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Hand clasping, arm folding, and handedness: Relationships and strengths of preference

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We investigated via a survey the relationship between hand clasping, arm folding, and handedness. We aimed to provide new data on degree of preference for each of these lateralities. We also examined the relative importance of thumb position versus interdigitisation of the fingers in determining one's comfort in a hand-clasping position. We explored this in the context of the fact that sensory acuity is greater for the thumb than other fingers, suggesting that preference for how the fingers are intermeshed may be more influenced by thumb than finger position. Lastly we performed an exploratory analysis to determine if self-reported menstrual phase—known to influence turning bias—also influences hand clasping, arm folding or the strength of one's handedness. Our study suggests that lateral preferences for hand clasping, arm folding, and handedness are independent. However, the degrees of lateral preference for hand clasping and arm folding are correlated. Our exploration of the relative importance of thumbs versus fingers to hand clasping revealed some trends that were not statistically significant, but worth future exploration. Our data on menstrual phase showed a reduced strength of preference for arm folding in mid-luteal females versus non-mid-luteal females.

Keywords: Hand clasping; Arm folding; Handedness; Menstrual phase; Strength of preference.

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Laterality, or lateral preference, is an individual's use of one side of their body over the other without any environmental or biological advantages for such preference (Dittmar, 2002). In this study we explore laterality in the upper limb postures of hand clasping (HC) and arm folding (AF) (see Figure 1).

Previous researchers have investigated lateral preferences in HC and AF, and explored relationships between these lateralities and handedness (Mohr, Thut, Landis, & Brugger, 2006). Mohr et al. (2006) found that

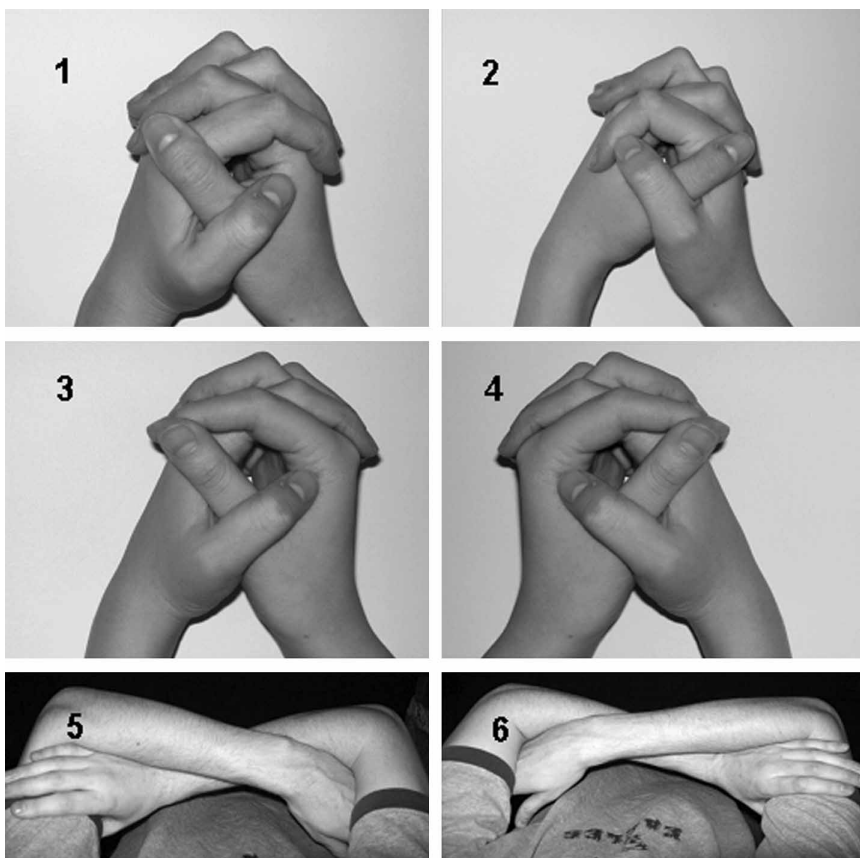


Figure 1. Four hand clasping positions (1–4) classified according to which thumb is on top, and whether there is complete or incomplete interdigitisation of the fingers. Two arm-folding positions (5–6) classified according to which arm was on top. 1. Left hand clasping with complete interdigitisation of the fingers (LHC). 2. Right hand clasping with complete interdigitisation (RHC). 3. Left hand clasping with incomplete interdigitisation (LHCI). 4. Right hand clasping with incomplete interdigitisation (RHCI). 5. Left arm folding (LAF). 6. Right arm folding (RAF).

right-handed people who are LAF and RHC (as defined in Figure 1) tend to have a weaker degree of handedness than right-handed people who are LAF and LHC. However, they did not look at degrees of lateral preference for HC and AF. The first aim of our study is to explore strengths of lateral preference for these two postures, and to determine if these degrees of preference relate to each other or to handedness. We hypothesised that degree of preferences would be correlated for HC, AF, and handedness. If this hypothesis were supported, it would provide insight into the aetiology of lateral preferences in general by suggesting that strengths of lateral preference are controlled by the same factors across various lateralised upper-limb postures.

