facing profile at the top and left-facing profile at the bottom.

Regarding the analysis of the association between cradling and profile preferences, we set out to include the first 40 participants tested for each combination of cradling-side preference (left or right) and stimulus sheet version (A or B). This design was adopted in order to prevent undesired effects of stimulus position (at the top or at the bottom of the sheet) on participants' profile preferences, previous research showing that stimuli presented at the top are associated with more positive affect compared with those presented at the bottom [63,64]. Data collection was scheduled so as to show each of the two stimulus sheet versions to the same number of participants. After the sample size of the first three groups (left-cradlers presented with version A of the stimulus sheet, right-cradlers presented with version B and left-cradlers presented with version B) reached the planned numerosity, only version A of the stimulus sheet was presented to the subsequent participants in order to reach the desired sample size also for the group of right-cradlers presented with this version of the stimulus sheet (see Supplementary Materials).

3. Results

3.1. Cradling Preferences

The proportions of left-cradlers (N = 149 [52.5%]), unbiased cradlers (N = 51 [18%]), and right-cradlers (N = 84 [29.6%]) differed significantly ($\chi^2_{(2)} = 52.528$; $p < 0.001$). In particular, a significantly larger proportion of participants were labeled as left-cradlers rather than unbiased cradlers ($\chi^2_{(1)} = 48.020$; $p < 0.001$) and right-cradlers ($\chi^2_{(1)} = 18.133$; $p < 0.001$), and a significantly larger proportion of participants were labeled as right-cradlers rather than unbiased cradlers ($\chi^2_{(1)} = 8.067$; $p < 0.005$).

3.2. Infant Profile Preferences

No statistical difference was observed in partipants' preference for the left- (N = 140 [49.3%]; and right-facing profile (N = 144 [50.7%]; $\chi^2_{(1)} = 0.056$; $p = 0.812$). However, when participants' responses were examined separately for the two versions of the stimulus sheet, a significant effect of the stimulus position was observed: when the left-facing profile was on the top (version A), a larger proportion of participants judged as more attractive the left- (N = 101 [66.4%]) rather than the right-facing profile (N = 51 [33.6%]); $\chi^2_{(1)} = 16.447$; $p < 0.001$); when the right-facing profile was on the top (version B), a larger proportion of participants judged as more attractive the right- (N = 93 [70.5%]) rather than the left-facing profile (N = 39 [29.5%]); $\chi^2_{(1)} = 22.091$; $p < 0.001$).

3.3. Infant Profile Preferences According to Cradling Preferences

Given that we were specifically interested in the correspondence between cradling-side preferences and profile preferences net of stimulus vertical position effects, we excluded from further analyses the unbiased cradlers and selected the first 40 participants (in chronological order) tested for each combination of cradling preferences and stimulus sheet version. Results showed that the proportion of participants judging as more attractive the left- rather than the right-facing profile was comparatively larger for left-cradlers (N = 47 [58.8%] vs. N = 33 [41.3%]) than for right-cradlers (N = 31 [38.8%] vs. N = 49 [61.3%]; $\chi^2_{(1)} = 5.629$ [continuity correction applied]; $p = 0.018$; **Figure 2**). Among participants presented with the version A of the stimulus sheet, the proportion of those judging as more attractive the left- rather than the right-facing profile was comparatively larger for left-cradlers (N = 33 [82.5%] vs. N = 7 [17.5%]) than for right-cradlers (N = 18 [45%] vs. N = 22 [55%]; $\chi^2_{(1)} = 10.602$ [continuity correction applied]; $p = 0.001$). Among participants presented with the version B of the stimulus sheet, the proportion of those judging as more attractive the left- rather than the right-facing

profile did not differ between left- (N = 14 [35%] vs. N = 26 [65%]) and right-cradlers (N = 13 [32.5%] vs. N = 27 [67.5%]; $\chi^2_{(1)} = 0$ [continuity correction applied]; p = 1).

