

Handedness as a major determinant of lateral bias in human functional cradling

Audrey L. H. van der Meer 

Developmental Neuroscience Laboratory,
Department of Psychology, Norwegian
University of Science and Technology
(NTNU), Trondheim, Norway

Correspondence

Audrey L. H. van der Meer.
Email: audrey.meer@ntnu.no

Abstract

Studies examining infant cradling have almost uniformly concluded with a general human left-side bias for cradling, indicating that people prefer to hold an infant to the left of their body. Explanations for the notion of the left-side cradling bias have traditionally been searched for in a variety of factors, for example, in terms of maternal heartbeat, genetic factors, in the form of an ear asymmetry where auditory information is perceived faster through the left ear, as a result of a right hemispheric functional specialization for perception of emotions and faces, and in identifying a motor bias of the infant, such as the tendency of newborn infants to lie with the face to the right when placed supine. Interestingly, handedness is generally considered an inadequate explanation for the lateralized cradling bias, despite it being an intuitively plausible one. In this brief review, I put forward the cradler's handedness as the most convincing and elegant determinant of the cradling bias. This explanation is consistent with a developmental cascades' framework where the cradling bias can be understood as the result of a multitude of factors across a range of levels and systems.

1 | UNIVERSAL LEFT-SIDE PREFERENCE FOR CRADLING

Almost 20 years ago, we argued that infant cradling is not a unitary activity and usually co-occurs with other manual activities, such as placing a dummy in the infant's mouth, caressing or soothing the infant,

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opening doors, and so on. Thus, cradling under natural conditions can be best described as an interactive, functional activity with a strong manual component. As a result, cradling-while-doing-something-else is considered the more standard case as opposed to cradling-for-the-sake-of-cradling (Van der Meer & Husby, 2006).

Cradling as a field of study has seen a resurgence of interest given the recent meta-analysis from Packheiser et al. (2019) and the comparative review by Vauclair (2022). Previous studies investigating cradling have usually concluded with a general human left-side bias for cradling (e.g., Dagenbach et al., 1988; Fleva & Khan, 2015; Manning & Denman, 1994; Salk, 1960, 1973; Turnbull & Lucas, 1991; Vauclair & Donnot, 2005). A cradling bias has also been found in great apes, such as chimpanzees and gorillas, with roughly 67% of cradles reported as left-sided (Manning & Chamberlain, 1990; Manning et al., 1994). However, this bias has not been replicated in any other primate species (Karenina & Giljov, 2018). For example, the studied species of nonhominid primates seem to show individual, but no population-level preferences for maternal cradling (Hopkins, 2004), while in common marmosets, no lateral bias for infant carrying has been found in mothers or in fathers (Rogers & Kaplan, 1998). Furthermore, the tendency to cradle on the left side has been found to specifically apply to holding infants, as opposed to holding an expensive vase or an old shoebox (Almerigi et al., 2002).

The phenomenon of a left-sided cradling preference has been reported in a variety of studies, independent of the method of measurement used. Some studies involved actual cradling (e.g., Manning & Chamberlain, 1991), imagined cradling with typical human participants (e.g., Almerigi et al., 2002; Harris et al., 2000, 2019; Malatesta, Manippa & Tommasi, 2022; Malatesta, Marzoli, Rapino & Tommasi, 2019), cradling a doll (Forrester et al., 2019, 2020; Malatesta, Marzoli, Piccioni & Tommasi, 2019; Malatesta, Manippa & Tommasi, 2022; Malatesta, Marzoli, Morelli, Pivetti & Tommasi, 2021; Packheiser et al., 2020; Van der Meer & Husby, 2006), naturalistic observations in animals (Boulinguez-Ambroise et al., 2020; Giljov et al., 2018; Karenina et al., 2018; Karenina & Giljov, 2018; Regaiolli et al., 2018), and studying photographs and works of art (e.g., Harris & Fitzgerald, 1985; Malatesta, Marzoli, Apicella et al., 2020; Manning & Denman, 1994). The universality of the left-cradling bias has been shown across cultures and ethnicities (Bolton, 1978; Brüser, 1981; Richards & Finger, 1975; Saling & Cooke, 1984), and across centuries of history (Alvarez, 1990; Finger, 1975; Grüsser, 1983). However, there is also some evidence that the left-side holding preference is not universal (Nakamichi, 1996) and that it may be disrupted in patients and/or atypical conditions (Herdien et al., 2021; Morgan et al., 2019; Pileggi et al., 2020).