No clear determinants of lateral preferences for HC and AF have been previously reported. McManus and Mascie-Taylor (1979) determined that there is no simple genetic explanation for the lateralisation of HC. Similarly, AF and handedness cannot be attributed to a simple genetic model (Dittmar, 2002). Lateral preferences in general may be influenced by environmental factors (Tambs, Magnus, & Berg, 1987) or by bilateral differences in the body parts involved (Reiss & Reiss, 1998). For HC, being LHC versus RHC appears to depend, in part, on the hemisphere of the brain that is dominant for motor control (Mohr, Thut, Landis, & Brugger, 2003; Mohr et al., 2006). Following that observation, a second aim of our study is to determine if thumb position versus finger position is more important to one's lateral preference for HC. We explored this by examining participants' relative levels of comfort in their preferred HC position versus three other clasping positions (shown in Figure 1). Humans have more sensory acuity in their thumb than in their fingers (Penfield & Boldrey, 1937). We thus hypothesised that thumb position would be more important to lateral preference for HC. This hypothesis, if supported, would provide a basis for further investigation into sensory, as well as motor, neurological influences on lateral preferences.

Previous research has found a relationship between cycling ovarian hormone levels and laterality in turning preference, which is the tendency to swivel to the right versus left when turning around 180 degrees (Mead & Hampson, 1996, 1997). Mead and Hampson (1997) found that turning preference in right-turning women was stronger in the menstrual versus mid-luteal phase. A third aim of this study is to determine the influence of menstrual phase on HC, AF, and handedness, in terms of lateral preference and strength of that preference. If our study shows that menstrual phase influences these lateral preferences as it does turning preference, it would provide a basis for further studies on the influence of hormones on lateral preferences in general.

METHOD

Survey design

We created a three-part survey. The first section was designed to determine lateral preferences for HC and AF, as well as the relative comforts of each HC position. Here, we instructed participants to clasp their hands without hesitation. The position that they assumed after this instruction was referred to as their natural position. They were then asked to identify this natural position as LHC, RHC, LHCI, or RHCI by comparing it with photographs of the four HC positions (shown in Figure 1). Similarly, we instructed participants to fold their arms without hesitation and identify their natural arm-folding method as either LAF or RAF by comparing it with photographs of the positions. To minimise order effects, the order of photograph presentation was randomised with each administration of the survey.

Participants were also asked to clasp their hands in all of the four positions shown in Figure 1 and rank the level of comfort for each position on an 8-point Likert scale of comfort (from 1 for “very comfortable” to 8 for “very uncomfortable”). Similarly, they were asked to fold their arms in both AF positions (see Figure 1) and rank the level of comfort for each position. We determined an individual’s *strength* of hand-clasping and arm-folding preference by finding the differences between the comfort rating on the 8-point Likert scale for the most preferred position and the rating for each of the other positions. We then added these differences to obtain a strength of preference score.

In the second section of the survey we determined the handedness and strength of handedness using a modified version of the Waterloo Handedness Survey (Brown, Roy, & Rohr, 2006; Steenhuis, Bryden, Schwartz, & Lawson, 1990). To determine handedness, we assigned “left-hand” responses a value of -1 , “either-hand” responses a value of 0 , and “right-hand” responses a value of 1 . We then added the values for the 18 questions, giving totals between -18 and $+18$. A negative total indicated left-handedness, a positive total indicated right-handedness, and a total of 0 indicated mixed-handedness. We determined *strength* of handedness by taking the absolute value of the participant’s total, giving a strength score between 0 and 18 . A large number indicated a greater strength of preference for the left or right than a smaller number, which indicated a tendency towards mixed-handedness.

The final section of the survey asked female participants when they had begun their last menstrual period. This information was collected in order to estimate menstrual phase, assuming a 4-week cycle.

Data collection

Institutional Review Board approval for this study was obtained from Dalhousie University. Paper copies of the survey were distributed to students and staff of the university, as well as to other residents of Halifax, Nova Scotia. Participants were permitted to complete the survey at any location of their choice, and to return the survey at their convenience.