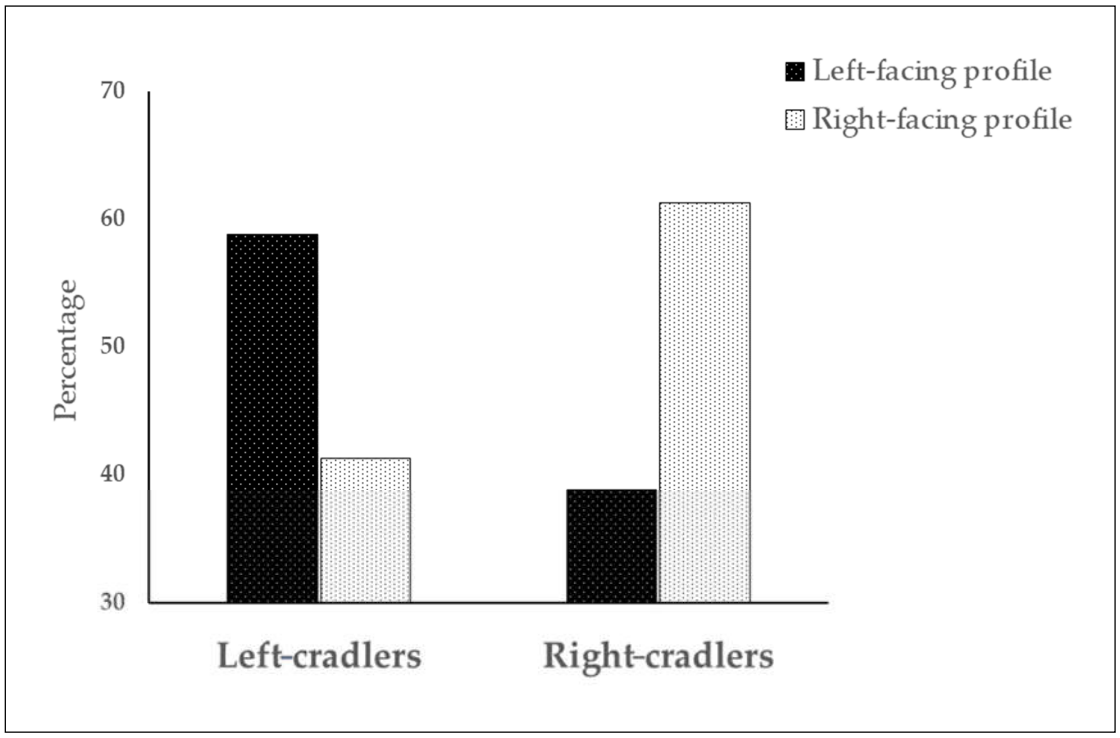


Figure 2. Percentage of left- and right-facing profile preferences according to cradling preferences.

4. Discussion

In the present study, we predicted that, compared with right-cradling women, left-cradling women would have shown a greater tendency to judge as more attractive the picture of an infant depicted in a left-facing profile rather than in a right-facing profile. In order to test our hypothesis, we recruited adult female participants—regardless of their parity status—and asked them to perform a multiple-trial doll-cradling task and, subsequently, to indicate which of two infant profile drawings (one left-facing and the other right-facing) was more attractive. It should be remarked that we assessed participants' cradling-side preferences by using a doll instead of a real infant. If, on the one hand, this might be considered a limitation of the study because of its limited ecological validity, it should be noticed, on the other hand, that the doll-cradling method has been largely used in past research, with findings comparable to those of studies involving real infants (see [9,65] for reviews). The use of a doll task allowed us to test a large sample of participants in a laboratory setting and to perform multiple trials while simultaneously controlling for the effects of doll position. Moreover, regarding the multiple trials, we firmly believe that this method prevented participants from being incorrectly overcategorized as left- or right-cradlers. In fact, only participants who held the doll on the same side in at least 4 trials out of 6 (or in the majority of trials in the very rare cases of midline responses), were categorized as left- or right-cradlers. Finally, we decided to test exclusively women—and not men—because previous studies showed that females generally exhibit a larger LCB compared with males, at least when they are not fathers [9].

Regarding the proportion of left- and right-cradlers observed in the present study, the results are in line with previous findings. In fact, when only participants showing a clear-cut lateral preference were considered (it should be pointed out that unbiased cradlers are usually absent in cradling studies because the use of multiple-trial cradling tasks is quite uncommon), about 64% of them were labeled as left-cradlers, a significantly larger proportion compared with that of right-

cradlers. These findings confirm once more that a strong LCB can also be observed in a population of young women required to hold a doll.

