






Review

The Intricate Web of Asymmetric Processing of Social Stimuli in Humans

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Abstract: Although the population-level preference for the use of the right hand is the clearest example of behavioral lateralization, it represents only the best-known instance of a variety of functional asymmetries observable in humans. What is interesting is that many of such asymmetries emerge during the processing of social stimuli, as often occurs in the case of human bodies, faces and voices. In the present paper, after reviewing previous literature about human functional asymmetries for social and emotional stimuli, we suggest some possible links among them and stress the necessity of a comprehensive account (in both ontogenetic and phylogenetic terms) for these not yet fully explained phenomena. In particular, we propose that the advantages of lateralization for emotion processing should be considered in light of previous suggestions that (i) functional hemispheric specialization enhances cognitive capacity and efficiency, and (ii) the alignment (at the population level) of the direction of behavioral asymmetries emerges, under social pressures, as an evolutionary stable strategy.

Keywords: hemispheric specialization; functional lateralization; sensory asymmetries; motor asymmetries; right-handedness; left-face bias; left-cradling bias; perceptual frequency effect



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1. Introduction

In humans, the population-level preference for the use of the right hand (around 90% of individuals being right-handed; e.g., see [1,2]) represents the clearest example of behavioral lateralization. However, it is only the best-known instance of a variety of functional asymmetries reported in humans, such as pseudoneglect [3], the right ear advantage (REA [4]), the left-face bias (LFB [5]), asymmetries in social touch [6], turning behavior [7] and similar. It is noteworthy that many of such asymmetries are observed during the processing of social stimuli, and in particular human bodies, faces and voices. In the present paper, we first review extant literature about human behavioral (and neural) asymmetries for social stimuli (with particular attention to the auditory, visual and haptic/motor domains), and then we suggest some possible links among them. Specifically, we endorse Vallortigara and Rogers' [8,9] suggestions that (i) functional hemispheric specialization may enhance cognitive capacity and efficiency and (ii) the directional alignment (at the population level) of behavioral asymmetries may represent an evolutionary stable strategy shaped by social pressures, and assume that such principles can be usefully applied to the case of asymmetries for social stimuli. In our opinion, a comprehensive account of these not yet fully explained phenomena will benefit from the identification of both ontogenetic and phylogenetic factors involved.

2. Auditory Asymmetries

Historically, the dichotic listening paradigm turned out to be the first procedure to disclose asymmetries in the perception of social stimuli. It is 60 years since Doreen

Kimura discovered the existence of a REA when different linguistic stimuli are presented simultaneously in the two ears [4,10]. This presentation mode—the so-called dichotic listening (DL)—was initially proposed by Broadbent [11] to study attention. However, it is only with Kimura’s discovery of a REA for speech sounds that such a paradigm was applied for the first time to neuropsychology. The original DL studies, consisting in the presentation of series of three, four or five pairs of digits to be reported later, had the limit of producing an effect of order and an involvement of working memory [12,13]. Consequently, the consonant–vowel (CV) syllable paradigm [14] was introduced, in which the stimuli typically consist of combinations of CV syllable pairs composed of the six stop consonants /b/, /d/, /g/, /k/, /p/, /t/ and the vowel /a/ (e.g., /ba/-/pa/) recorded as natural voices. In each trial, the two syllables of a pair are presented simultaneously, one in each ear, and participants have to identify and report the stimulus perceived first or best. Typically, they indicate more stimuli presented to the right than to the left ear (namely, the REA; Figure 1a). A REA is also observed in the discrimination of sound duration for CV syllables [15]. The mechanism at the basis of this effect can be accounted for by the structural, or neuroanatomical, model suggested by Kimura [16,17]. This model states that the REA is a consequence of the organization of cerebral auditory pathways, in which the contralateral pathway predominates over the ipsilateral one, in association with the specialization of the left temporal lobe for speech processing. It follows that the presentation of an auditory stimulus in one ear activates the contralateral auditory cortex more than the ipsilateral one [16,18,19], and that verbal stimuli presented to the right ear overcome those presented to the left ear. The input from the left ear can be transferred across the corpus callosum from the contralateral auditory cortex to reach the ipsilateral one [20], but such a transfer would cause a delay and attenuation of speech information. Besides the structural model, an attentional model has been proposed [21,22], according to which the perceptual asymmetry would be due to the dynamic imbalance in hemispheric activation, the left hemisphere being more activated than the right one by verbal inputs [23,24]. However, both models emphasize the left-hemispheric specialization for verbal stimuli.

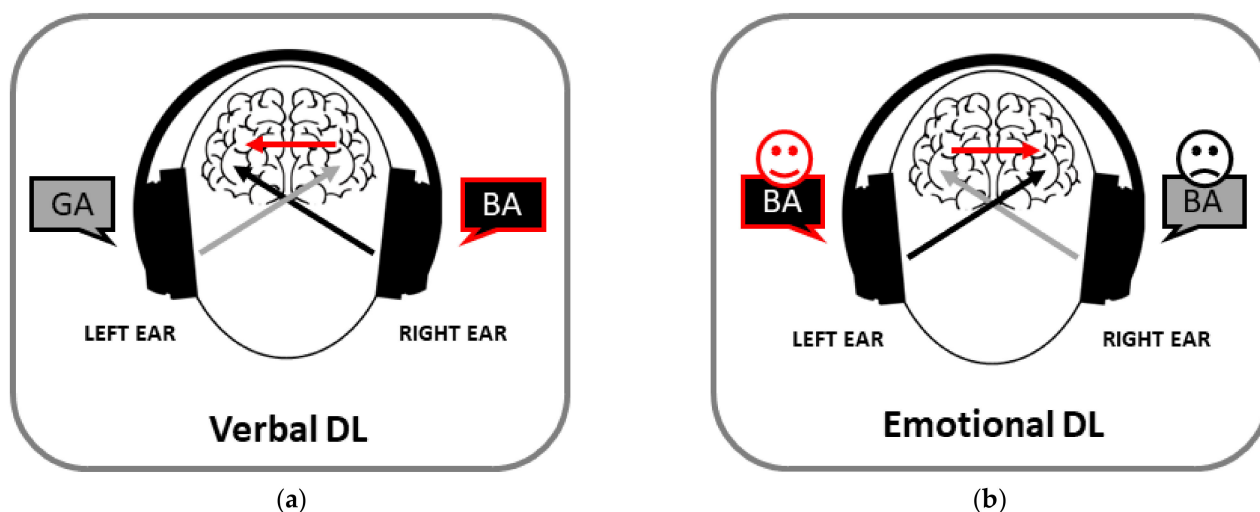


Figure 1. Examples of verbal (a) and emotional (b) dichotic listening (DL). Participants tend to report the stimulus presented to the right and left ear, respectively.

The hemispheric asymmetry originating the REA has been largely confirmed by several neuroimaging studies. For example, a positron emission tomography study by Hugdahl et al. [25] revealed bilateral activation in the areas of language perception during the presentation of dichotic CV syllables, with the involvement of the superior temporal gyrus and a significantly stronger activation in the left hemisphere. Moreover, data from electrophysiological and neuroimaging studies [26–28] showed an involvement of the upper posterior part of the temporal lobes, including the primary and secondary auditory cortices.

The crucial role of the auditory cortex in the processing of verbal dichotic stimuli has also been supported by research with transcranial electric stimulation (tES). For example, tES delivered bilaterally to both temporal cortices seems to increase the REA compared with a control (sham) condition [29]. However, a unilateral stimulation of the temporal cortex would not modulate the REA [30,31].

Thus, the REA reflects the left-hemispheric dominance for verbal stimuli [32,33], and after decades of research it can be considered a global phenomenon of human perception [34,35]. The magnitude of the REA may vary among different populations, but it is observed from childhood [36,37] to old age [38], in males and females [37,39] and in right- and left-handers [40,41]. In addition, the REA for verbal material is observed across different languages in bilingual individuals [42–44], further confirming that this bias is related to the left-hemispheric specialization for language.

Further evidence of a right ear preference for linguistic sounds came from a dichotic speech illusion paradigm, in which a white noise could be presented alone or simultaneously with a vowel in one of the two ears: a right ear preference was found both when the verbal stimulus was absent and when it was present, extending the REA for verbal processing from the perceptual to the illusory domain [45]. The presence of a REA was also observed in paradigms involving imagery, and specifically in studies in which participants were invited to imagine hearing a voice in one ear only [46–48]. Interestingly, a REA seems to emerge also in ecological conditions, with listening individuals orienting their head so as to offer their right ear to a speaking individual during verbal exchanges in a noisy environment [49].

Although DL has corroborated the specialization of the left hemisphere for speech processing beyond the original neuropsychological findings [50,51], this technique can also be used to explore the asymmetries involved in the processing of other characteristics of vocal stimuli. For instance, discriminating the pitch, intensity, identity or gender of a vocal stimulus can produce an opposite pattern of asymmetries, indicating a right-hemispheric advantage [52–54]. The same occurs when the DL technique is used to investigate the lateralization of emotional perception. Indeed, a left ear advantage (LEA) is generally reported for the identification of emotional stimuli (syllables with positive and negative intonation) presented dichotically (Figure 1b), which supports the hypothesis of a right hemisphere superiority for emotions [55,56]. Studies carried out with split-brain patients (individuals with surgical resection of the corpus callosum) confirmed a left-hemispheric superiority in verbal DL [57] and a right-hemispheric superiority in the emotional evaluation of CV syllables pronounced with happy or sad accent [58].

Finally, we must emphasize that the size and direction of ear advantage in DL can be modulated by various factors. For example, varying the focus of attention to either the right or left ear results in an increase in the REA or LEA, respectively, compared with a condition without attentional instructions [59]. Furthermore, the modulation of the REA effect has been studied in relation to the manipulation of other cognitive factors such as, for instance, memory retention [60,61] and music pleasantness [62]. The relative advantage of the right or left ear in DL can also be affected by the time delay and acoustic similarity between the two stimuli [63,64], which further shows that the functional interhemispheric asymmetry involved is not stable. In this respect, a recent study has also found that such an asymmetry can be dynamically modulated through the application of biofeedback during a lead-lag dichotic paradigm [65].

3. Visual Asymmetries

The second paradigm that revealed asymmetries in the perception of social stimuli is that of chimeric faces [66,67]. Levy et al. [67] photographed actors in smiling and neutral poses, cut down the photographs along their midsagittal axis and finally juxtaposed an emotional hemiface to a neutral hemiface of the same actor (Figure 2). Each chimeric face obtained in this way was presented together with its mirror image, one stimulus above the other, and the observers were required to select the face which looked happier

in the pair. The authors found that participants judged as more expressive the chimeras in which the emotional half was on the left side of the face from the observer's point of view (and thus directly projected to the right hemisphere). The authors also reported that this left visual field (LVF) advantage was stronger in right-handers than in left-handers, revealing that handedness plays a role in hemispheric asymmetries for faces, as confirmed by following studies (e.g., [68]). The main advantage of this paradigm is that of being a free-viewing presentation task, so that the printed stimuli can be observed for all the required time without affecting the LVF advantage. The chimeric face paradigm became a milestone in the field of hemispheric asymmetries for face processing [69] so that it was soon transformed into a computerized task, in which the presentation time of each stimulus is easily controllable, allowing for many experimental manipulations. For instance, the two chimeras can be presented either simultaneously, side by side [70], or one after the other, in the center of the screen [71]; response times can also be collected, further confirming the LVF advantage [72]. Facial features other than emotional expressions have been manipulated in the chimeric face paradigm, such as gender (female/male [73]), age (younger/older [5]) and ethnicity (e.g., Caucasian/Asian [74]). For instance, Chiang et al. [73] used a free viewing chimeric face paradigm and showed that the LVF advantage emerges by 6 years of age and reaches a plateau at about 10 years of age, as regards both emotions and gender. Burt and Perrett [5] extended the evidence of a LVF bias in adults to facial age and attractiveness.

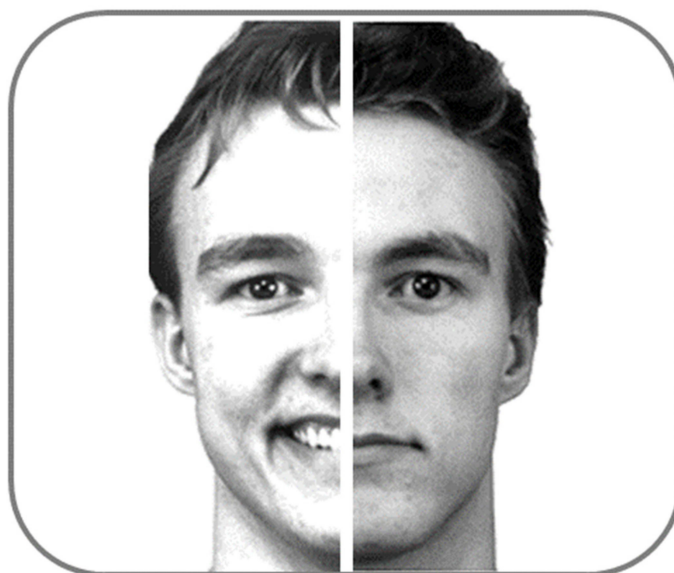


Figure 2. Example of a chimeric face. The present image has been created by juxtaposing one happy (original image id: AM08HAS) and one neutral (original image id: AM08NES) hemiface of the same actor from the Karolinska Directed Emotional Faces [75]).

Despite the great importance of the chimeric face paradigm in the research on hemispheric asymmetries for faces, other paradigms can be exploited to the same aim. Among these, the divided visual field (DVF) paradigm is based on the same neural assumptions as the chimeric face task, namely the contralateral projections of the human visual system [76]. In this paradigm, a stimulus is flashed in either the LVF or the right visual field (RVF) for less than 150 ms, which is about the minimum time needed to make a saccadic movement. In this way, a stimulus presented in the LVF or in the RVF is supposed to be directly projected to the right or left hemisphere, respectively (e.g., [77]). By means of such an experimental manipulation, the ability of one hemisphere in processing a specific stimulus can be directly compared with that of the opposite hemisphere, allowing researchers to further confirm the LVF advantage for faces [78]. The same paradigm has also been exploited to investigate another hemispheric imbalance, namely that for positive vs. negative emotional valence: for instance, in an electroencephalography study [79], angry (negative

valence) and happy (positive valence) faces were presented either unilaterally (LVF or RVF) or bilaterally (one in the LVF and the other in the RVF, simultaneously). Behavioral results supported the so-called valence hypothesis [80], according to which the right and left hemispheres are specialized for negative and positive emotions, respectively, but the event-related potentials (ERPs) confirmed a right-hemispheric dominance for all emotional stimuli (see also [81,82]), as assumed by the right hemisphere hypothesis for emotional stimuli [83,84]. This unexpected evidence parallels the contrasting results found in previous research on hemispheric asymmetries in emotion processing, both theories receiving support from a number of studies (e.g., see [85]).