The first explanation for the leftward cradling bias was the heartbeat hypothesis proposed by Salk (1960, 1973), suggesting that the cradling bias might be associated with the infant being able to listen to the mother's heartbeat more easily due to her heart lying ever so slightly to the left in the chest. However, positive effects of heartbeat stimulations could not be found in follow-up studies (Brackbill et al., 1966; Palmqvist, 1975). Moreover, a case study in a mother with dextrocardia was unable to verify the heartbeat hypothesis (Todd & Butterworth, 1998). Thus, based on the existing evidence, the heartbeat hypothesis does not appear to provide a feasible account for the leftward cradling bias. Another more recent hypothesis, based on a growing number of studies using popular and more widely available neurophysiological and neuroimaging techniques, claims that the left-side cradling bias is caused by hemispheric asymmetry in emotional processing (Bourne & Todd, 2004; Harris et al., 2001, 2010; Huggenberger et al., 2009; Ocklenburg et al., 2018; Vauclair, 2022; Vauclair & Donnot, 2005). According to this hypothesis, parents would intuitively cradle on the left because they want to keep the infant in their left visual field which is projected to the right cerebral hemisphere specialized in face and/or emotional processing. However, Packheiser et al. (2019) provide several arguments that question the feasibility of this hypothesis as well. For example, they argue that humans have binocular vision and as long as the infant is foveated, the emotional bias theory does not

provide a plausible explanation for the left cradling bias. Further, they refer to a study of Matheson and Turnbull (1998) where 12 out of 12 participants that were all blind, showed a left-sided cradling bias, also going against the emotional bias hypothesis. Finally, Marzoli et al. (2022) recently published an extensive review of the works linking the left-cradling bias with other visual and auditory biases (e.g., Manning et al., 1997), where they also reported inconsistent results.

A third major hypothesis states that a (prenatal) bias in motor preferences and handedness is the driving force underlying a cradling bias. A person's handedness influences virtually all motor tasks. Why a person develops a distinct preference for one hand or foot over the other has not been fully accounted for, but rather than posing that handedness is shaped by genetic or environmental factors, or a combination thereof, more and more scholars argue that handedness emerges as the result of developmental cascades beginning prenatally (e.g., Campbell et al., 2018; Michel et al., 2013). For example, Nelson (2022) describes a postural asymmetry in the intrauterine environment as the result of fetal growth so that the more the fetus grows, the more restricted its position and movements become. In preparation for birth, the fetus turns head-down with the head turned such that one ear (typically the right) faces outward. In this position, movement of the left arm of the fetus is restricted more than that of the right arm (Nelson, 2022). This prenatal asymmetry has been put forward to underlie handedness in humans (Previc, 1991). Fetal position in the womb, in turn, predicts postnatal head orientation preference when infants are placed supine (Michel, 1981; Michel & Goodwin, 1979). Most infants are born in a left position and show a right supine head turn preference, naturally leading to newborn infants viewing the right hand more than the left. Before the onset of reaching, infants spend hours looking at their hands, and so they should, for many lessons in practical optics need to be learned familiarizing themselves with their own body and learning about how far they can reach, what is within reach and out of reach, and whether a toy is too big for their hand to grasp, in terms of their affordances for manipulation (Van der Meer & Van der Weel, 2019, 2022). It turns out that the hand that is viewed more is also moved more (Michel & Harkins, 1986; Van der Meer, 1997; Van der Meer et al., 1995). And which way the infant prefers to turn their head predicts which hand they prefer to use for reaching (Michel, 1981; Michel & Harkins, 1986). This, in turn, predicts their later hand preference for manipulating objects (Babik & Michel, 2016; Campbell et al., 2015). Taken together, there is now ample evidence that handedness emerges in human infants via cascading developmental events (Nelson, 2022). The developmental cascades' perspective (e.g., Iverson, 2021; Masten & Cicchetti, 2010) offers a new framework to understand change that focuses on how change is the result of a multitude of factors across a range of levels and systems.