A total of 266 individuals completed the survey, 109 of these were males and 157 were females. Participants ranged in age from 16 to 27 years old. A total of 49 participants (34 of whom were female) completed the survey a second time, 1 week later. We surveyed these participants twice in order to assess individual differences in strengths of preference for HC, AF, and handedness between the first and second surveys.

Analysis I: Relationship between hand clasping, arm folding, and handedness

To determine if lateral preference for hand clasping, arm folding, and handedness are independent of each other, we used Pearson's chi-square tests assuming equal probability for preference for all hand clasping positions. We then categorised participants using only two methods of hand clasping based on the position of the thumbs regardless of finger positioning (i.e., RHC + RHCI vs LHC + LHCI) and repeated the chi-square tests.

Correlation coefficients were calculated for the three possible pairings of the strengths of preference for HC, AF, and handedness.

Analysis II: Hand-clasping position preferences

All data were analysed in relation to the preferred HC position. The comfort rating for the preferred position was occasionally left blank by participants. In such cases a value of 1, the most comfortable rating, was assigned for the preferred position. Due to some participants' misinterpretation of survey directions, a few responses for comfort ratings were made in reverse. The preferred position was ranked as most uncomfortable and other positions, which participants found difficult to assume, were ranked as most comfortable. In these instances of obvious and unambiguous reversal the ratings were corrected so that the preferred position was ranked as most comfortable. These reversals did not affect strength of preference scores.

Pearson's correlation tests were used to determine if comfort ratings for hand-clasping positions that shared a dominant thumb (i.e., had the same thumb on top during clasping) were more strongly correlated than the comfort ratings for positions that did not share a dominant thumb. Pearson correlation tests were also used to determine if comfort ratings for RHC

were correlated with those for LHC, and if ratings for RHCI were correlated with those for LHCI.

Analysis III: Menstrual cycling and the strength of preference

To determine the effect of menstrual phase on lateral preference we used paired data from female participants who were surveyed twice, 1 week apart. We also analysed responses from females who were surveyed once. We asked the participants if they were taking hormonal contraceptives, and took this into consideration in our analysis.

We grouped all the menstruating females according to their self-reported stage in the menstrual cycle. Participants who started their current cycle 2 or 3 weeks ago were adjudged to be in the mid-luteal phase.

We used a two-sample *t*-test, assuming equal variances, to determine whether the difference in mean strength of lateral preferences between mid-luteal and non-mid-luteal groups was significant in the pooled female data. We then used the paired *t*-test to determine if strengths of handedness, HC, and AF preferences varied with the menstrual cycle for females surveyed twice. We excluded from this analysis females who did not know when their last period was and females who were not experiencing a menstrual cycle. We only included in this analysis females who shifted in or out of the mid-luteal phase between their first and second surveys.

Lastly we compared paired data, from the population sampled twice, to see if there were any individual differences between strengths of lateral preference from the first to the second survey.

A *p*-value of .05 was considered significant for each analysis.

RESULTS

Relationship between hand clasping, arm folding, and handedness

Out of 266 participants, 244 were right-handed, 18 were left-handed, and 4 were mixed-handed. A chi-square test found no significant relationship between lateral preference for the four HC positions and AF (all $p > .3$). In addition, we found no relationship between AF and HC when considering only two methods of HC (RHC + RHCI and LHC + LHCI).

No significant relationships were observed (all $p > .3$) between the four HC methods and participants' handedness. Similarly, no relationship between HC and handedness was observed when considering only two HC positions (RHC + RHCI and LHC + LHCI).

TABLE 1
Pearson's correlation coefficients for different combinations of the degrees of preference for hand claspings, arm folding, and handedness

<i>Variables</i>	<i>Sample size</i>	<i>Pearson correlation coefficient</i>	<i>p-value</i>
Hand claspings and arm folding	266	0.277	< .001
Hand claspings and handedness	266	0.091	.138
Arm folding and handedness	266	0.117	.057

We did not find any significant relationship between AF and handedness. However, a significant correlation between the strength of AF preference and the strength of HC preference was observed ($n = 266$, $r^2 = .277$, $p = < .001$; see Table 1). Table 1 also shows that we found no other significant correlations between strengths of preference for the three lateralities that we considered.

Hand-clasping position preferences

The LHC and LAF were the most common methods of hand claspings and arm folding respectively. This result concurs with previous findings (Mohr et al., 2006). The position that is naturally assumed was most commonly rated the most comfortable by participants. However, contrary to our hypothesis, the position in which the dominant thumb (in terms of preferred clasping position) remained above the hand does not appear to have the second best comfort rating (Figure 2). RHC participants most commonly chose LHC as their second most comfortable position, and vice versa. Those participants who chose LHCI as their natural position most often reported LHC as their second most comfortable. Participants who were RHCI most often rated LHCI and RHC to be second most comfortable.