Hemispheric asymmetries have also been explored in neurological populations, and a special contribution in this field comes from studies with split-brain patients [86,87]. For example, when presented with emotional chimeric faces, the performance of A.P., a patient with a large callosal resection sparing the splenium, confirmed the right-hemispheric superiority, but that of D.D.V., a patient with a complete callosal resection, revealed a RVF advantage [58], possibly attributable to the left-hemispheric superiority in labeling the emotional content of the stimulus presented contralaterally. A.P.'s performance confirmed the right-hemispheric superiority also in a different study in which chimeric faces were manipulated to obtain hybrid stimuli, in which the emotional content was presented only in the lowest spatial frequencies of the image, superimposed to the neutral expression of the same face filtered at high spatial frequencies (resulting in an apparently neutral face, which contained subliminal emotional content [88]). However, when the same hybrid faces were presented unilaterally by means of a DVF paradigm, both A.P.'s and healthy participants' performances revealed a right/left-hemispheric superiority in processing subliminal negative/positive emotions, respectively (see also [89]). It has been proposed that, starting from a right-hemispheric superiority for facial emotion processing, a valence-specific asymmetry can be observed when more than one stimulus has to be processed at once, and that such a hemispheric division of labor could be intended as an evolutionary tool to optimize the processing of multiple stimuli [88]. Moreover, ERPs recorded on healthy participants during the presentation of hybrid emotional faces in the center of the screen confirmed a higher activity of the right hemisphere, independently of the emotional valence [90], similar to that found for unfiltered emotional faces [79]. However, no effects of left vs. right transcranial stimulation on emotion processing were found [91], so that hemispheric asymmetries for emotions remain a still open research field [85].

A complex pattern of results has also been described in a study in which healthy participants and a male split-brain patient, D.D.C., were required to categorize the gender of faces [92]. Differently from healthy participants, who showed—regardless of their own sex—a right- and left-hemispheric specialization for categorizing female and male faces (see also [93,94]), D.D.C. showed a right-hemispheric superiority in categorizing male faces. Indeed, his performance was at chance level for female faces presented in either visual field and for male faces presented in the RVF, but it did not differ from that of controls (and was higher than chance) for male faces presented in the LVF [92]. Different results were observed in another male patient with a lesion involving the posterior portion of the corpus callosum (the splenium) and the left medial occipitotemporal area: when required to categorize the gender of female/male chimeric faces, the patient based his response on the left hemiface, thus showing a right-hemispheric dominance for gender categorization [95] (see also [96]).

We can conclude that the superiority of the right hemisphere in face processing is a widely accepted bias, which has been largely confirmed by means of the chimeric face paradigm as well as the DVF paradigm, in both healthy observers and split-brain patients [86]. Consistently, such a bias was not found in patients with right brain lesions [97]. Moreover, the LVF advantage did not emerge in schizophrenic and depressed patients tested with chimeric stimuli [98], indicating that in these clinical conditions there could be an alteration of the normal interhemispheric balance. In this respect, also the peculiar evidence found in some studies with split-brain patients, which differs from that observed

in controls, confirms a crucial role of the interhemispheric connections in this domain [86]. The main role of the right hemisphere in face processing is conclusively supported by extensive evidence of a brain region specialized in face processing, localized predominantly in the right temporal cortex (e.g., [99,100]), namely the fusiform face area [101]. Furthermore, the acquired lesion of this area in the right hemisphere leads to the selective inability to recognize the identity of a person through her/his face (i.e., prosopagnosia [102,103]), even if the same person can be recognized by other cues such as the voice. All these results confirm the specialization of the right hemisphere in face processing, although it has to be considered that faces are very complex social stimuli, conveying different information, including gender, age, ethnicity, emotion, identity and so on. Even if an overall right-hemispheric superiority is widely confirmed for most of these facial features, some others need to be further explored in order to obtain clearer results (as discussed above, one of these domains is facial gender, for which there is contrasting evidence (e.g., [92,95,96])). Finally, handedness seems to play an important role in hemispheric asymmetry for faces, as shown by functional magnetic resonance studies revealing a stronger activation of the left fusiform face area in left-handers than in right-handers during face perception [104].

4. Perceptual and Attentional Asymmetries for Human Bodies

In more recent years, the DVF paradigm was also introduced in the study of human body parts, and in particular hands. Specifically, the lateralized presentation of bodies and body parts has been suggested as a way to study hemispheric asymmetries in motor representations [105–107]. For instance, it has been shown that participants respond faster when left and right hand stimuli are presented to the ipsilateral hemifield/contralateral hemisphere than when they are presented to the contralateral hemifield/ipsilateral hemisphere [105]. Moreover, Parsons et al. [107] found that callosotomy patients were faster and more accurate in judging the laterality of both left and right hand stimuli when they were presented to the ipsilateral hemifield/contralateral hemisphere than when they were presented to the contralateral hemifield/ipsilateral hemisphere (similar results were observed in healthy controls). In agreement with such findings, de Lussanet et al. [106] suggested that each hemisphere contains better visuo-motor representations for the contralateral body side than for the ipsilateral body side. Specifically, these authors showed that—compared with leftward-facing point-light walkers (PLWs)—rightward-facing PLWs were recognized better in the RVF, whereas—compared with rightward-facing PLWs—leftward-facing PLWs were recognized better in the LVF. In other words, compared with PLWs facing toward the point of gaze, those facing away from the point of gaze appeared more vivid. Such a lateralized facing effect was explained by de Lussanet et al. [106] by proposing that the visual perception of lateralized body stimuli is facilitated when the corresponding visual and body representations are located in the same hemisphere (given the contralateral organization of both the visual and motor-somatosensory systems). Actually, this is true when a PLW faces away from the observer's fixation point, so that a lateralized embodiment of the observed body is fostered because the hemibody seen in the foreground is processed by the sensory-motor cortex located in the same side as the visual cortex processing the stimulus. In line with previous studies [105–107], Marzoli et al. [108,109] and Lucafò et al. [110,111] showed that both static and dynamic human silhouettes with ambiguous handedness or footedness were interpreted more frequently as right-limbed in the RVF than in the LVF, corroborating the notion that a link exists between the visual representation of others' bodies and the hemispheric specialization of one's own body. Compared with the findings by Aziz-Zadeh et al. [105], de Lussanet et al. [106] and Parsons et al. [107], those by Lucafò, Marzoli et al. [108,109] indicate that the right and left hemispheres do not merely facilitate the recognition of stimuli with a specific laterality (respectively, left and right hands or leftward- and rightward-facing PLWs), but that they can also foster a biased interpretation of ambiguous stimuli (respectively, left and right limb actions). Thus, whereas several studies show that right- and left-handed individuals differ as regards the laterality of hand action representations, the DVF paradigm indicates that each hemisphere is biased not

only to perform but also to perceive contralateral hand actions, revealing a subtle instance of embodiment.

It should be noticed that asymmetries in the perception of human bodies or body parts have also been reported in studies that do not resort to the DVF paradigm. Specifically, various studies investigating the perception of sport actions showed that the result of right limb actions is anticipated better than that of left limb actions [112–118]. As suggested by Hagemann [112] and Loffing et al. [114] (see also [113,115,116,118,119]), the ability to discriminate actions performed with the left hand is less developed than that to discriminate actions performed with the right hand. This is consistent with the advantage that left-handers and left-footers exhibit in several interactive sports [119–136]. These findings could be considered as evidence of the perceptual and attentional bias toward the right side of others' bodies reported by Lucafò, Marzoli and collaborators. Specifically, these authors used static silhouettes with ambiguous orientation [108,137,138] (Figure 3) and dynamic silhouettes with ambiguous spinning direction [110,111,139], and thus with ambiguous handedness or footedness, and found that participants exhibited a significant tendency to interpret the silhouettes as right-limbed rather than left-limbed. On the whole, these results could be interpreted as due to a perceptual frequency effect (see also [140]): in most social exchanges, we observe and interact with right-limbed individuals, which might result in a better discrimination of right limb movements by both right- and left-handers. From an evolutionary point of view, the attentional and perceptual bias toward the right limbs could be adaptive in daily social life, given the high frequency of face-to-face interactions with right-limbed individuals (for a more detailed discussion, see [141]). Therefore, the tendency to pay attention to the body region that usually contains others' dominant hands or feet might entail an enhanced detection of both communicative and aggressive acts, because the right limb is more used than the left in both types of behavior. However, the aforementioned perceptual frequency effect [140], by prompting individuals to preferentially attend to the right side of human bodies rather than to the left one, might jeopardize the monitoring of left limb actions. This would result in a reduced ability to discriminate left limb actions in comparison with right limb actions, which in turn might account for the “surprise effect” regarded as the crucial factor for the advantage shown by left-handers in fighting and sport [119–136].

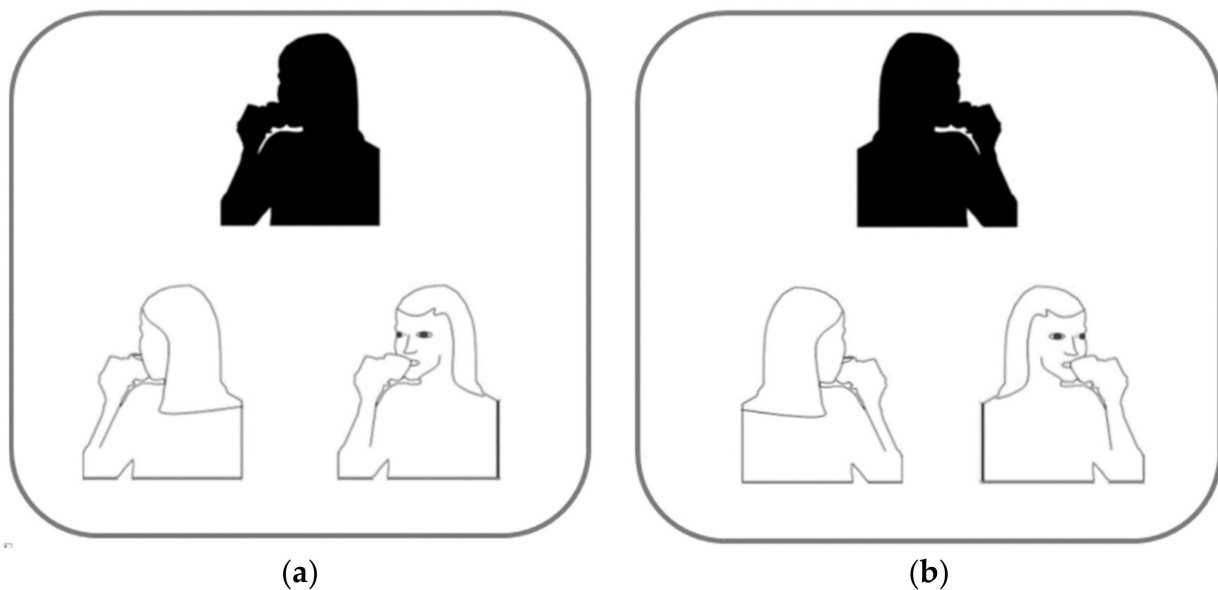


Figure 3. Examples of static silhouettes with ambiguous orientation with the action represented on the left (a) and right (b) side of the figure. Although participants tend to perceive front- rather than back-facing stimuli, a larger proportion of right- rather than left-handed actions is perceived.

5. Asymmetries in Social Touch

Many other examples of behavioral asymmetries can be found during social interactions among humans, and are mainly observed in complex motor activities such as embracing, kissing and infant-holding, wherein the motor behavior shared reciprocally by two persons entails necessarily a sensory counterpart, social touch [6,142]. Relatively few studies have systematically investigated the first two instances of interactive social touch, showing a substantial rightward asymmetry for both embracing [143,144] and kissing [145], with the latter finding being considered as more controversial (e.g., see [146]). As regards infant-holding, the left-cradling bias (LCB: the tendency to hold infants predominantly using the left rather than the right arm [147]; Figure 4) has received much more scholarly attention over the last 60 years. Although this lateralized behavior, differently from those reviewed above, refers to a motor rather than perceptual asymmetry, it nonetheless entails dealing with a human social stimulus (the infant) and seems to be related as well to perceptual asymmetries for social/emotional stimuli. Accordingly, we argue that a guiding thread exists between the aforementioned LVF advantage for faces, the higher social salience of infant facial features found in women than in men [148–150], and the left-sided infant positioning during cradling interactions being shown to a greater extent by women than by men [151]. First of all, it should be noticed that a fairly robust LCB has been shown—regardless of assessment methodologies—both in left-handed women (and men, although to a lesser degree [152,153]) and in a mother affected by situs inversus with dextrocardia (i.e., a condition in which the heart is atypically placed in the right rather than the left side of the chest [154]). Therefore, the two first explanations proposed, namely the “handedness” (i.e., cradling infants with the non-dominant hand would free the dominant arm for other tasks [155]) and “heartbeat” (i.e., cradling infants on the left side would enhance the soothing effect of the mother’s heartbeat sound [147]) hypotheses cannot be accepted as reliable accounts of the LCB. On the contrary, it is now believed that the LCB is due to a population-level right-hemispheric dominance for socio-emotional processing, as suggested by several studies carried out in this particular field over the last three decades (e.g., [156]). For example, Harris et al. [157] used the chimeric face paradigm in order to reveal the relationship between participants’ right-hemispheric specialization for processing facial emotion and their lateral cradling preference, as assessed by means of an imagination task. These authors found that participants who imagined holding the infant on the left side showed a stronger LVF advantage (i.e., judged as more expressive the chimeras in which the emotional half was on the left side of the face) compared with participants who imagined holding the infant on the right side. Bourne and Todd [158] confirmed this finding using the chimeric face paradigm as well and a life-like doll to assess participants’ cradling lateral preferences. Consistent findings were reported by Vauclair and Donnot [159], who used a similar methodology (chimeric face paradigm and doll cradling task), although only in women. Interestingly, Harris et al. [160] corroborated their previous findings by showing a relationship between the LVF advantage for emotional faces and the left-side bias for holding when participants handled a doll, but not a book or a bag. Furthermore, Huggenberger et al. [161] argued that cradling-side preferences might serve the function of saving cognitive resources during the monitoring of socio-emotional states from the infant face: these authors showed that the preferred side of cradling corresponded to a lower response bias (i.e., the erroneous assignment of emotional states to neutral stimuli) to infant face stimuli presented in the ipsilateral visual field. Very recently, using a task consisting in the simple evaluation of the attractiveness of neutral baby faces, it has been found that left-cradling women showed a larger preference for left-facing profiles (i.e., those including the more expressive side of the face [162]) rather than right-facing profiles of human babies compared with right-cradling women [163]. Despite few instances of inconsistent results (e.g., [164–167]), it is possible to conclude that a relationship exists between the LCB and the LVF advantage for faces, further supporting the “hemispheric asymmetry” account of the LCB.



Figure 4. Example of left-crading bias (LCB).

Assuming that, as seen before, the right hemisphere of the brain is specialized not only for the visual processing of faces, but also for the auditory processing of emotional voices and sounds, a link between the LCB and auditory lateralization has also been suggested [168]. This issue was widely discussed in the early 2000s and then surprisingly shelved. In fact, very few studies have examined in depth such a potential link by exploiting standardized paradigms (e.g., DL), and inconsistent results were observed. In particular, Turnbull and Bryson [169] empirically investigated, in a sample of nulliparous women, the relationship between the LCB, as measured with a doll task, and the LEA for speech prosody, as measured with an emotional DL task (i.e., a task in which the same sentence spoken in different emotional tone is simultaneously presented to the left and right ear). They reported no significant correlation between the measures of LCB and LEA, apparently not supporting the existence of an association between the cradling lateral preference and the right-hemispheric dominance for the auditory processing of social stimuli. However, Sieratzki et al. [170] raised methodological issues about Turnbull and Bryson's [169] results, reanalyzed their data and claimed that the LEA was almost significantly larger in left-crading participants (94.4%) than in right-crading participants (75%); see also [171] for further details on this controversy. Whilst Donnot and Vauclair [164] confirmed the absence of an association between the LCB and asymmetries in the auditory modality in a sample of new mothers, Donnot [172], who tested only left-handers in order to neutralize the potential effects of handedness, showed a significant correlation between the LCB and the LEA for perceiving emotions in left-handed female students, but not in left-handed mothers. When taken together, all the above mentioned results seem to converge toward a cerebral explanation of the population-level LCB underpinned by the right-hemispheric specialization for the processing of socio-emotional stimuli in humans. However, conflicting, albeit sparse, results on visual and auditory asymmetries cannot be ignored.