Interestingly, similar arguments, starting from Michel's theories, have recently been associated with the infant cradling side and implemented in a double-function model of the early mother-infant asymmetrical interaction. Here, left cradling is considered as part of a wider environmental framework, thus representing a genuine maternal effect provoking cascading effects on the infant's development (Boulinguez-Ambroise et al., 2021, 2022; Malatesta, Marzoli & Tommasi, 2020; Malatesta, Marzoli, Apicella, et al., 2020; Malatesta, Marzoli, Morelli, Pivetti & Tommasi, 2021; Malatesta, Marzoli, Prete & Tommasi, 2021; Malatesta, Manippa & Tommasi, 2022; Malatesta, Marzoli & Tommasi, 2022).

2 | POINT OF VIEW: HANDEDNESS SUFFICIENTLY EXPLAINS THE CRADLING BIAS IN HUMANS

Several studies have pointed out handedness as a possible explanation of the cradling bias. With the right hand being the dominant hand for about nine out of 10 adults (Papadatou-Pastou et al., 2020),

the handedness hypothesis is certainly the most straightforward and intuitively plausible explanation, given that cradling is a motor task that can be done with both arms and that there is a preferred arm, hand, or foot for nearly everything we do (Van der Meer & Husby, 2006). Huheey (1977) was the first to propose an explanation of the cradling preference in terms of handedness. He suggested that mothers cradle their infants in their non-preferred arm to free the preferred arm to do other tasks with. Dagenbach et al. (1988) reported considerable differences between left- and right-handers in a small sample of 37 mothers, as under half of left-handed mothers held their child on the left side compared to almost three quarters of right-handed mothers. And in a sample of 29 left-handed mothers when asked which side they preferred to hold their baby, Donnot (2007) did not find a leftward cradling bias with only 48% of new mums indicating they would prefer to cradle on the left, that is, in their dominant arm.

When considering handedness as an explanation of the cradling bias, it is imperative to include enough left-handers and to assess handedness carefully. Van der Meer and Husby (2006) actively recruited left-handed and ambidextrous participants and tested 765 persons ranging in age from 4 to 86 years in a functional cradling task holding a life-sized doll, where manual interaction was part of the situation. Participants were expected to functionally cradle the doll in their non-dominant arm when the act of cradling co-occurred with inserting a dummy in the doll's mouth. Participants, who were naïve to the handedness hypothesis, were told to imagine that the doll was a familiar infant that was crying. They were then instructed to pick up the doll, comfort it, and give it the dummy that was lying over the doll's head. After the cradling task, handedness was measured as a quantitative variable on a continuum rather than as a dichotomous variable with the extended version of the Edinburgh Handedness Inventory (Oldfield, 1971). Handedness laterality quotients (LQs) were calculated giving scores between -1.00 (strongly left-handed) and $+1.00$ (strongly right-handed). The distribution of handedness in the sample was 64.3% right-handed ($LQ \geq +0.6$), 24.7% mixed-handed ($+0.60 > LQ > -0.60$), and 11% left-handed participants ($LQ \leq -0.60$). For the doll-holding task, the left cradlers had a significantly higher LQ than the right cradlers. Of participants assessed as right-handed, 79.1% cradled in the left arm. In the mixed-handed group, 66.1% cradled in the left arm, whereas just 39.3% of the left-handers cradled in the left arm. Bringing in the LQ more directly by plotting LQs on the x -axis against percentage of people cradling in the left arm, a staircase generally going up from left to right with increasing values of LQ was found (Figure 1), indicating that the more right-handed a person, the more likely he or she is to cradle on the left side. Taken together, this well-powered study clearly points to handedness as the determining factor of a functional cradling preference, with almost three quarters of participants ($N = 567$) cradling a doll in their non-preferred arm (Van der Meer & Husby, 2006).