The participants did not show any preference for the left- or right-facing infant profile. This lack of a significant result is rather surprising. Indeed, although an overall preference for the left- or right-facing profile was not among our variables of interest and we did not make a specific prediction in this regard, a preference for the left-facing profile could be expected because: i) given that women exhibit a significant LCB, its anticipated association with the preference for a left-facing baby profile might have implied an overall preference for left-facing stimuli, and ii) several studies have reported a preference to portray human faces (as shown by images spanning from ancient artistic paintings to modern selfies) with a left rather than right cheek pose, that is as left- rather than right-facing faces [66–74], a tendency that seems to be paralleled by more positive evaluations of the former compared with the latter [75,76] (but see [77] for opposite results). In our opinion, it is plausible that the possible (and probably weak) preference for left-facing profiles could have been masked by the significant effect of stimulus position, which turned out to be the strongest effect observed in this study. Indeed, in line with past research [63,64], the majority of participants judged the profile at the top of the stimulus sheet as more attractive than the profile at the bottom. Although previous studies related the preference for left- or right-facing profiles to different variables such as cultural and demographic factors [69,72,78,79], reading/writing habits [80], handedness and other motor biases [69,80,81] (see also [82]), poser's sex [73,77], emotional expression [54,72,83] and trustworthiness [84], perceived person-related traits [74] and political orientation [85], and selfie-taking styles (i.e., with the camera pointing toward the selfie-taker vs. toward their reflection in a mirror [66,71]), no study has ever examined its possible relationship with cradling-side preferences. However, to be honest, such a link (at least in terms of the cradled individual's point of view) had already been proposed—although on a purely speculative basis—by McManus and Humphrey [73] and Conesa et al. [68,86], who hypothesized that the preference for left-facing profiles might arise from the LCB during a critical period for the development of vision (i.e., the first four months of life), given that when infants are held on the left arm of mothers, they are exposed to the left profile of the mother's face.

Consistent with our predictions, left- and right-cradling participants exhibited a comparatively greater preference, respectively, for the left- and right-facing profile of an infant face. Previous research demonstrated that the LCB was related to the right hemisphere specialization for emotion recognition from human faces [19–23], as well as to an attentional and perceptual advantage of the left visual hemifield for baby faces [29]. In this study, we showed that the simple evaluation in terms of attractiveness of an infant face profile—not expressing any emotion—was reversed in left- and right-cradlers. By relating a motor asymmetry with a congruent perceptual asymmetry, our data seem to suggest a possibly adaptive role of hemispheric asymmetries in the ecological setting of the caregiver–infant interaction.

So far, the population-level distribution of left-cradling asymmetry was supposed to fulfil a double function: i) to facilitate the fast identification of the infant's cues of distress through the mother's left visual hemifield/right hemisphere, and ii) to provide the infant with an optimal emotional information by exposing him/her to the more expressive (i.e., the left) side of the mother's face [13,31,32], which in turn has been related to the emergence of the left-cheek bias in face profile drawings [68,73,86]. The present results might add a further element in this complex framework: from the mother's perspective, the LCB might serve the function of placing the infant not only in the cradler's visual hemifield that is better specialized for decoding facial emotions, but also in a position congruent with an exposure to her/his left-profile/hemiface, which in turn is the one exhibiting the greater expressiveness and readability [54,58–60].

Finally, some limitations of the present study should be considered. First, we did not counterbalance between participants the order of presentation of the two tasks, all participants performing the cradling task before the baby-profile task. We came to such a decision because we deemed that performing the baby-profile task first could have affected the following cradling task more than the reverse condition, the former task being more explicit than the latter. However, we envisage replicating the present experiment in a further study in which also a sample of participants

performing the tasks in the reverse order will be included, so as to assess the potential effects of task order on participants' responses. Second, the measure used to assess the preference for the baby profile could have weakened the relationship found between cradling and profile preferences because of the very strong effect of stimulus position. Moreover, when the left-facing profile was at the top of the stimulus sheet and the right-facing profile at the bottom, left-cradling participants exhibited a greater preference for the left-facing profile compared with right-cradling participants, whereas no difference was observed when the right-facing profile was at the top of the stimulus sheet and the left-facing profile at the bottom. This result was not expected and we do not have a clear account for it, but tentative explanations could involve differences in perceptual asymmetries between the upper and lower visual hemifields [87], a possible advantage of the up-right/down-left vs. up-left/down-right mapping [88], or the attribution of more positive characteristics to the combination of up-and-right rather than down-and-left codes [89]. Such confounds could be overcome in studies using a more complex design (e.g., by using face profiles of more than one real infant as stimuli sequentially presented on a screen). Therefore, future investigations are needed to address these issues and to confirm the present results.

In summary, our findings seem to be in agreement with the right hemisphere hypothesis of the LCB and warrant further investigations aimed at deepening our understanding of the evolutionary aspects of this phenomenon. What is certain is that cradling asymmetry constitutes one elective framework of a complex biobehavioral system involving two individuals (the cradling and the cradled ones, usually the mother and the infant), whose perceptual, emotional and communicative biases, postural preferences, and motor and emotional feedbacks act synergistically to the benefit of both and in order to foster their socio-emotional bond. We hope that the present study may represent a further step toward the development of a comprehensive model of this complex and fascinating phenomenon.

Supplementary Materials: The dataset generated for this study is included in the link: www.mdpi.com/2073-8994/12/6/911/s1.

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