In dealing with the LCB, many authors seem to also consider the role of both the mental state of the cradling individual (usually the mother) and the quality of the mother–infant socio-emotional relationship. In particular, it has been widely shown that depression [173–176], stress and social pressures [177–181], anxiety [167,182], negative attachment styles [183,184], low social and cognitive competencies [185,186], autistic traits and low empathic abilities [187–189] and even racial prejudice toward the cradled individual [190] could decrease to some extent the prevalence of the LCB. Therefore, it could be hypothesized that the typical LCB can be reduced or reversed by any impairment in the socio-emotional well-being of the cradling individual, which in turn might somehow have a negative effect on the

exchange of emotional information (through the respective right cerebral hemispheres) between the cradler and the cradled individual. It should be remarked that this point has been very recently pushed beyond by suggesting an epigenetic role of the LCB on the brain development of the cradled child. In particular, it has been hypothesized that the typical LCB “received” during infancy might be part of a complex biobehavioral system fostering the development of a typically lateralized brain in the child, whereas systematic deviations from the LCB might represent an early sign—among many others—of the later incidence of neurodevelopmental disorders [151,191,192]. Given that the aforementioned aspects represent a still open issue, it should be said that further investigations are needed to conclusively determine the role of the right hemisphere in the emergence of the LCB as a population-level bias, as well as to find out which—and to what extent—environmental, epigenetic and other potential factors are influential.

6. A Possible Role for Social Interactions in the Link between Perceptual and Motor Asymmetries?

On the basis of the reviewed literature, we can notice how many instances of human behavioral lateralization emerge when social stimuli (and, specifically, human faces, voices and bodies) are involved. It is noteworthy that, to our knowledge, there are no occurrences of similarly strong perceptual asymmetries for non-social stimuli (indeed, most instances of perceptual asymmetries for non-social stimuli are detected, by and large, in laboratory settings). Therefore, one might wonder whether a common origin for such asymmetries for social stimuli could be identified. In this respect, we must point out that an association between handedness and perceptual asymmetries has often been suggested [193], but its explanation has not usually gone beyond the proposal of hypothesized advantages in terms of division of labor between the hemispheres or related disorders when such a division is absent [194–196]. However, it should be stressed how some authors have recently proposed a link between perceptual and motor asymmetries, although there is not yet a common view in this respect (e.g., [197–199]). If the link between perceptual and motor asymmetries is extended to social interactions among conspecifics, this view would be in line with previous data showing a relationship between cradling asymmetries and aesthetic preferences for baby face profiles [163] or a right-ear orienting in individual listening in a noisy environment [49], as well as with the account in terms of perceptual frequency proposed for the left-handers’ and left-footers’ advantage in sports [119–136] and for the attentional and perceptual bias toward the right side of human bodies [108,110–118,137–139]. However, what is still missing is a comprehensive theory allowing to account for the emergence of the different asymmetries in social behavior and their possible relationships. Of course, outlining a similar theory represents an ambitious but worthy challenge, because it could deeply improve our understanding of brain asymmetries. The fact that such asymmetries seem to involve mostly social stimuli constitutes a useful standing point, circumscribing the range of phenomena to be investigated.

It has been proposed that lateralization could result in a substantial increase in the brain capacity to execute several processes simultaneously and that it might remain stable at the population level for the sake of coordination among conspecifics [9], and thus it is not astonishing that also in humans it emerges mainly during the processing of social stimuli. However, whereas the coordination hypothesis might account for various instances of motor asymmetries (in particular, handedness, cradling, embracing and kissing), it cannot be easily applied to several perceptual asymmetries whose alignment at the population level does not reveal—at first sight—a clear adaptive function. The (maybe) simplest explanation could be that a genetic specification for the site of each brain function might improve brain efficiency, for example, by reducing the so-called “cognitive crowding” [194–196], but such an account suffers from the fact that no single specific gene has yet been identified for either motor or perceptual asymmetries, which likely have a polygenic basis [200]. An alternative explanation could be that, once certain “core asymmetries” are established (likely under genetic control during typical development), they foster the emergence of

further asymmetries which are more affected by epigenetic factors (e.g., see [198,201] for similar considerations), and this would be in agreement with the polygenic view on brain lateralization. Although, in light of the present knowledge, this might appear an ambitious theory, we point out how some authors have already attempted to link the development of motor and perceptual asymmetries. For example, Karim et al. [198] hypothesize that biases in visuospatial functions might foster other instances of cerebral lateralization such as handedness and turning behavior. However, these authors recognize that further studies are warranted to test their models as well as to clarify the effects of cultural and environmental factors on the emergence of behavioral and neural asymmetries. A similarly crucial role of environment in the development of lateralization has been proposed by Rogers [199], who also hypothesizes that sensory lateralization precedes motor lateralization. Several authors suggest that the development of handedness might arise from a spontaneous preference to turn the head to the right which can be already observed in fetuses and newborns [202–207]. However, social aspects could also be involved in the emergence of right-handedness, children imitating adults' handedness preferences [208–211]. Interestingly, this might also explain the finding that left-handedness is more common among right-cradled children [212], both because their right-cradling mothers are more likely to be left-handed [155,212,213] (see [152] for a meta-analysis and review) and because holding the infant on the right side would free the left hand for other tasks [155,214]. In this respect, it should be noticed that cradling side seems to be associated with hand preferences of both mother and infant also in nonhuman primates [215–217].

7. Potential Effects of Social Interactions on Functional Lateralization

Observed handedness—due to the high prevalence of right-handed individuals at the population level (e.g., see [1,2])—might account for both the left-handers' edge in sports [119–136] and the attentional and perceptual bias toward the right side of human bodies [108,110–118,137–139], likely due to the potential advantage of attending to the right side of others' bodies, which usually hosts their dominant hand and foot. Marzoli, Prete and Tommasi [141] also proposed that such an attentional and perceptual bias toward the right limbs of others, which fall in the observer's LVF during face-to-face interactions, might foster the emergence of several leftward biases in spatial attention, such as those observed in pseudoneglect (see [3] for a review) and face perception (e.g., [5]). In particular, the notion that continuous interactions with right-handed individuals might contribute to the emergence of the leftward bias for faces would be corroborated by research showing that such a bias can also be found in children aged around 5 years and seems to increase until reaching a level comparable to that of adults by the age of around 10 years (see [218] for a review). This proposal is further supported by the finding that, whereas in infancy a broad leftward bias can be observed for both upright and inverted human faces, monkey faces and objects, in adulthood a leftward bias is only observed for upright human faces [219] (see [220] for congruent findings in chimpanzees). Moreover, the increase in leftward bias is observed exclusively for human faces, which likely indicates the involvement of experience-dependent developmental factors [221]. A leftward bias for human faces was also found in laboratory-raised rhesus monkeys and domestic dogs [219]. We point out that in dogs no bias was observed for monkey and dog faces, and we suppose that such a selectivity might be explained more by continuous interactions with right-handed humans (see [220] for congruent findings in chimpanzees) than by other interpretations such as the existence, not only in humans but also in dogs, of a right-hemispheric specialization for human but not dog faces. It should be noticed that there is some evidence of population-level right-handedness in various primates such as rhesus monkeys, baboons, gorillas and chimpanzees [222,223]. Such a bias is observed more often in captive than in wild primates, and during communicative gestures than in non-communicative gestures. This specificity could be a consequence of interactions with humans [222,223] and could indicate that also in nonhuman primates social factors might contribute to the emergence of the left-face/LVF bias observed during emotional processing (see [224] for a review). The proposal that left-

ward biases might be promoted by the frequent interaction with right-handed individuals is in agreement with both experience-expectant and experience-dependent views of brain development [225], as well as with previous research indicating that the lateralization of face processing can be affected by experience (e.g., infant holding biases [226] and reading habits [227–230]). However, it should be remarked that the emergence of such biases cannot be accounted for by reading habits both because eye-tracking studies indicate that, as regards face perception, a LVF bias appears within the first 9–11 months of life [231,232] and because the leftward bias becomes increasingly more specific for upright human faces with age [219]. On the contrary, our hypothesis would be in agreement with the reduced left-bias for chimeric faces observed in adults whose mothers exhibited a right-cradling bias [226], given that such women are more likely to be left-handed [155,212,213] (see [152] for a meta-analysis and review) and—more in general—to use the left hand for concurrent tasks while cradling [155,214]. Moreover, the age-related increase in the strength and selectivity of the LFB [218,219] might be due to the growing experience with right-handed individuals. The developmental trend observed in right-hemispheric specialization for faces has also been ascribed to a concomitant increase in right-hemispheric specialization for configural processing [233], which is disrupted by face inversion [234]. The configural processing of human bodies is also disrupted by inversion (e.g., [235,236]), and it was suggested that human body configural information might incorporate the implicit knowledge that the dominant hand is commonly located on the right side [141], a hypothesis corroborated by the finding that the bias to perceive right-handed actions in ambiguous human silhouettes is abolished by inversion [138]. In our opinion, the proposed link between the high prevalence of right-handedness and the emergence of a LFB might also account for why face inversion disrupts not only configural processing [234] but also the leftward bias/right-hemispheric advantage for face processing [233,237–241]. The association between configural processing and the leftward bias/right-hemispheric specialization for faces seems to be further supported by their analogous developmental trends, given that, as occurs for the LFB, configural processing and face-inversion effects also reach a level comparable to that of adults by the age of around 10 years [242–244]. In this respect, it should be noticed that both the face inversion effect [245,246] and the leftward bias for face processing [231,247] (see also [248]) are observed to a lesser extent in individuals with autism, who show impaired configural processing [249].

8. Selectivity of Perceptual Asymmetries in Light of Face-to-Face Interactions with Right-Handed Individuals

The possible association between social factors and the LFB seems to be supported by the fact that adult humans show a leftward bias for upright human faces, but not for other stimuli such as fractals, landscapes or vases [250,251]. In particular, Leonards and Scott-Samuel [250] suggested that the leftward bias could be specific to socially relevant stimuli. Such a hypothesis is consistent with research indicating that the leftward bias for faces increases when the stimuli or tasks imply a higher emotional load [238,252,253]. Moreover, centrally presented social stimuli consisting of gaze cues improve the ability to detect spatially congruent targets shown in the LVF (i.e., the region that contains the right hand of the observed individuals during face-to-face interactions) but not in the RVF, whereas the effect of non-social stimuli consisting of arrow cues is similar in both visual fields [254] (see also [255]). A series of studies by Mogg and Bradley [256,257] corroborated the notion that social relevance might foster the emergence of leftward attentional asymmetries. These authors found that, compared with happy and neutral faces, threatening faces prompted a greater attentional capture when the faces were flashed subliminally in the LVF but not in the RVF, and this effect was stronger for more anxious participants. A similar pattern of results was reported by Field [258], who generalized the leftward bias for threatening stimuli to another population (children aged 7–9 years) and another class of stimuli (animals). Thus, although the leftward bias/right-hemispheric dominance seems to be particularly evident for faces, it can be extended to other classes of stimuli, as also

demonstrated by results that generalize the LVF bias to pictures of houses and cars [259] and line drawings of common objects [260]. However, we deem that more general perceptual and attentional asymmetries might emerge from an early leftward bias for bodies and/or faces: given that the bodies and faces of our conspecifics are at the same time the most ecologically relevant and one of the most recurring stimuli we encounter in everyday life, the asymmetrical processing elicited by such stimuli might generalize to other domains (at least to some degree). In this respect, the fact the leftward bias for faces and pseudoneglect exhibit a similar developmental trend might suggest their related origin [261–263].

According to the literature reviewed, compared to non-social stimuli, social (and, in particular, emotional) stimuli are more likely to elicit perceptual and attentional asymmetries. As already claimed by Watling et al. [218], future studies should clarify which are the advantages provided to emotion processing by lateralization and which are the related sex differences. For example, children's left hemispatial advantage for emotion perception is positively related to their ability to recognize emotional states in eyes and in cartoon situations [264], as well as in faces, but this is true exclusively for males [265]. Dahl et al. [220] extended such findings by showing that in both humans and chimpanzees the ability to discriminate faces of both species is positively related to left-lateralized processing. On the whole, these findings might indicate an association between the lateralized processing of faces and the recognition of others' emotional/cognitive states. This link seems to be corroborated by their similar developmental trend, given that theory of mind emerges by the age of 4 years and improves during childhood [266]. It should be also remarked that the leftward bias for faces reaches a level comparable to that of adults by the age of around 10 years [73,233,247,264], shortly before the emergence in children of a preference for the left eye (from the observer's perspective) during face scanning [267] and of a clear enhancement of the ability to recognize emotion from eyes [268]. As already proposed [141], an advantageous consequence of the right-hemispheric dominance for emotion processing might consist in the possibility to monitor both emotional states and actions of other individuals within the same hemisphere. Moreover, the constant association between the facial expressions and eye movements of interaction partners' and their right-handed actions might strengthen leftward biases. Given that emotions are expressed more intensely on the left side of the face, which is in the RVF of observers in face-to-face interactions [269], the LFB observed for emotion processing might be regarded as counterintuitive. However, it should be noticed that the expression of anger seems to be more intense on the right side of the face [270] and that, compared with pro-social emotions, anti-social emotions (and, in particular, anger) seem to elicit a larger LFB [271]. Thus, the LFB appears to be less counterintuitive if one considers the potential ecological advantages that might ensue from the combined tendency to direct attention toward both the hemiface that expresses threat-related facial displays more intensely and the region that contains the right arm of an angry individual. This would be especially important during interactions among males (because of their higher odds of resulting in violent conflicts), and it is not surprising that, compared with females, males exhibit a stronger LFB [68] (see also [272]; see [121,132,273] for consistent findings in sport studies). Moreover, the LFB reaches its utmost degree in males observing male faces that express anger rather than any of the other basic emotions or female faces that express any basic emotion [274]. The prominent role of anger in comparison with other emotions has also been highlighted by Indersmitten and Gur [270] (see [271] for similar considerations), who emphasized both its enhanced likelihood of being detected by the observer (the fact that anger is expressed more intensely on the right hemiface increases its impact on the right hemisphere, which is specialized for emotion processing) and its quality of evolutionarily important precursor of action (it activates the organism in anticipation of conflicts). In this respect, it is not astonishing that a greater leftward bias is observed in more anxious than in less anxious individuals [275–278], and one could also wonder whether a greater attention toward the right limbs of human bodies is observed in anxious than in non-anxious individuals.