Interestingly, almost a quarter of participants in the study by Van der Meer and Husby (2006) were categorized as mixed-handers, which is 2.5 times higher than in a recent large-scale meta-analysis (Papadatou-Pastou et al., 2020). We chose to measure handedness on a continuum and included three instead of two handedness groups using rather strict criteria for left- and right-handedness. By using only two handedness categories, prior studies may have oversimplified handedness groups. Future studies on cradling should consider using a more continuous measure of handedness and at least add a mixed-handed group.

It should be noted that left- and mixed-handers were slightly less prone to cradle in their non-dominant arm than right-handers. This could be because we are constantly influenced by our environment, which is predominantly made by and for right-handers. As a result, many left-handed and especially mixed-handed people learn to be more flexible in the use of their right hand, and those who only show a slight preference for the left hand may be more inclined to change their handedness pattern under influence of the right-handed majority (Bolton, 1978; Hopkins & Rönnqvist, 1998).

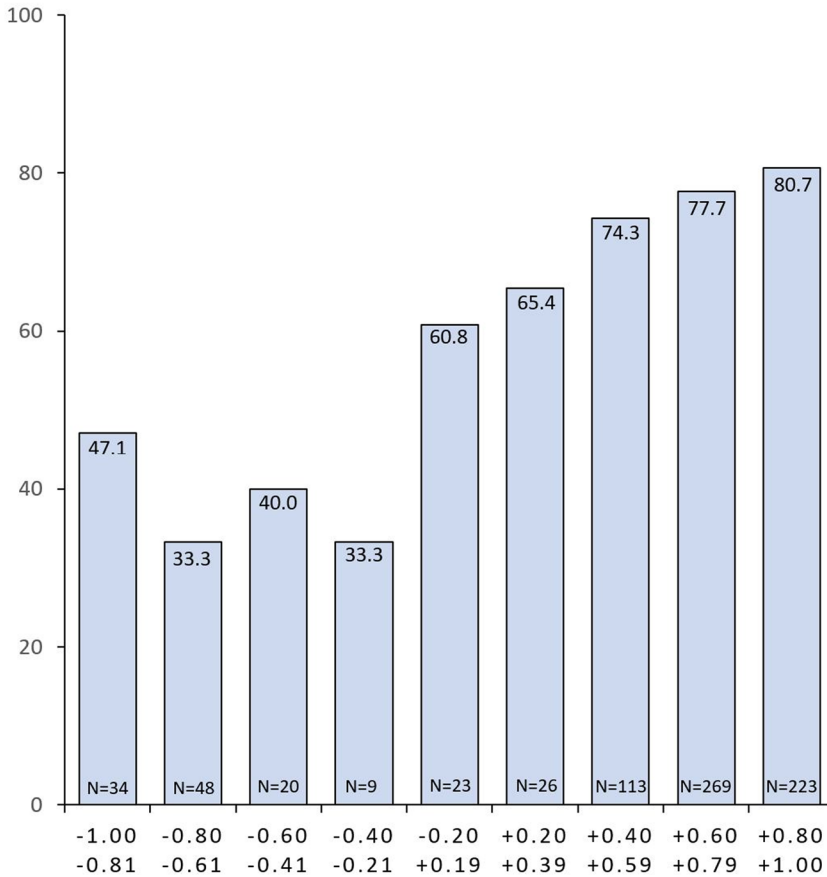


FIGURE 1 Distribution of handedness laterality quotients (LQ, x-axis) for 765 participants in a functional cradling task plotted against the percentage of left arm crdlers (y-axis), as assessed by the Edinburgh Handedness Inventory (Oldfield, 1971) giving scores between -1.00 (strongly left-handed) and $+1.00$ (strongly right-handed). A staircase is shown going up from left to right, indicating that the more right-handed a person, the more likely they cradle in their left arm. Reproduced from Van der Meer and Husby (2006).