9. Conclusions

The abovementioned advantages of lateralization for emotion processing are in agreement with previous suggestions (e.g., [8,9]) that (i) functional hemispheric specialization may enhance cognitive capacity and efficiency (e.g., a positive association is found between the LFB for emotion perception and performance in emotion recognition [264,265]), and (ii) the directional alignment (at the population level) of behavioral asymmetries may represent an evolutionary stable strategy shaped by social pressures (e.g., the LFB for emotion processing would be fostered by the advantage of monitoring the emotional states of others and their dominant hand within the same hemisphere). Both points are consistent with both ontogenetic and phylogenetic accounts. For example, the constant exposure to right-handed individuals might facilitate a perceptual and attentional bias toward the right side of others' bodies, corresponding roughly to a LVF bias from the observer's point of view (noteworthy, the effects of such a bias seem to be intensified and attenuated by a specific perceptual training represented by the visual presentation of right- and left-handed actions, respectively [118]), as well as a leftward bias/right-hemispheric advantage for the processing of emotional faces, which in turn could lead to a general specialization of the right hemisphere for emotion processing. In turn, the left-cradling bias might arise from the right-hemisphere specialization for emotion processing in the visual, auditory or tactile domain (for consistent findings, see [158–161,170,172]). On the contrary, it has also been proposed that the mother's left-cradling preference might foster a LFB in the cradled individual [226]. Analogously, McManus and Humphrey [279] and Conesa et al. [280,281] speculated that the LCB might account for a preference for left-facing profiles, because when newborns are held on the mother's left arm during the first months of life, they are also exposed to her left profile during a critical period for the development of vision. Moreover, the possible advantage for cradlers of freeing their dominant arm for other tasks cannot be ruled out [155,214] with regard to the emergence of a LCB. It has also been suggested [214] that the LCB might have emerged—for the very same advantage—during human evolution, which would be consistent with the idea that specific genes or—more likely—sets of genes have been selected in order to locate different functions in different brain areas (e.g., cradling behavior and emotion processing in the right hemisphere; speech and praxis in the left hemisphere [282]) so as to improve neural and behavioral efficiency, for example, by avoiding “cognitive crowding” [194–196,283]. In this respect, the LCB might be included in a set of lateralized behaviors which can improve individuals' biological fitness. Although it is unclear which evolutionary pressures shaped such behavioral asymmetries, animal studies suggest a common pattern of lateralization in vertebrates. In particular, the right hemisphere could be dominant for avoidance responses, for detecting and reacting to threatening stimuli (e.g., predators), and for monitoring conspecifics (including infants), whereas the left hemisphere could be dominant for processing approach and manipulation responses (see [8] for a review). In line with the proposal of Giljov, Karenina and Malashichev [284], the LCB would emerge (if not exclusively, at least mainly) when a face-to-face interaction between mother and child occurs. This situation implies that the right hemisphere processes most socio-emotional information, and several studies indicate a crucial role for visual information in the modulation of the LCB [156–161,163]. As for humans [152,155,212,213], the LCB seems to predict both infant's and mother's hand preferences also in nonhuman primates [215–217]. As previously stated, some evidence of population-level right-handedness is observed in various primates and could be a consequence of interactions with right-handed humans [222,223], which might also account for the leftward bias for human faces observed in primates and dogs [219,220]. These findings suggest that social factors might contribute to the emergence of the LFB/LVF bias observed during emotional processing also in other species, and nonhuman primates in particular (see [224] for a review). However, animal studies should be considered with caution in respect to the origin of the LFB, because several results do not indicate a central role of interaction with humans. For example, a LVF advantage for conspecific [285] but not human [286] faces is observed in sheep. Moreover, a LVF preference for monitoring a

human-like dummy mask [287] is found in domestic chicks without any visual experience of human eyes and gaze, indicating that the emergence of leftward biases for human faces can be entirely independent from interaction with humans. Nonetheless, many authors aim to establish an evolutionary link between animal and human laterality. For example, a recent review by Boulinguez-Ambroise, Aychet and Pouydebat [215] attempts to frame the evolution of human handedness by examining limb preferences in animals. In particular, these authors claim that limb lateralization in animals is associated with both genetic and ontogenetic factors (the latter including social interactions) and that limb lateralization for actions directed to self or conspecifics is related to hemispheric asymmetries for emotion processing. In our opinion, the effects of epigenetic factors acting on the basis of genetically driven “core asymmetries” and of environmental influences should be considered when attempting to explain the origin of asymmetries in the processing of social stimuli (e.g., see [198,201] for similar considerations). In summary, outlining a broad theory allowing to account for the emergence of asymmetries in social behavior is an ambitious goal, but we hope that the present review may stimulate further investigations on this complex topic.

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References

1. Coren, S. The Lateral Preference Inventory for Measurement of Handedness, Footedness, Eyedness, and Earedness: Norms for Young Adults. *Bull. Psychon. Soc.* **1993**, *31*, 1–3. [[CrossRef](#)]
2. Papadatou-Pastou, M.; Ntolka, E.; Schmitz, J.; Martin, M.; Munafò, M.R.; Ocklenburg, S.; Paracchini, S. Human Handedness: A Meta-Analysis. *Psychol. Bull.* **2020**, *146*, 481–524. [[CrossRef](#)]
3. Jewell, G.; McCourt, M.E. Pseudoneglect: A Review and Meta-Analysis of Performance Factors in Line Bisection Tasks. *Neuropsychologia* **2000**, *38*, 93–110. [[CrossRef](#)]
4. Kimura, D. Cerebral Dominance and the Perception of Verbal Stimuli. *Can. J. Psychol./Rev. Can. Psychol.* **1961**, *15*, 166–171. [[CrossRef](#)]
5. Burt, D.M.; Perrett, D.I. Perceptual Asymmetries in Judgements of Facial Attractiveness, Age, Gender, Speech and Expression. *Neuropsychologia* **1997**, *35*, 685–693. [[CrossRef](#)]
6. Packheiser, J.; Schmitz, J.; Metzen, D.; Reinke, P.; Radtke, F.; Friedrich, P.; Güntürkün, O.; Peterburs, J.; Ocklenburg, S. Asymmetries in Social Touch-Motor and Emotional Biases on Lateral Preferences in Embracing, Cradling and Kissing. *Laterality* **2020**, *25*, 325–348. [[CrossRef](#)] [[PubMed](#)]
7. Stochl, J.; Croudace, T. Predictors of Human Rotation. *Laterality* **2013**, *18*, 265–281. [[CrossRef](#)] [[PubMed](#)]
8. Vallortigara, G.; Rogers, L.J. Survival with an Asymmetrical Brain: Advantages and Disadvantages of Cerebral Lateralization. *Behav. Brain Sci.* **2005**, *28*, 575–633. [[CrossRef](#)]
9. Vallortigara, G.; Rogers, L.J. A Function for the Bicameral Mind. *Cortex* **2020**, *124*, 274–285. [[CrossRef](#)]
10. Kimura, D. Some Effects of Temporal-Lobe Damage on Auditory Perception. *Can. J. Psychol.* **1961**, *15*, 156–165. [[CrossRef](#)]
11. Broadbent, D.E. The Role of Auditory Localization in Attention and Memory Span. *J. Exp. Psychol.* **1954**, *47*, 191–196. [[CrossRef](#)]
12. Bryden, M.P. An Overview of the Dichotic Listening Procedure and Its Relation to Cerebral Organization. In *Handbook of Dichotic Listening: Theory, Methods and Research*; John Wiley & Sons: Oxford, UK, 1988; pp. 1–43, ISBN 978-0-471-91267-5.
13. Bryden, M.P. Order of Report in Dichotic Listening. *Can. J. Psychol./Rev. Can. Psychol.* **1962**, *16*, 291–299. [[CrossRef](#)]
14. Shankweiler, D.; Studdert-Kennedy, M. Identification of Consonants and Vowels Presented to Left and Right Ears. *Q. J. Exp. Psychol.* **1967**, *19*, 59–63. [[CrossRef](#)]
15. Brancucci, A.; D’Anselmo, A.; Martello, F.; Tommasi, L. Left Hemisphere Specialization for Duration Discrimination of Musical and Speech Sounds. *Neuropsychologia* **2008**, *46*, 2013–2019. [[CrossRef](#)]
16. Kimura, D. Functional Asymmetry of the Brain in Dichotic Listening. *Cortex* **1967**, *3*, 163–178. [[CrossRef](#)]

17. Sidtis, J.J. Dichotic Listening after Commissurotomy. In *Handbook of Dichotic Listening: Theory, Methods and Research*; John Wiley & Sons: Oxford, UK, 1988; pp. 161–184, ISBN 978-0-471-91267-5.
18. Brancucci, A.; Babiloni, C.; Babiloni, F.; Galderisi, S.; Mucci, A.; Tecchio, F.; Zappasodi, F.; Pizzella, V.; Romani, G.L.; Rossini, P.M. Inhibition of Auditory Cortical Responses to Ipsilateral Stimuli during Dichotic Listening: Evidence from Magnetoencephalography. *Eur. J. Neurosci.* **2004**, *19*, 2329–2336. [[CrossRef](#)]
19. Della Penna, S.; Brancucci, A.; Babiloni, C.; Franciotti, R.; Pizzella, V.; Rossi, D.; Torquati, K.; Rossini, P.M.; Romani, G.L. Lateralization of Dichotic Speech Stimuli Is Based on Specific Auditory Pathway Interactions: Neuromagnetic Evidence. *Cereb. Cortex* **2007**, *17*, 2303–2311. [[CrossRef](#)]
20. Pollmann, S.; Maertens, M.; von Cramon, D.Y.; Lepsien, J.; Hugdahl, K. Dichotic Listening in Patients with Splenial and Nonsplenial Callosal Lesions. *Neuropsychology* **2002**, *16*, 56–64. [[CrossRef](#)]
21. Kinsbourne, M. Dichotic Imbalance Due to Isolated Hemisphere Occlusion or Directional Rivalry? *Brain Lang.* **1980**, *11*, 221–224. [[CrossRef](#)]
22. Kinsbourne, M. The Cerebral Basis of Lateral Asymmetries in Attention. *Acta Psychol.* **1970**, *33*, 193–201. [[CrossRef](#)]
23. Binder, J.R.; Frost, J.A.; Hammeke, T.A.; Bellgowan, P.S.; Springer, J.A.; Kaufman, J.N.; Possing, E.T. Human Temporal Lobe Activation by Speech and Nonspeech Sounds. *Cereb. Cortex* **2000**, *10*, 512–528. [[CrossRef](#)]
24. Brancucci, A.; Tommasi, L. “Binaural Rivalry”: Dichotic Listening as a Tool for the Investigation of the Neural Correlate of Consciousness. *Brain Cogn.* **2011**, *76*, 218–224. [[CrossRef](#)]
25. Hugdahl, K.; Brønneck, K.; Kyllingsbaek, S.; Law, I.; Gade, A.; Paulson, O.B. Brain Activation during Dichotic Presentations of Consonant-Vowel and Musical Instrument Stimuli: A 15O-PET Study. *Neuropsychologia* **1999**, *37*, 431–440. [[CrossRef](#)]
26. Brancucci, A.; Della Penna, S.; Babiloni, C.; Vecchio, F.; Capotosto, P.; Rossi, D.; Franciotti, R.; Torquati, K.; Pizzella, V.; Rossini, P.M.; et al. Neuromagnetic Functional Coupling during Dichotic Listening of Speech Sounds. *Hum. Brain Mapp.* **2008**, *29*, 253–264. [[CrossRef](#)]
27. Van den Noort, M.; Specht, K.; Rimol, L.M.; Erslund, L.; Hugdahl, K. A New Verbal Reports fMRI Dichotic Listening Paradigm for Studies of Hemispheric Asymmetry. *Neuroimage* **2008**, *40*, 902–911. [[CrossRef](#)]
28. Westerhausen, R.; Kompus, K.; Hugdahl, K. Mapping Hemispheric Symmetries, Relative Asymmetries, and Absolute Asymmetries Underlying the Auditory Laterality Effect. *Neuroimage* **2014**, *84*, 962–970. [[CrossRef](#)]
29. Prete, G.; D’Anselmo, A.; Tommasi, L.; Brancucci, A. Modulation of the Dichotic Right Ear Advantage during Bilateral but Not Unilateral Transcranial Random Noise Stimulation. *Brain Cogn.* **2018**, *123*, 81–88. [[CrossRef](#)]
30. D’Anselmo, A.; Prete, G.; Tommasi, L.; Brancucci, A. The Dichotic Right Ear Advantage Does Not Change with Transcranial Direct Current Stimulation (TDCS). *Brain Stimul.* **2015**, *8*, 1238–1240. [[CrossRef](#)] [[PubMed](#)]
31. Marquardt, L.; Kusztrits, I.; Craven, A.R.; Hugdahl, K.; Specht, K.; Hirnstein, M. A Multimodal Study of the Effects of TDCS on Dorsolateral Prefrontal and Temporo-Parietal Areas during Dichotic Listening. *Eur. J. Neurosci.* **2021**, *53*, 449–459. [[CrossRef](#)] [[PubMed](#)]
32. Hugdahl, K. Hemispheric Asymmetry: Contributions from Brain Imaging. *Wiley Interdiscip. Rev. Cogn. Sci.* **2011**, *2*, 461–478. [[CrossRef](#)] [[PubMed](#)]
33. Tervaniemi, M.; Hugdahl, K. Lateralization of Auditory-Cortex Functions. *Brain Res. Rev.* **2003**, *43*, 231–246. [[CrossRef](#)]
34. Bless, J.J.; Westerhausen, R.; von Koss Torkildsen, J.; Gudmundsen, M.; Kompus, K.; Hugdahl, K. Laterality across Languages: Results from a Global Dichotic Listening Study Using a Smartphone Application. *Laterality* **2015**, *20*, 434–452. [[CrossRef](#)] [[PubMed](#)]
35. Hugdahl, K. Fifty Years of Dichotic Listening Research—Still Going and Going and *Brain Cogn.* **2011**, *76*, 211–213. [[CrossRef](#)]
36. Fennell, E.B.; Satz, P.; Morris, R. The Development of Handedness and Dichotic Ear Listening Asymmetries in Relation to School Achievement: A Longitudinal Study. *J. Exp. Child Psychol.* **1983**, *35*, 248–262. [[CrossRef](#)]
37. Hirnstein, M.; Westerhausen, R.; Korsnes, M.S.; Hugdahl, K. Sex Differences in Language Asymmetry Are Age-Dependent and Small: A Large-Scale, Consonant-Vowel Dichotic Listening Study with Behavioral and fMRI Data. *Cortex* **2013**, *49*, 1910–1921. [[CrossRef](#)]
38. Westerhausen, R.; Bless, J.; Kompus, K. Behavioral Laterality and Aging: The Free-Recall Dichotic-Listening Right-Ear Advantage Increases With Age. *Dev. Neuropsychol.* **2015**, *40*, 313–327. [[CrossRef](#)]
39. Voyer, D. Sex Differences in Dichotic Listening. *Brain Cogn.* **2011**, *76*, 245–255. [[CrossRef](#)]
40. Bryden, M.P. Correlates of the Dichotic Right-Ear Effect. *Cortex* **1988**, *24*, 313–319. [[CrossRef](#)]
41. Dos Santos Sequeira, S.; Woerner, W.; Walter, C.; Kreuder, F.; Lueken, U.; Westerhausen, R.; Wittling, R.A.; Schweiger, E.; Wittling, W. Handedness, Dichotic-Listening Ear Advantage, and Gender Effects on Planum Temporale Asymmetry—a Volumetric Investigation Using Structural Magnetic Resonance Imaging. *Neuropsychologia* **2006**, *44*, 622–636. [[CrossRef](#)]
42. Bedoin, N.; Ferragne, E.; Marsico, E. Hemispheric Asymmetries Depend on the Phonetic Feature: A Dichotic Study of Place of Articulation and Voicing in French Stops. *Brain Lang.* **2010**, *115*, 133–140. [[CrossRef](#)]
43. D’Anselmo, A.; Reiterer, S.; Zuccarini, F.; Tommasi, L.; Brancucci, A. Hemispheric Asymmetries in Bilinguals: Tongue Similarity Affects Lateralization of Second Language. *Neuropsychologia* **2013**, *51*, 1187–1194. [[CrossRef](#)] [[PubMed](#)]
44. Tanaka, S.; Kanzaki, R.; Yoshibayashi, M.; Kamiya, T.; Sugishita, M. Dichotic Listening in Patients with Situs Inversus: Brain Asymmetry and Situs Asymmetry. *Neuropsychologia* **1999**, *37*, 869–874. [[CrossRef](#)]

45. Prete, G.; D'Anselmo, A.; Brancucci, A.; Tommasi, L. Evidence of a Right Ear Advantage in the Absence of Auditory Targets. *Sci. Rep.* **2018**, *8*, 15569. [[CrossRef](#)] [[PubMed](#)]
46. Altamura, M.; Prete, G.; Elia, A.; Angelini, E.; Padalino, F.A.; Bellomo, A.; Tommasi, L.; Fairfield, B. Do Patients with Hallucinations Imagine Speech Right? *Neuropsychologia* **2020**, *146*, 107567. [[CrossRef](#)] [[PubMed](#)]
47. Prete, G.; Marzoli, D.; Brancucci, A.; Tommasi, L. Hearing It Right: Evidence of Hemispheric Lateralization in Auditory Imagery. *Hear. Res.* **2016**, *332*, 80–86. [[CrossRef](#)]
48. Prete, G.; Tommasi, V.; Tommasi, L. Right News, Good News! The Valence Hypothesis and Hemispheric Asymmetries in Auditory Imagery. *Lang. Cogn. Neurosci.* **2020**, *35*, 409–419. [[CrossRef](#)]
49. Marzoli, D.; Tommasi, L. Side Biases in Humans (*Homo Sapiens*): Three Ecological Studies on Hemispheric Asymmetries. *Naturwissenschaften* **2009**, *96*, 1099–1106. [[CrossRef](#)]
50. Broca, M.P. Remarques Sur Le Siege de La Faculte Du Langage Articule Suivies Dune Observation Daphemie (Perte de La Parole). *Bull. Mem. Soc. Anat. Paris* **1861**, *6*, 330–357.
51. Wernicke, C. *Der Aphasische Symptomencomplex: Eine Psychologische Studie auf Anatomischer Basis*; Max Cohn & Weigert: Breslau, Germany, 1874.
52. Brancucci, A.; Babiloni, C.; Rossini, P.M.; Romani, G.L. Right Hemisphere Specialization for Intensity Discrimination of Musical and Speech Sounds. *Neuropsychologia* **2005**, *43*, 1916–1923. [[CrossRef](#)]
53. Prete, G.; Fabri, M.; Foschi, N.; Tommasi, L. Voice Gender Categorization in the Connected and Disconnected Hemispheres. *Soc. Neurosci.* **2020**, *15*, 385–397. [[CrossRef](#)]
54. Zatorre, R.J.; Evans, A.C.; Meyer, E.; Gjedde, A. Lateralization of Phonetic and Pitch Discrimination in Speech Processing. *Science* **1992**, *256*, 846–849. [[CrossRef](#)]
55. Erhan, H.; Borod, J.C.; Tenke, C.E.; Bruder, G.E. Identification of Emotion in a Dichotic Listening Task: Event-Related Brain Potential and Behavioral Findings. *Brain Cogn.* **1998**, *37*, 286–307. [[CrossRef](#)]
56. Gadea, M.; Espert, R.; Salvador, A.; Marti-Bonmatí, L. The Sad, the Angry, and the Asymmetrical Brain: Dichotic Listening Studies of Negative Affect and Depression. *Brain Cogn.* **2011**, *76*, 294–299. [[CrossRef](#)]
57. Musiek, F.E.; Weihing, J. Perspectives on Dichotic Listening and the Corpus Callosum. *Brain Cogn.* **2011**, *76*, 225–232. [[CrossRef](#)]
58. Prete, G.; Marzoli, D.; Brancucci, A.; Fabri, M.; Foschi, N.; Tommasi, L. The Processing of Chimeric and Dichotic Emotional Stimuli by Connected and Disconnected Cerebral Hemispheres. *Behav. Brain Res.* **2014**, *271*, 354–364. [[CrossRef](#)]
59. Hugdahl, K.; Law, I.; Kyllingsbaek, S.; Brønneck, K.; Gade, A.; Paulson, O.B. Effects of Attention on Dichotic Listening: An 15O-PET Study. *Hum. Brain Mapp.* **2000**, *10*, 87–97. [[CrossRef](#)]
60. D'Anselmo, A.; Marzoli, D.; Brancucci, A. The Influence of Memory and Attention on the Ear Advantage in Dichotic Listening. *Hear. Res.* **2016**, *342*, 144–149. [[CrossRef](#)]
61. Milovanov, R.; Tervaniemi, M.; Takio, F.; Hämäläinen, H. Modification of Dichotic Listening (DL) Performance by Musico-Linguistic Abilities and Age. *Brain Res.* **2007**, *1156*, 168–173. [[CrossRef](#)]
62. Prete, G.; Fabri, M.; Foschi, N.; Brancucci, A.; Tommasi, L. The “Consonance Effect” and the Hemispheres: A Study on a Split-Brain Patient. *Laterality* **2015**, *20*, 257–269. [[CrossRef](#)]
63. Beiter, R.C.; Sharf, D.J. Influence of Encoding and Acoustic Similarity on the Ear Advantage and Lag Effect in Dichotic Listening. *J. Speech Hear. Res.* **1976**, *19*, 78–92. [[CrossRef](#)]
64. Freeman, B.A.; Beasley, D.S. Lead and Lag Effects Associated with the Staggered Spondaic Word Test. *J. Speech Hear. Res.* **1976**, *19*, 572–577. [[CrossRef](#)]
65. Demareva, V.; Mukhina, E.; Bobro, T.; Abitov, I. Does Double Biofeedback Affect Functional Hemispheric Asymmetry and Activity? A Pilot Study. *Symmetry* **2021**, *13*, 937. [[CrossRef](#)]
66. Schwartz, M.; Smith, M.L. Visual Asymmetries with Chimeric Faces. *Neuropsychologia* **1980**, *18*, 103–106. [[CrossRef](#)]
67. Levy, J.; Heller, W.; Banich, M.T.; Burton, L.A. Asymmetry of Perception in Free Viewing of Chimeric Faces. *Brain Cogn.* **1983**, *2*, 404–419. [[CrossRef](#)]
68. Bourne, V.J. Examining the Relationship between Degree of Handedness and Degree of Cerebral Lateralization for Processing Facial Emotion. *Neuropsychology* **2008**, *22*, 350–356. [[CrossRef](#)] [[PubMed](#)]
69. Voyer, D.; Voyer, S.D.; Tramonte, L. Free-Viewing Laterality Tasks: A Multilevel Meta-Analysis. *Neuropsychology* **2012**, *26*, 551–567. [[CrossRef](#)] [[PubMed](#)]
70. Nicholls, M.E.R.; Smith, A.; Mattingley, J.B.; Bradshaw, J.L. The Effect of Body and Environment-Centred Coordinates on Free-Viewing Perceptual Asymmetries for Vertical and Horizontal Stimuli. *Cortex* **2006**, *42*, 336–346. [[CrossRef](#)]
71. Tommasi, V.; Prete, G.; Tommasi, L. Assessing the Presence of Face Biases by Means of Anorthoscopic Perception. *Atten. Percept. Psychophys.* **2020**, *82*, 2673–2692. [[CrossRef](#)]
72. Bourne, V.J. Chimeric Faces, Visual Field Bias, and Reaction Time Bias: Have We Been Missing a Trick? *Laterality* **2008**, *13*, 92–103. [[CrossRef](#)]
73. Chiang, C.H.; Ballantyne, A.O.; Trauner, D.A. Development of Perceptual Asymmetry for Free Viewing of Chimeric Stimuli. *Brain Cogn.* **2000**, *44*, 415–424. [[CrossRef](#)]
74. Prete, G.; Tommasi, L. The Own-Race Bias and the Cerebral Hemispheres. *Soc. Neurosci.* **2019**, *14*, 549–558. [[CrossRef](#)]
75. Lundqvist, D.; Flykt, A.; Öhman, A. *The Karolinska Directed Emotional Faces (KDEF)*; CD ROM from Department of Clinical Neuroscience, Psychology Section, Karolinska Institutet: Solna, Stockholm County, Sweden, 1998; ISBN 91-630-7164-9.

76. Bourne, V.J. The Divided Visual Field Paradigm: Methodological Considerations. *Laterality* **2006**, *11*, 373–393. [[CrossRef](#)]
77. Prete, G.; Laeng, B.; Tommasi, L. Lateralized Hybrid Faces: Evidence of a Valence-Specific Bias in the Processing of Implicit Emotions. *Laterality* **2014**, *19*, 439–454. [[CrossRef](#)]
78. Prete, G.; Marzoli, D.; Tommasi, L. Upright or Inverted, Entire or Exploded: Right-Hemispheric Superiority in Face Recognition Withstands Multiple Spatial Manipulations. *PeerJ* **2015**, *3*, e1456. [[CrossRef](#)]
79. Prete, G.; Capotosto, P.; Zappasodi, F.; Tommasi, L. Contrasting Hemispheric Asymmetries for Emotional Processing from Event-Related Potentials and Behavioral Responses. *Neuropsychology* **2018**, *32*, 317–328. [[CrossRef](#)]
80. Davidson, R.J.; Mednick, D.; Moss, E.; Saron, C.; Schaffer, C.E. Ratings of Emotion in Faces Are Influenced by the Visual Field to Which Stimuli Are Presented. *Brain Cogn.* **1987**, *6*, 403–411. [[CrossRef](#)]
81. Wyczesany, M.; Capotosto, P.; Zappasodi, F.; Prete, G. Hemispheric Asymmetries and Emotions: Evidence from Effective Connectivity. *Neuropsychologia* **2018**, *121*, 98–105. [[CrossRef](#)]
82. Prete, G.; Croce, P.; Zappasodi, F.; Tommasi, L.; Capotosto, P. Exploring Brain Activity for Positive and Negative Emotions by Means of EEG Microstates. *Sci. Rep.* **2022**, *12*, 3404. [[CrossRef](#)]
83. Gainotti, G. Emotional Behavior and Hemispheric Side of the Lesion. *Cortex* **1972**, *8*, 41–55. [[CrossRef](#)]
84. Gainotti, G. Unconscious Processing of Emotions and the Right Hemisphere. *Neuropsychologia* **2012**, *50*, 205–218. [[CrossRef](#)]
85. Stanković, M. A Conceptual Critique of Brain Lateralization Models in Emotional Face Perception: Toward a Hemispheric Functional-Equivalence (HFE) Model. *Int. J. Psychophysiol.* **2021**, *160*, 57–70. [[CrossRef](#)] [[PubMed](#)]
86. Prete, G.; Tommasi, L. Split-Brain Patients: Visual Biases for Faces. *Prog. Brain Res.* **2018**, *238*, 271–291. [[CrossRef](#)] [[PubMed](#)]
87. Prete, G.; Tommasi, L. Split-Brain Patients. In *Encyclopedia of Evolutionary Psychological Science*; Springer International Publishing AG: Cham, Switzerland, 2021; pp. 1–5.
88. Prete, G.; Laeng, B.; Fabri, M.; Foschi, N.; Tommasi, L. Right Hemisphere or Valence Hypothesis, or Both? The Processing of Hybrid Faces in the Intact and Callosotomized Brain. *Neuropsychologia* **2015**, *68*, 94–106. [[CrossRef](#)] [[PubMed](#)]
89. Prete, G.; D’Ascenzo, S.; Laeng, B.; Fabri, M.; Foschi, N.; Tommasi, L. Conscious and Unconscious Processing of Facial Expressions: Evidence from Two Split-Brain Patients. *J. Neuropsychol.* **2015**, *9*, 45–63. [[CrossRef](#)]
90. Prete, G.; Capotosto, P.; Zappasodi, F.; Laeng, B.; Tommasi, L. The Cerebral Correlates of Subliminal Emotions: An Eleoencephalographic Study with Emotional Hybrid Faces. *Eur. J. Neurosci.* **2015**, *42*, 2952–2962. [[CrossRef](#)]
91. Prete, G.; Laeng, B.; Tommasi, L. Transcranial Random Noise Stimulation (TRNS) over Prefrontal Cortex Does Not Influence the Evaluation of Facial Emotions. *Soc. Neurosci.* **2019**, *14*, 676–680. [[CrossRef](#)]
92. Prete, G.; Fabri, M.; Foschi, N.; Tommasi, L. Face Gender Categorization and Hemispheric Asymmetries: Contrasting Evidence from Connected and Disconnected Brains. *Neuroscience* **2016**, *339*, 210–218. [[CrossRef](#)]
93. Prete, G.; Malatesta, G.; Tommasi, L. Facial Gender and Hemispheric Asymmetries: A Hf-TRNS Study. *Brain Stimul.* **2017**, *10*, 1145–1147. [[CrossRef](#)]
94. Parente, R.; Tommasi, L. A Bias for the Female Face in the Right Hemisphere. *Laterality* **2008**, *13*, 374–386. [[CrossRef](#)]
95. Luo, B.; Shan, C.; Zhu, R.; Weng, X.; He, S. Functional Foveal Splitting: Evidence from Neuropsychological and Multimodal MRI Investigations in a Chinese Patient with a Splenium Lesion. *PLoS ONE* **2011**, *6*, e23997. [[CrossRef](#)]
96. Mason, M.F.; Macrae, C.N. Categorizing and Individuating Others: The Neural Substrates of Person Perception. *J. Cogn. Neurosci.* **2004**, *16*, 1785–1795. [[CrossRef](#)]
97. Mattingley, J.B.; Bradshaw, J.L.; Nettleton, N.C.; Bradshaw, J.A. Can Task Specific Perceptual Bias Be Distinguished from Unilateral Neglect? *Neuropsychologia* **1994**, *32*, 805–817. [[CrossRef](#)]
98. David, A.S. Spatial and Selective Attention in the Cerebral Hemispheres in Depression, Mania, and Schizophrenia. *Brain Cogn.* **1993**, *23*, 166–180. [[CrossRef](#)]
99. Rizzolatti, G.; Umiltà, C.; Berlucchi, G. Opposite Superiorities of the Right and Left Cerebral Hemispheres in Discriminative Reaction Time to Physiognomical and Alphabetical Material. *Brain* **1971**, *94*, 431–442. [[CrossRef](#)]
100. McCarthy, G.; Puce, A.; Gore, J.C.; Allison, T. Face-Specific Processing in the Human Fusiform Gyrus. *J. Cogn. Neurosci.* **1997**, *9*, 605–610. [[CrossRef](#)]
101. Kanwisher, N.; McDermott, J.; Chun, M.M. The Fusiform Face Area: A Module in Human Extrastriate Cortex Specialized for Face Perception. *J. Neurosci.* **1997**, *17*, 4302–4311. [[CrossRef](#)]
102. Barton, J.J.S.; Press, D.Z.; Keenan, J.P.; O’Connor, M. Lesions of the Fusiform Face Area Impair Perception of Facial Configuration in Prosopagnosia. *Neurology* **2002**, *58*, 71–78. [[CrossRef](#)]
103. Barton, J.J.S. Structure and Function in Acquired Prosopagnosia: Lessons from a Series of 10 Patients with Brain Damage. *J. Neuropsychol.* **2008**, *2*, 197–225. [[CrossRef](#)]
104. Frässle, S.; Krach, S.; Paulus, F.M.; Jansen, A. Handedness Is Related to Neural Mechanisms Underlying Hemispheric Lateralization of Face Processing. *Sci. Rep.* **2016**, *6*, 27153. [[CrossRef](#)]
105. Aziz-Zadeh, L.; Iacoboni, M.; Zaidel, E. Hemispheric Sensitivity to Body Stimuli in Simple Reaction Time. *Exp. Brain Res.* **2006**, *170*, 116–121. [[CrossRef](#)]
106. De Lussanet, M.H.E.; Fadiga, L.; Michels, L.; Seitz, R.J.; Kleiser, R.; Lappe, M. Interaction of Visual Hemifield and Body View in Biological Motion Perception. *Eur. J. Neurosci.* **2008**, *27*, 514–522. [[CrossRef](#)]
107. Parsons, L.M.; Gabrieli, J.D.; Phelps, E.A.; Gazzaniga, M.S. Cerebrally Lateralized Mental Representations of Hand Shape and Movement. *J. Neurosci.* **1998**, *18*, 6539–6548. [[CrossRef](#)] [[PubMed](#)]