This right-hand advantage is clearly reflected in common items such as computer keyboards, musical instruments, cameras, and scissors, and is even evident in social gestures such as the handshake (Van der Meer & Husby, 2006).

Most cradling studies report a stronger preference to cradle on the left for women than for men (e.g., Bourne & Todd, 2004; Manning & Denman, 1994; Van der Meer & Husby, 2006). This could easily be explained by the fact that women, in general, have more opportunities to handle babies than men. Bogren (1984) reported no cradling preference in couples who had recently become parents. However, already in the first few days after having given birth, breastfeeding mothers discover the advantage of cradling their babies in their non-dominant arm (Stables & Hewitt, 1995). Studies that fail to find any significant gender differences in cradling, often still report a stronger cradling bias in participants who have experience with children (Bundy, 1979), or when fathers are compared to men without children (De Château, 1983).

A left-sided cradling preference has been reported for preschool-aged girls, but not for boys (De Château & Andersson, 1976; Saling & Bonert, 1983). This can be explained by the fact that boys play less with dolls than girls (Theimer et al., 2001). According to Provins (1992), playing with

dolls largely simulates the activities that are involved in parenting or looking after small children, and should consequently not be underestimated as an important source of experience with babies. Through playing with dolls girls will learn, more so than boys, that it is more practical to cradle in the non-dominant arm (Van der Meer & Husby, 2006). It will be interesting to see whether these differences in experience with handling babies will gradually cease to exist due to more modern practices of gender-neutral education, gender-neutral toys (for a recent systematic review and meta-analysis on sex differences in children's toy preferences, see Todd et al., 2018), and as a result of new fathers being much more involved in handling and taking care of their offspring than a mere 50 years ago. Depending on available information about whether fathers took parental leave, and if so, how much, it would be possible to examine existing studies by decade to reveal a potential shift. This could be an important potential covariate for the research question regarding sex, handedness, and the left cradling bias for future work.

3 | A BIAS IN MOTOR PREFERENCES AND HANDEDNESS LIKELY BEHIND THE LEFT-SIDED CRADLING PREFERENCE

A leftward cradling bias has been reported in many empirical studies investigating human cradling. Factors that have been suggested to modulate cradling asymmetry are the cradler's handedness and sex. However, these moderating factors have not been shown consistently, likely due to low sample sizes, the inclusion of too few or no left-handers, and varying experimental paradigms. A recent paper conducted three meta-analyses across 40 studies and found clear handedness and sex effects on lateral biases in human cradling (Packheiser et al., 2019). They reported that left-handers demonstrate a significantly less pronounced leftward cradling bias compared to right-handers and that males are less lateralized compared to females.

Here I presented evidence that a bias in motor preferences and handedness is the driving force underlying a cradling preference. Humans prefer to use their non-dominant hand for cradling young infants, and as the ratio between right-handers and left-handers is estimated to be 9:1 (Corballis, 2003), there is a considerable majority of right-handers in the population who consequently cradle in their non-dominant left arm. Rather than introducing a genetic hemispheric asymmetry in emotional processing that is assumed stronger in women than men (e.g., Vauclair, 2022), a much more elegant explanation is that handedness emerges in human infants via cascading developmental events starting already in the intrauterine environment (Nelson, 2022), and that women and girls have more experience with handling babies and dolls. As a result, they are learning-by-doing from an early age that cradling in the non-dominant arm is more practical because it leaves the dominant hand free for doing other things with.

CONFLICT OF INTEREST STATEMENT

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

ORCID

Audrey L. H. van der Meer  <https://orcid.org/0000-0001-9899-4688>

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