108. Marzoli, D.; Pagliara, A.; Prete, G.; Malatesta, G.; Lucafò, C.; Padulo, C.; Brancucci, A.; Tommasi, L. Hemispheric Asymmetries in the Processing of Body Sides: A Study with Ambiguous Human Silhouettes. *Neurosci. Lett.* **2017**, *656*, 114–119. [[CrossRef](#)]
109. Marzoli, D.; Pagliara, A.; Prete, G.; Malatesta, G.; Lucafò, C.; Padulo, C.; Brancucci, A.; Tommasi, L. Lateralized Embodiment of Ambiguous Human Silhouettes: Data on Sex Differences. *Data Brief* **2019**, *25*, 104009. [[CrossRef](#)] [[PubMed](#)]
110. Lucafò, C.; Marzoli, D.; Prete, G.; Tommasi, L. Laterality Effects in the Spinning Dancer Illusion: The Viewing-from-above Bias Is Only Part of the Story. *Br. J. Psychol.* **2016**, *107*, 698–709. [[CrossRef](#)]
111. Lucafò, C.; Marzoli, D.; Padulo, C.; Troiano, S.; Pelosi Zazzerini, L.; Malatesta, G.; Amodeo, I.; Tommasi, L. Hemifield-Specific Rotational Biases during the Observation of Ambiguous Human Silhouettes. *Symmetry* **2021**, *13*, 1349. [[CrossRef](#)]
112. Hagemann, N. The Advantage of Being Left-Handed in Interactive Sports. *Atten. Percept. Psychophys.* **2009**, *71*, 1641–1648. [[CrossRef](#)] [[PubMed](#)]
113. Loffing, F.; Hagemann, N.; Schorer, J.; Baker, J. Skilled Players' and Novices' Difficulty Anticipating Left- vs. Right-Handed Opponents' Action Intentions Varies across Different Points in Time. *Hum. Mov. Sci.* **2015**, *40*, 410–421. [[CrossRef](#)]
114. Loffing, F.; Schorer, J.; Hagemann, N.; Baker, J. On the Advantage of Being Left-Handed in Volleyball: Further Evidence of the Specificity of Skilled Visual Perception. *Atten. Percept. Psychophys.* **2012**, *74*, 446–453. [[CrossRef](#)]
115. Loffing, F.; Hagemann, N. Zum Einfluss Des Anlaufwinkels Und Der Füßigkeit Des Schützen Auf Die Antizipation Von Elfmeterschüssen. *Z. Sportpsychol.* **2015**, *21*, 63–73. [[CrossRef](#)]
116. Loffing, F.; Hagemann, N. Motor Competence Is Not Enough: Handedness Does Not Facilitate Visual Anticipation of Same-Handed Action Outcome. *Cortex* **2020**, *130*, 94–99. [[CrossRef](#)]
117. McMorris, T.; Colenso, S. Anticipation of Professional Soccer Goalkeepers When Facing Right- and Left-Footed Penalty Kicks. *Percept. Mot. Ski.* **1996**, *82*, 931–934. [[CrossRef](#)]
118. Schorer, J.; Loffing, F.; Hagemann, N.; Baker, J. Human Handedness in Interactive Situations: Negative Perceptual Frequency Effects Can Be Reversed! *J. Sports Sci.* **2012**, *30*, 507–513. [[CrossRef](#)]
119. Richardson, T.; Gilman, R.T. Left-Handedness Is Associated with Greater Fighting Success in Humans. *Sci. Rep.* **2019**, *9*, 15402. [[CrossRef](#)]
120. Bisiacchi, P.; Ripoll, H.; Stein, J.; Simonet, P.; Azemar, G. Left-Handedness in Fencers: An Attentional Advantage? *Percept. Mot. Ski.* **1985**, *61*, 507–513. [[CrossRef](#)]
121. Breznik, K. On the Gender Effects of Handedness in Professional Tennis. *J. Sports Sci. Med.* **2013**, *12*, 346–353.
122. Brooks, R.; Bussière, L.F.; Jennions, M.D.; Hunt, J. Sinister Strategies Succeed at the Cricket World Cup. *Proc. Biol. Sci.* **2004**, *271* (Suppl. S3), S64–S66. [[CrossRef](#)]
123. Cingoz, Y.E.; Gursoy, R.; Ozan, M.; Hazar, K.; Dalli, M. Research on the Relation between Hand Preference and Success in Karate and Taekwondo Sports with Regards to Gender. *Adv. Phys. Educ.* **2018**, *8*, 308. [[CrossRef](#)]
124. Dochtermann, N.A.; Gienger, C.M.; Zappettini, S. Born to Win? Maybe, but Perhaps Only against Inferior Competition. *Anim. Behav.* **2014**, *96*, e1–e3. [[CrossRef](#)]
125. Goldstein, S.R.; Young, C.A. “Evolutionary” Stable Strategy of Handedness in Major League Baseball. *J. Comp. Psychol.* **1996**, *110*, 164. [[CrossRef](#)]
126. Grouios, G. Motoric Dominance and Sporting Excellence: Training versus Heredity. *Percept. Mot. Ski.* **2004**, *98*, 53–66. [[CrossRef](#)] [[PubMed](#)]
127. Grouios, G.; Koidou, E.; Tsormpatzoudis, C.; Alexandris, K. Handedness in Sport. *J. Hum. Mov. Stud.* **2002**, *43*, 347–361.
128. Gursoy, R. Effects of Left- or Right-Hand Preference on the Success of Boxers in Turkey. *Br. J. Sports Med.* **2009**, *43*, 142–144. [[CrossRef](#)] [[PubMed](#)]
129. Harris, L.J. In Fencing, What Gives Left-Handers the Edge? Views from the Present and the Distant Past. *Laterality* **2010**, *15*, 15–55. [[CrossRef](#)]
130. Holtzen, D.W. Handedness and Professional Tennis. *Int. J. Neurosci.* **2000**, *105*, 101–119. [[CrossRef](#)]
131. Lawler, T.P.; Lawler, F.H. Left-Handedness in Professional Basketball: Prevalence, Performance, and Survival. *Percept. Mot. Ski.* **2011**, *113*, 815–824. [[CrossRef](#)]
132. Loffing, F.; Hagemann, N.; Strauss, B. Left-Handedness in Professional and Amateur Tennis. *PLoS ONE* **2012**, *7*, e49325. [[CrossRef](#)]
133. Loffing, F.; Hagemann, N. Pushing through Evolution? Incidence and Fight Records of Left-Oriented Fighters in Professional Boxing History. *Laterality Asymmetries Body Brain Cogn.* **2015**, *20*, 270–286. [[CrossRef](#)]
134. Pollet, T.V.; Stulp, G.; Groothuis, T.G. Born to Win? Testing the Fighting Hypothesis in Realistic Fights: Left-Handedness in the Ultimate Fighting Championship. *Anim. Behav.* **2013**, *86*, 839–843. [[CrossRef](#)]
135. Tran, U.S.; Voracek, M. Footedness Is Associated with Self-Reported Sporting Performance and Motor Abilities in the General Population. *Front. Psychol.* **2016**, *7*, 1199. [[CrossRef](#)]
136. Ziyagil, M.A.; Gursoy, R.; Dane, S.; Yuksel, R. Left-Handed Wrestlers Are More Successful. *Percept. Mot. Ski.* **2010**, *111*, 65–70. [[CrossRef](#)]
137. Marzoli, D.; Lucafò, C.; Pagliara, A.; Cappuccio, R.; Brancucci, A.; Tommasi, L. Both Right- and Left-Handers Show a Bias to Attend Others' Right Arm. *Exp. Brain Res.* **2015**, *233*, 415–424. [[CrossRef](#)]
138. Marzoli, D.; Lucafò, C.; Padulo, C.; Prete, G.; Giacinto, L.; Tommasi, L. Inversion Reveals Perceptual Asymmetries in the Configural Processing of Human Body. *Front. Behav. Neurosci.* **2017**, *11*, 126. [[CrossRef](#)]

139. Lucafò, C.; Marzoli, D.; Zdybek, P.; Malatesta, G.; Smerilli, F.; Ferrara, C.; Tommasi, L. The Bias toward the Right Side of Others Is Stronger for Hands than for Feet. *Symmetry* **2021**, *13*, 146. [[CrossRef](#)]
140. Faurie, C.; Raymond, M. Handedness, Homicide and Negative Frequency-Dependent Selection. *Proc. Biol. Sci.* **2005**, *272*, 25–28. [[CrossRef](#)]
141. Marzoli, D.; Prete, G.; Tommasi, L. Perceptual Asymmetries and Handedness: A Neglected Link? *Front. Psychol.* **2014**, *5*, 163. [[CrossRef](#)]
142. Ocklenburg, S.; Packheiser, J.; Schmitz, J.; Rook, N.; Güntürkün, O.; Peterburs, J.; Grimshaw, G.M. Hugs and Kisses—The Role of Motor Preferences and Emotional Lateralization for Hemispheric Asymmetries in Human Social Touch. *Neurosci. Biobehav. Rev.* **2018**, *95*, 353–360. [[CrossRef](#)] [[PubMed](#)]
143. Packheiser, J.; Rook, N.; Dursun, Z.; Mesenhöller, J.; Wenglorz, A.; Güntürkün, O.; Ocklenburg, S. Embracing Your Emotions: Affective State Impacts Lateralisation of Human Embraces. *Psychol. Res.* **2019**, *83*, 26–36. [[CrossRef](#)]
144. Turnbull, O.H.; Stein, L.; Lucas, M.D. Lateral Preferences in Adult Embracing: A Test of the “Hemispheric Asymmetry” Theory of Infant Cradling. *J. Genet. Psychol.* **1995**, *156*, 17–21. [[CrossRef](#)]
145. Güntürkün, O. Adult Persistence of Head-Turning Asymmetry. *Nature* **2003**, *421*, 711. [[CrossRef](#)]
146. Sedgewick, J.R.; Holtzlander, A.; Elias, L.J. Kissing Right? Absence of Rightward Directional Turning Bias During First Kiss Encounters Among Strangers. *J. Nonverbal. Behav.* **2019**, *43*, 271–282. [[CrossRef](#)]
147. Salk, L. The Effects of the Normal Heartbeat Sound on the Behaviour of the Newborn Infant: Implications for Mental Health. *World Ment. Health* **1960**, *12*, 168–175.
148. Glocker, M.L.; Langleben, D.D.; Ruparel, K.; Loughead, J.W.; Valdez, J.N.; Griffin, M.D.; Sachser, N.; Gur, R.C. Baby Schema Modulates the Brain Reward System in Nulliparous Women. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 9115–9119. [[CrossRef](#)]
149. Hahn, A.C.; Perrett, D.I. Neural and Behavioral Responses to Attractiveness in Adult and Infant Faces. *Neurosci. Biobehav. Rev.* **2014**, *46*, 591–603. [[CrossRef](#)] [[PubMed](#)]
150. Proverbio, A.M. Sex Differences in Social Cognition: The Case of Face Processing. *J. Neurosci. Res.* **2017**, *95*, 222–234. [[CrossRef](#)]
151. Malatesta, G.; Marzoli, D.; Prete, G.; Tommasi, L. Human Lateralization, Maternal Effects and Neurodevelopmental Disorders. *Front. Behav. Neurosci.* **2021**, *15*, 668520. [[CrossRef](#)]
152. Packheiser, J.; Schmitz, J.; Berretz, G.; Papadatou-Pastou, M.; Ocklenburg, S. Handedness and Sex Effects on Lateral Biases in Human Cradling: Three Meta-Analyses. *Neurosci. Biobehav. Rev.* **2019**, *104*, 30–42. [[CrossRef](#)]
153. Donnot, J.; Vauclair, J. Biais de latéralité dans la façon de porter un très jeune enfant: Une revue de la question. *Neuropsychiatr. Enfance Adolesc.* **2005**, *53*, 413–425. [[CrossRef](#)]
154. Todd, B.; Butterworth, G. Her Heart Is in the Right Place: An Investigation of the ‘Heartbeat Hypothesis’ as an Explanation of the Left Side Cradling Preference in a Mother with Dextrocardia. *Early Dev. Parent.* **1998**, *7*, 229–233. [[CrossRef](#)]
155. Van der Meer, A.; Husby, Å. Handedness as a Major Determinant of Functional Cradling Bias. *Laterality* **2006**, *11*, 263–276. [[CrossRef](#)]
156. Manning, J.T.; Chamberlain, A.T. Left-Side Cradling and Brain Lateralization. *Ethol. Sociobiol.* **1991**, *12*, 237–244. [[CrossRef](#)]
157. Harris, L.J.; Almerigi, J.B.; Carbary, T.J.; Fogel, T.G. Left-Side Infant Holding: A Test of the Hemispheric Arousal-Attentional Hypothesis. *Brain Cogn.* **2001**, *46*, 159–165. [[CrossRef](#)]
158. Bourne, V.J.; Todd, B.K. When Left Means Right: An Explanation of the Left Cradling Bias in Terms of Right Hemisphere Specializations. *Dev. Sci.* **2004**, *7*, 19–24. [[CrossRef](#)] [[PubMed](#)]
159. Vauclair, J.; Donnot, J. Infant Holding Biases and Their Relations to Hemispheric Specializations for Perceiving Facial Emotions. *Neuropsychologia* **2005**, *43*, 564–571. [[CrossRef](#)]
160. Harris, L.J.; Cárdenas, R.A.; Spradlin, M.P.; Almerigi, J.B. Why Are Infants Held on the Left? A Test of the Attention Hypothesis with a Doll, a Book, and a Bag. *Laterality* **2010**, *15*, 548–571. [[CrossRef](#)]
161. Huggenberger, H.J.; Suter, S.E.; Reijnen, E.; Schachinger, H. Cradling Side Preference Is Associated with Lateralized Processing of Baby Facial Expressions in Females. *Brain Cogn.* **2009**, *70*, 67–72. [[CrossRef](#)]
162. Borod, J.C.; Haywood, C.S.; Koff, E. Neuropsychological Aspects of Facial Asymmetry during Emotional Expression: A Review of the Normal Adult Literature. *Neuropsychol. Rev.* **1997**, *7*, 41–60. [[CrossRef](#)]
163. Malatesta, G.; Marzoli, D.; Tommasi, L. Keep a Left Profile, Baby! The Left-Cradling Bias Is Associated with a Preference for Left-Facing Profiles of Human Babies. *Symmetry* **2020**, *12*, 911. [[CrossRef](#)]
164. Donnot, J.; Vauclair, J. Infant Holding Preferences in Maternity Hospitals: Testing the Hypothesis of the Lateralized Perception of Emotions. *Dev. Neuropsychol.* **2007**, *32*, 881–890. [[CrossRef](#)]
165. Harris, L.J.; Cárdenas, R.A.; Stewart, N.D.; Almerigi, J.B. Are Only Infants Held More Often on the Left? If so, Why? Testing the Attention-Emotion Hypothesis with an Infant, a Vase, and Two Chimeric Tests, One “Emotional,” One Not. *Laterality* **2019**, *24*, 65–97. [[CrossRef](#)]
166. Lucas, M.D.; Turnbull, O.H.; Kaplan-Solms, K.L. Laterality of Cradling in Relation to Perception and Expression of Facial Affect. *J. Genet. Psychol.* **1993**, *154*, 347–352. [[CrossRef](#)]
167. Vauclair, J.; Scola, C. Infant-Holding Biases in Mothers and Affective Symptoms during Pregnancy and after Delivery. *Infant. Child Dev.* **2009**, *18*, 106–121. [[CrossRef](#)]
168. Sieratzki, J.S.; Woll, B. Why Do Mothers Cradle Babies on Their Left? *Lancet* **1996**, *347*, 1746–1748. [[CrossRef](#)]

169. Turnbull, O.H.; Bryson, H.E. The Leftward Cradling Bias and Hemispheric Asymmetry for Speech Prosody. *Laterality* **2001**, *6*, 21–28. [[CrossRef](#)]
170. Sieratzki, J.S.; Roy, P.; Woll, B. Left Cradling and Left Ear Advantage for Emotional Speech: Listen to the Other Side Too. *Laterality* **2002**, *7*, 351–353. [[CrossRef](#)]
171. Turnbull, O.H. The Leftward Cradling Bias and Audition: Cross-Modal Confusion? A Response to Sieratzki, Roy, and Woll. *Laterality* **2002**, *7*, 355–357. [[CrossRef](#)]
172. Donnot, J. Lateralisation of Emotion Predicts Infant-Holding Bias in Left-Handed Students, but Not in Left-Handed Mothers. *Laterality* **2007**, *12*, 216–226. [[CrossRef](#)]
173. Malatesta, G.; Marzoli, D.; Rapino, M.; Tommasi, L. The Left-Cradling Bias and Its Relationship with Empathy and Depression. *Sci. Rep.* **2019**, *9*, 6141. [[CrossRef](#)]
174. Pileggi, L.-A.; Storey, S.; Malcolm-Smith, S. Depressive Symptoms Disrupt Leftward Cradling. *J. Child Adolesc. Ment. Health* **2020**, *32*, 35–43. [[CrossRef](#)]
175. Scola, C.; Arciszewski, T.; Measelle, J.; Vaclair, J. Infant-Holding Bias Variations in Mother-Child Relationships: A Longitudinal Study. *Eur. J. Psychol. Educ.* **2013**, *10*, 707–722. [[CrossRef](#)]
176. Weatherill, R.P.; Almerigi, J.B.; Levendosky, A.A.; Bogat, G.A.; Von Eye, A.; Harris, L.J. Is Maternal Depression Related to Side of Infant Holding? *Int. J. Behav. Dev.* **2004**, *28*, 421–427. [[CrossRef](#)]
177. Boulinguez-Ambroise, G.; Pouydebat, E.; Disarbois, É.; Meguerditchian, A. Human-like Maternal Left-Cradling Bias in Monkeys Is Altered by Social Pressure. *Sci. Rep.* **2020**, *10*, 11036. [[CrossRef](#)]
178. Morgan, B.; Hunt, X.; Sieratzki, J.; Woll, B.; Tomlinson, M. Atypical Maternal Cradling Laterality in an Impoverished South African Population. *Laterality* **2019**, *24*, 320–341. [[CrossRef](#)]
179. Reissland, N.; Hopkins, B.; Helms, P.; Williams, B. Maternal Stress and Depression and the Lateralisation of Infant Cradling. *J. Child Psychol. Psychiatry* **2009**, *50*, 263–269. [[CrossRef](#)]
180. Suter, S.E.; Huggenberger, H.J.; Schächinger, H. Cold Pressor Stress Reduces Left Cradling Preference in Nulliparous Human Females. *Stress* **2007**, *10*, 45–51. [[CrossRef](#)]
181. Suter, S.E.; Huggenberger, H.J.; Blumenthal, T.D.; Schachinger, H. Differential Effect of Ill-Being and Chronic Stress on Cradling Behavior of First and Multi-Time Parents. *Infant Behav. Dev.* **2011**, *34*, 170–178. [[CrossRef](#)]
182. De Château, P.; Holmberg, H.; Winberg, J. Left-Side Preference in Holding and Carrying Newborn Infants. *Acta Paediatr.* **1978**, *67*, 169–175. [[CrossRef](#)]
183. Bogren, L.Y. Side Preference in Women and Men When Holding Their Newborn Child: Psychological Background. *Acta Psychiatr. Scand.* **1984**, *69*, 13–23. [[CrossRef](#)] [[PubMed](#)]
184. Malatesta, G.; Marzoli, D.; Piccioni, C.; Tommasi, L. The Relationship between the Left-Cradling Bias and Attachment to Parents and Partner. *Evol. Psychol.* **2019**, *17*, 147470491984811. [[CrossRef](#)] [[PubMed](#)]
185. Forrester, G.S.; Davis, R.; Mareschal, D.; Malatesta, G.; Todd, B.K. The Left Cradling Bias: An Evolutionary Facilitator of Social Cognition? *Cortex* **2019**, *118*, 116–131. [[CrossRef](#)] [[PubMed](#)]
186. Forrester, G.S.; Davis, R.; Malatesta, G.; Todd, B.K. Evolutionary Motor Biases and Cognition in Children with and without Autism. *Sci. Rep.* **2020**, *10*, 17385. [[CrossRef](#)]
187. Herdien, L.; Malcolm-Smith, S.; Pileggi, L.-A. Leftward Cradling Bias in Males and Its Relation to Autistic Traits and Lateralised Emotion Processing. *Brain Cogn.* **2020**, *147*, 105652. [[CrossRef](#)]
188. Pileggi, L.-A.; Malcolm-Smith, S.; Hoogenhout, M.; Thomas, K.G.; Solms, M. Cradling Bias Is Absent in Children with Autism Spectrum Disorders. *J. Child Adolesc. Ment. Health* **2013**, *25*, 55–60. [[CrossRef](#)]
189. Pileggi, L.-A.; Malcolm-Smith, S.; Solms, M. Investigating the Role of Social-Affective Attachment Processes in Cradling Bias: The Absence of Cradling Bias in Children with Autism Spectrum Disorders. *Laterality* **2015**, *20*, 154–170. [[CrossRef](#)]
190. Malatesta, G.; Marzoli, D.; Morelli, L.; Pivetti, M.; Tommasi, L. The Role of Ethnic Prejudice in the Modulation of Cradling Lateralization. *J. Nonverbal. Behav.* **2021**, *45*, 187–205. [[CrossRef](#)]
191. Malatesta, G.; Marzoli, D.; Apicella, F.; Abiuso, C.; Muratori, F.; Forrester, G.S.; Vallortigara, G.; Scattoni, M.L.; Tommasi, L. Received Cradling Bias During the First Year of Life: A Retrospective Study on Children With Typical and Atypical Development. *Front. Psychiatry* **2020**, *11*, 91. [[CrossRef](#)]
192. Malatesta, G.; Marzoli, D.; Tommasi, L. The Association between Received Maternal Cradling and Neurodevelopment: Is Left Better? *Med. Hypotheses* **2020**, *134*, 109442. [[CrossRef](#)]
193. Bryden, M.P. Perceptual Asymmetry in Vision: Relation to Handedness, Eyedness, and Speech Lateralization. *Cortex* **1973**, *9*, 419–435. [[CrossRef](#)]
194. Lidzba, K.; Staudt, M.; Wilke, M.; Krägeloh-Mann, I. Visuospatial Deficits in Patients with Early Left-Hemispheric Lesions and Functional Reorganization of Language: Consequence of Lesion or Reorganization? *Neuropsychologia* **2006**, *44*, 1088–1094. [[CrossRef](#)]
195. McManus, C. *Right Hand, Left Hand: The Origins of Asymmetry in Brains, Bodies, Atoms and Cultures*; Harvard University Press: Cambridge, MA, USA, 2002; ISBN 978-0-674-01613-2.
196. Nicholls, M.E.R.; Chapman, H.L.; Loetscher, T.; Grimshaw, G.M. The Relationship between Hand Preference, Hand Performance, and General Cognitive Ability. *J. Int. Neuropsychol. Soc.* **2010**, *16*, 585–592. [[CrossRef](#)]

197. Felisatti, A.; Aagten-Murphy, D.; Laubrock, J.; Shaki, S.; Fischer, M.H. The Brain's Asymmetric Frequency Tuning: Asymmetric Behavior Originates from Asymmetric Perception. *Symmetry* **2020**, *12*, 2083. [[CrossRef](#)]
198. Karim, A.K.M.R.; Proulx, M.J.; Likova, L.T. Anticlockwise or Clockwise? A Dynamic Perception-Action-Laterality Model for Directionality Bias in Visuospatial Functioning. *Neurosci. Biobehav. Rev.* **2016**, *68*, 669–693. [[CrossRef](#)]
199. Rogers, L.J. Asymmetry of Motor Behavior and Sensory Perception: Which Comes First? *Symmetry* **2020**, *12*, 690. [[CrossRef](#)]
200. McManus, I.C.; Davison, A.; Armour, J.A.L. Multilocus Genetic Models of Handedness Closely Resemble Single-Locus Models in Explaining Family Data and Are Compatible with Genome-Wide Association Studies. *Ann. N. Y. Acad. Sci.* **2013**, *1288*, 48–58. [[CrossRef](#)] [[PubMed](#)]
201. Behrmann, M.; Plaut, D.C. A Vision of Graded Hemispheric Specialization. *Ann. N. Y. Acad. Sci.* **2015**, *1359*, 30–46. [[CrossRef](#)] [[PubMed](#)]
202. Coryell, J.F.; Michel, G.F. How Supine Postural Preferences of Infants Can Contribute toward the Development of Handedness. *Infant Behav. Dev.* **1978**, *1*, 245–257. [[CrossRef](#)]
203. Hopkins, B.; Lems, W.; Janssen, B.; Butterworth, G. Postural and Motor Asymmetries in Newborns. *Hum. Neurobiol.* **1987**, *6*, 153–156. [[PubMed](#)]
204. Konishi, Y.; Mikawa, H.; Suzuki, J. Asymmetrical Head-Turning of Preterm Infants: Some Effects on Later Postural and Functional Laterality. *Dev. Med. Child Neurol.* **1986**, *28*, 450–457. [[CrossRef](#)]
205. Michel, G.F. Right-Handedness: A Consequence of Infant Supine Head-Orientation Preference? *Science* **1981**, *212*, 685–687. [[CrossRef](#)]
206. Michel, G.F.; Harkins, D.A. Postural and Lateral Asymmetries in the Ontogeny of Handedness during Infancy. *Dev. Psychobiol.* **1986**, *19*, 247–258. [[CrossRef](#)]
207. Rönqvist, L.; Hopkins, B.; van Emmerik, R.; de Groot, L. Lateral Biases in Head Turning and the Moro Response in the Human Newborn: Are They Both Vestibular in Origin? *Dev. Psychobiol.* **1998**, *33*, 339–349. [[CrossRef](#)]
208. Fagard, J.; Lemoine, C. The Role of Imitation in the Stabilization of Handedness during Infancy. *J. Integr. Neurosci.* **2006**, *5*, 519–533. [[CrossRef](#)]
209. Harkins, D.A.; Michel, G.F. Evidence for a Maternal Effect on Infant Hand-Use Preferences. *Dev. Psychobiol.* **1988**, *21*, 535–541. [[CrossRef](#)]
210. Harkins, D.A.; Uğiris, I.Ç. Hand-Use Matching between Mothers and Infants during the First Year. *Infant Behav. Dev.* **1991**, *14*, 289–298. [[CrossRef](#)]
211. Michel, G.F. Maternal Influences on Infant Hand-Use during Play with Toys. *Behav. Genet.* **1992**, *22*, 163–176. [[CrossRef](#)]
212. Scola, C.; Vauclair, J. Is Infant Holding-Side Bias Related to Motor Asymmetries in Mother and Child? *Dev. Psychobiol.* **2010**, *52*, 475–486. [[CrossRef](#)]
213. Dagenbach, D.; Harris, L.J.; Fitzgerald, H.E. A Longitudinal Study of Lateral Biases in Parents' Cradling and Holding of Infants. *Infant Ment. Health J.* **1988**, *9*, 218–234. [[CrossRef](#)]
214. Huheey, J.E. Concerning the Origin of Handedness in Humans. *Behav. Genet.* **1977**, *7*, 29–32. [[CrossRef](#)]
215. Boulinguez-Ambroise, G.; Aychet, J.; Pouydebat, E. Limb Preference in Animals: New Insights into the Evolution of Manual Laterality in Hominids. *Symmetry* **2022**, *14*, 96. [[CrossRef](#)]
216. Boulinguez-Ambroise, G.; Pouydebat, E.; Disarbois, É.; Meguerditchian, A. Maternal Cradling Bias in Baboons: The First Environmental Factor Affecting Early Infant Handedness Development? *Dev. Sci.* **2022**, *25*, e13179. [[CrossRef](#)]
217. Hopkins, W.D. Laterality in Maternal Cradling and Infant Positional Biases: Implications for the Development and Evolution of Hand Preferences in Nonhuman Primates. *Int. J. Primatol.* **2004**, *25*, 1243–1265. [[CrossRef](#)]
218. Watling, D.; Workman, L.; Bourne, V.J. Emotion Lateralisation: Developments throughout the Lifespan. *Laterality* **2012**, *17*, 389–411. [[CrossRef](#)] [[PubMed](#)]
219. Guo, K.; Meints, K.; Hall, C.; Hall, S.; Mills, D. Left Gaze Bias in Humans, Rhesus Monkeys and Domestic Dogs. *Anim. Cogn.* **2009**, *12*, 409–418. [[CrossRef](#)] [[PubMed](#)]
220. Dahl, C.D.; Rasch, M.J.; Tomonaga, M.; Adachi, I. Laterality Effect for Faces in Chimpanzees (*Pan Troglodytes*). *J. Neurosci.* **2013**, *33*, 13344–13349. [[CrossRef](#)] [[PubMed](#)]
221. Balas, B.; Moulson, M.C. Developing a Side Bias for Conspecific Faces during Childhood. *Dev. Psychol.* **2011**, *47*, 1472–1478. [[CrossRef](#)] [[PubMed](#)]
222. Cochet, H.; Byrne, R.W. Evolutionary Origins of Human Handedness: Evaluating Contrasting Hypotheses. *Anim. Cogn.* **2013**, *16*, 531–542. [[CrossRef](#)] [[PubMed](#)]
223. Meguerditchian, A.; Vauclair, J.; Hopkins, W.D. On the Origins of Human Handedness and Language: A Comparative Review of Hand Preferences for Bimanual Coordinated Actions and Gestural Communication in Nonhuman Primates. *Dev. Psychobiol.* **2013**, *55*, 637–650. [[CrossRef](#)]
224. Lindell, A. Continuities in Emotion Lateralization in Human and Non-Human Primates. *Front. Hum. Neurosci.* **2013**, *7*, 464. [[CrossRef](#)]
225. Greenough, A.; Lagercrantz, H.; Pool, J.; Dahlin, I. Plasma Catecholamine Levels in Preterm Infants. *Acta Paediatr.* **1987**, *76*, 54–59. [[CrossRef](#)]
226. Vervloed, M.P.J.; Hendriks, A.W.; van den Eijnde, E. The Effects of Mothers' Past Infant-Holding Preferences on Their Adult Children's Face Processing Lateralisation. *Brain Cogn.* **2011**, *75*, 248–254. [[CrossRef](#)]

227. Heath, R.; Rouhana, A.; Abi Ghanem, D. Asymmetric Bias in Perception of Facial Affect among Roman and Arabic Script Readers. *Laterality* **2005**, *10*, 51–64. [[CrossRef](#)]
228. Megreya, A.M.; Havard, C. Left Face Matching Bias: Right Hemisphere Dominance or Scanning Habits? *Laterality* **2011**, *16*, 75–92. [[CrossRef](#)]
229. Sakhuja, T.; Gupta, G.; Singh, M.; Vaid, J. Reading Habits Affect Asymmetries in Facial Affect Judgments: A Replication. *Brain Cogn.* **1996**, *32*, 162–165.
230. Vaid, J.; Singh, M. Asymmetries in the Perception of Facial Affect: Is There an Influence of Reading Habits? *Neuropsychologia* **1989**, *27*, 1277–1287. [[CrossRef](#)]
231. Dundas, E.M.; Best, C.A.; Minshe, N.J.; Strauss, M.S. A Lack of Left Visual Field Bias When Individuals with Autism Process Faces. *J. Autism Dev. Disord.* **2012**, *6*, 1104–1111. [[CrossRef](#)]
232. Liu, S.; Quinn, P.C.; Wheeler, A.; Xiao, N.; Ge, L.; Lee, K. Similarity and Difference in the Processing of Same- and Other-Race Faces as Revealed by Eye Tracking in 4- to 9-Month-Olds. *J. Exp. Child Psychol.* **2011**, *108*, 180–189. [[CrossRef](#)]
233. Anes, M.D.; Short, L.A. Adult-like Competence in Perceptual Encoding of Facial Configuration by the Right Hemisphere Emerges after 10 Years of Age. *Perception* **2009**, *38*, 333–342. [[CrossRef](#)]
234. Maurer, D.; Grand, R.L.; Mondloch, C.J. The Many Faces of Configural Processing. *Trends Cogn. Sci.* **2002**, *6*, 255–260. [[CrossRef](#)]
235. Reed, C.L.; Stone, V.E.; Bozova, S.; Tanaka, J. The Body-Inversion Effect. *Psychol. Sci.* **2003**, *14*, 302–308. [[CrossRef](#)]
236. Reed, C.L.; Stone, V.E.; Grubb, J.D.; McGoldrick, J.E. Turning Configural Processing Upside down: Part and Whole Body Postures. *J. Exp. Psychol. Hum. Percept. Perform.* **2006**, *32*, 73–87. [[CrossRef](#)]
237. Bourne, V.J. Examining the Effects of Inversion on Lateralisation for Processing Facial Emotion. *Cortex* **2011**, *47*, 690–695. [[CrossRef](#)] [[PubMed](#)]
238. Coolican, J.; Eskes, G.A.; McMullen, P.A.; Lecky, E. Perceptual Biases in Processing Facial Identity and Emotion. *Brain Cogn.* **2008**, *66*, 176–187. [[CrossRef](#)] [[PubMed](#)]
239. Ellis, H.D.; Shepherd, J.W. Recognition of Upright and Inverted Faces Presented in the Left and Right Visual Fields. *Cortex* **1975**, *11*, 3–7. [[CrossRef](#)]
240. Leehey, S.; Carey, S.; Diamond, R.; Cahn, A. Upright and Inverted Faces: The Right Hemisphere Knows the Difference. *Cortex* **1978**, *14*, 411–419. [[CrossRef](#)]
241. Luh, K.E. Effect of Inversion on Perceptual Biases for Chimeric Faces. *Brain Cogn.* **1998**, *37*, 105–108.
242. Carey, S.; Diamond, R. From Piecemeal to Configurational Representation of Faces. *Science* **1977**, *195*, 312–314. [[CrossRef](#)]
243. Diamond, R.; Carey, S. Developmental Changes in the Representation of Faces. *J. Exp. Child Psychol.* **1977**, *23*, 1–22. [[CrossRef](#)]
244. Mondloch, C.J.; Le Grand, R.; Maurer, D. Configural Face Processing Develops More Slowly than Featural Face Processing. *Perception* **2002**, *31*, 553–566. [[CrossRef](#)]
245. Hobson, R.P.; Ouston, J.; Lee, A. What's in a Face? The Case of Autism. *Br. J. Psychol.* **1988**, *79*, 441–453. [[CrossRef](#)]
246. Tantam, D.; Monaghan, L.; Nicholson, H.; Stirling, J. Autistic Children's Ability to Interpret Faces: A Research Note. *J. Child Psychol. Psychiatry* **1989**, *30*, 623–630. [[CrossRef](#)]
247. Taylor, S.; Workman, L.; Yeomans, H. Abnormal Patterns of Cerebral Lateralisation as Revealed by the Universal Chimeric Faces Task in Individuals with Autistic Disorder. *Laterality* **2012**, *17*, 428–437. [[CrossRef](#)]
248. Dundas, E.; Gastgeb, H.; Strauss, M.S. Left Visual Field Biases When Infants Process Faces: A Comparison of Infants at High- and Low-Risk for Autism Spectrum Disorder. *J. Autism Dev. Disord.* **2012**, *42*, 2659–2668. [[CrossRef](#)]
249. Behrmann, M.; Avidan, G.; Leonard, G.L.; Kimchi, R.; Luna, B.; Humphreys, K.; Minshe, N. Configural Processing in Autism and Its Relationship to Face Processing. *Neuropsychologia* **2006**, *44*, 110–129. [[CrossRef](#)]
250. Leonards, U.; Scott-Samuel, N.E. Idiosyncratic Initiation of Saccadic Face Exploration in Humans. *Vis. Res.* **2005**, *45*, 2677–2684. [[CrossRef](#)]
251. Mertens, I.; Siegmund, H.; Grüsser, O.-J. Gaze Motor Asymmetries in the Perception of Faces during a Memory Task. *Neuropsychologia* **1993**, *31*, 989–998. [[CrossRef](#)]
252. Gallois, P.; Buquet, C.; Charlier, J.; Paris, V.; Hache, J.C.; Dereux, J.F. Asymmetry of visual perceptive activity of faces and emotional facial expressions. *Rev. Neurol.* **1989**, *145*, 661–664.
253. Thompson, L.A.; Malloy, D.M.; LeBlanc, K.L. Lateralization of Visuospatial Attention across Face Regions Varies with Emotional Prosody. *Brain Cogn.* **2009**, *69*, 108–115. [[CrossRef](#)]
254. Marotta, A.; Lupiáñez, J.; Casagrande, M. Investigating Hemispheric Lateralization of Reflexive Attention to Gaze and Arrow Cues. *Brain Cogn.* **2012**, *80*, 361–366. [[CrossRef](#)]
255. Greene, D.J.; Zaidel, E. Hemispheric Differences in Attentional Orienting by Social Cues. *Neuropsychologia* **2011**, *49*, 61–68. [[CrossRef](#)]
256. Mogg, K.; Bradley, B.P. Orienting of Attention to Threatening Facial Expressions Presented under Conditions of Restricted Awareness. *Cogn. Emot.* **1999**, *13*, 713–740. [[CrossRef](#)]
257. Mogg, K.; Bradley, B.P. Selective Orienting of Attention to Masked Threat Faces in Social Anxiety. *Behav. Res. Ther.* **2002**, *40*, 1403–1414. [[CrossRef](#)]
258. Field, A.P. Watch Out for the Beast: Fear Information and Attentional Bias in Children. *J. Clin. Child Adolesc. Psychol.* **2006**, *35*, 431–439. [[CrossRef](#)] [[PubMed](#)]

259. Levine, S.C.; Banich, M.T.; Koch-Weser, M. Variations in Patterns of Lateral Asymmetry among Dextrals. *Brain Cogn.* **1984**, *3*, 317–334. [[CrossRef](#)]
260. Kim, H.; Levine, S.C.; Kertesz, S. Are Variations among Subjects in Lateral Asymmetry Real Individual Differences or Random Error in Measurement?: Putting Variability in Its Place. *Brain Cogn.* **1990**, *14*, 220–242. [[CrossRef](#)]
261. Bradshaw, J.L.; Pierson-Savage, J.M.; Nettleton, N.C. Hemispace Asymmetries. In *Contemporary Reviews in Neuropsychology*; Whitaker, H.A., Ed.; Springer Series in Neuropsychology; Springer: New York, NY, USA, 1988; pp. 1–35, ISBN 978-1-4612-3780-8.
262. Dellatolas, G.; Viguier, D.; Deloche, G.; De Agostini, M. Right-Left Orientation and Significance of Systematic Reversal in Children. *Cortex* **1998**, *34*, 659–676. [[CrossRef](#)]
263. Failla, C.V.; Sheppard, D.M.; Bradshaw, J.L. Age and Responding-Hand Related Changes in Performance of Neurologically Normal Subjects on the Line-Bisection and Chimeric-Faces Tasks. *Brain Cogn.* **2003**, *52*, 353–363. [[CrossRef](#)]
264. Workman, L.; Chilvers, L.; Yeomans, H.; Taylor, S. Development of Cerebral Lateralisation for Recognition of Emotions in Chimeric Faces in Children Aged 5 to 11. *Laterality* **2006**, *11*, 493–507. [[CrossRef](#)]
265. Watling, D.; Bourne, V.J. Sex Differences in the Relationship Between Children’s Emotional Expression Discrimination and Their Developing Hemispheric Lateralization. *Dev. Neuropsychol.* **2013**, *38*, 496–506. [[CrossRef](#)]
266. Baron-Cohen, S. The Eye Direction Detector (EDD) and the Shared Attention Mechanism (SAM): Two Cases for Evolutionary Psychology. In *Joint Attention: Its Origins and Role in Development*; Lawrence Erlbaum Associates, Inc.: Hillsdale, NJ, USA, 1995; pp. 41–59. ISBN 978-0-8058-1437-8.
267. Birmingham, E.; Ristic, J.; Kingstone, A. Investigating Social Attention: A Case for Increasing Stimulus Complexity in the Laboratory. In *Cognitive Neuroscience, Development, and Psychopathology: Typical and Atypical Developmental Trajectories of Attention*; Oxford University Press: New York, NY, USA, 2012; pp. 251–276, ISBN 978-0-19-531545-5.
268. Tonks, J.; Williams, W.H.; Frampton, I.; Yates, P.; Slater, A. Assessing Emotion Recognition in 9–15-Years Olds: Preliminary Analysis of Abilities in Reading Emotion from Faces, Voices and Eyes. *Brain Inj.* **2007**, *21*, 623–629. [[CrossRef](#)]
269. Sackeim, H.A.; Gur, R.C. Lateral Asymmetry in Intensity of Emotional Expression. *Neuropsychologia* **1978**, *16*, 473–481. [[CrossRef](#)]
270. Indersmitten, T.; Gur, R.C. Emotion Processing in Chimeric Faces: Hemispheric Asymmetries in Expression and Recognition of Emotions. *J. Neurosci.* **2003**, *23*, 3820–3825. [[CrossRef](#)]
271. Workman, L.; Peters, S.; Taylor, S. Lateralisation of Perceptual Processing of Pro- and Anti-Social Emotions Displayed in Chimeric Faces. *Laterality* **2000**, *5*, 237–249. [[CrossRef](#)]
272. Godard, O.; Fiori, N. Sex Differences in Face Processing: Are Women Less Lateralized and Faster than Men? *Brain Cogn.* **2010**, *73*, 167–175. [[CrossRef](#)]
273. Raymond, M.; Pontier, D.; Dufour, A.B.; Møller, A.P. Frequency-Dependent Maintenance of Left Handedness in Humans. *Proc. Biol. Sci.* **1996**, *263*, 1627–1633. [[CrossRef](#)]
274. Rahman, Q.; Anchassi, T. Men Appear More Lateralized When Noticing Emotion in Male Faces. *Emotion* **2012**, *12*, 174–179. [[CrossRef](#)]
275. Bourne, V.J.; Vladeanu, M. Lateralisation for Processing Facial Emotion and Anxiety: Contrasting State, Trait and Social Anxiety. *Neuropsychologia* **2011**, *49*, 1343–1349. [[CrossRef](#)]
276. Heller, W.; Etienne, M.A.; Miller, G.A. Patterns of Perceptual Asymmetry in Depression and Anxiety: Implications for Neuropsychological Models of Emotion and Psychopathology. *J. Abnorm. Psychol.* **1995**, *104*, 327–333. [[CrossRef](#)]
277. Keller, J.; Nitschke, J.B.; Bhargava, T.; Deldin, P.J.; Gergen, J.A.; Miller, G.A.; Heller, W. Neuropsychological Differentiation of Depression and Anxiety. *J. Abnorm. Psychol.* **2000**, *109*, 3–10. [[CrossRef](#)]
278. Voelz, Z.R.; Gencoz, F.; Gencoz, T.; Pettit, J.W.; Perez, M.; Joiner, T.E. Patterns of Hemispheric Perceptual Asymmetries: Left Hemispatial Biases Predict Changes in Anxiety and Positive Affect in Undergraduate Women. *Emotion* **2001**, *1*, 339–347. [[CrossRef](#)]
279. McManus, I.C.; Humphrey, N.K. Turning the left cheek. *Nature* **1973**, *243*, 271–272. [[CrossRef](#)]
280. Conesa, J. Preference for the Half-Left Profile Pose: Three Inclusive Models. *Percept. Mot. Ski.* **1996**, *82*, 1070. [[CrossRef](#)] [[PubMed](#)]
281. Conesa, J.; Brunold-Conesa, C.; Miron, M. Incidence of the Half-Left Profile Pose in Single-Subject Portraits. *Percept. Mot. Ski.* **1995**, *81*, 920–922. [[CrossRef](#)] [[PubMed](#)]
282. Vingerhoets, G. Phenotypes in Hemispheric Functional Segregation? Perspectives and Challenges. *Phys. Life Rev.* **2019**, *30*, 1–18. [[CrossRef](#)] [[PubMed](#)]
283. Papadatou-Pastou, M.; Tomprou, D.-M. Intelligence and Handedness: Meta-Analyses of Studies on Intellectually Disabled, Typically Developing, and Gifted Individuals. *Neurosci. Biobehav. Rev.* **2015**, *56*, 151–165. [[CrossRef](#)]
284. Giljov, A.; Karenina, K.; Malashichev, Y. Facing Each Other: Mammal Mothers and Infants Prefer the Position Favouring Right Hemisphere Processing. *Biol. Lett.* **2018**, *14*, 20170707. [[CrossRef](#)]
285. Peirce, J.W.; Leigh, A.E.; Kendrick, K.M. Configurational Coding, Familiarity and the Right Hemisphere Advantage for Face Recognition in Sheep. *Neuropsychologia* **2000**, *38*, 475–483. [[CrossRef](#)]
286. Peirce, J.W.; Leigh, A.E.; da Costa, A.P.C.; Kendrick, K.M. Human Face Recognition in Sheep: Lack of Configurational Coding and Right Hemisphere Advantage. *Behav. Process.* **2001**, *55*, 13–26. [[CrossRef](#)]
287. Salva, O.R.; Regolin, L.; Vallortigara, G. Chicks Discriminate Human Gaze with Their Right Hemisphere. *Behav. Brain Res.* **2007**, *177*, 15–21. [[CrossRef](#)]