Comfort ratings for positions in which the dominant thumb is shared were not more strongly correlated than ratings for positions that do not share a dominant thumb. Comfort ratings for RHC and LHC were negatively correlated ($r = -.619$, $n = 266$, $p < .001$). Also, a correlation ($r = .195$, $n = 266$, $p < .001$) was observed between RHCI and LHCI position comfort ratings.

Menstrual cycling and the strength of preference

In an analysis of the paired data, strength of handedness scores were more consistent over the two surveys than strength of preference scores for HC and AF (Table 2). Also, males were more consistent than females in their scores for strength of handedness and strength of preference for hand claspings and arm folding (Table 2).

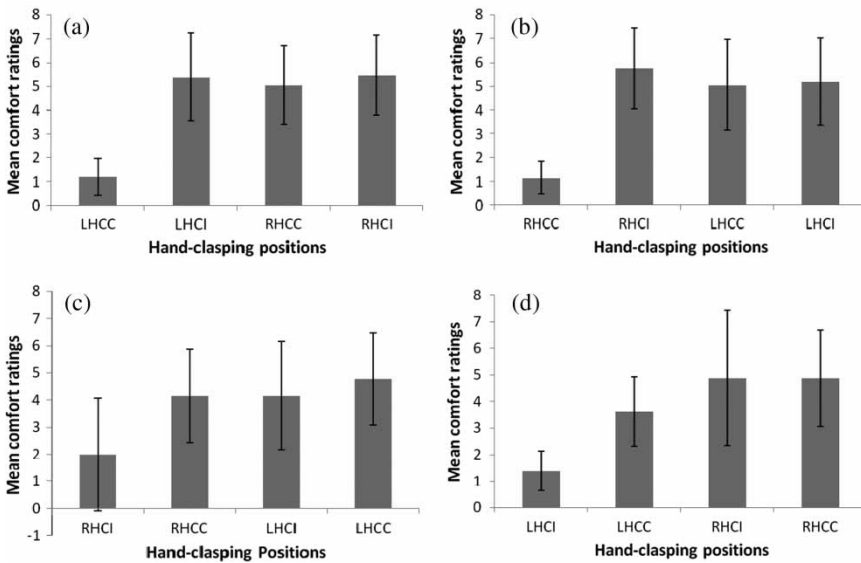


Figure 2. The mean comfort ratings for all four hand-clasping positions, graphed according to natural position, which is indicated by the leftmost bar on each graph. (a) RHC (RHCC) is the natural position ($n = 91$ respondents). (b) LHC (LHCC) is the natural position ($n = 154$ respondents). (c) RHCI is the natural position ($n = 13$ respondents). (d) LHCI is the natural position ($n = 8$ respondents). The ratings scale included numbers from 1–8, 1 being very comfortable and 8 being very uncomfortable. Error bars indicate one standard deviation away from the mean.

Analysis of paired female data did not show any significant differences between the strengths of laterality preferences at mid-luteal versus non-mid-luteal phases. There were also no significant differences in strengths of preferences when considering paired data from female participants who were or were not taking hormonal contraceptives.

Only the arm-folding strength of preference for the pooled female data showed a significant ($p = .025$) difference between menstrual phases:

TABLE 2
Correlation coefficients for strengths of preferences indicated at the first versus the second time of surveying

	<i>Hand clasping</i>		<i>Arm folding</i>		<i>Handedness</i>	
	r^2	p	r^2	P	r^2	p
Females ($n = 34$)	.64	< .001	.72	< .001	.73	< .001
Males ($n = 15$)	.70	.003	.92	< .001	.94	< .001
All ($n = 49$)	.61	< .001	.78	< .001	.86	< .001

Data for the individuals who were surveyed twice ($n = 49$).

TABLE 3
Female responses

	<i>Hand clasping</i>		<i>Arm folding</i>		<i>Handedness</i>	
	<i>NML</i>	<i>ML</i>	<i>NML</i>	<i>ML</i>	<i>NML</i>	<i>ML</i>
Mean (strength of preference score)	13.500	12.623	4.557	3.826	11.300	10.913
Variance	9.587	19.474	3.091	4.146	30.358	41.669
<i>n</i>	70	69	70	69	70	69
<i>t</i> Stat ($T < = t$) two-tail		1.358		2.267		0.380
<i>p</i>		.177		.025		.704

Analysis of female responses revealed that those in the non-mid-luteal (NML) group had a stronger strength of preference for arm folding than those in the mid-luteal (ML) group.

mid-luteal females had weaker preference for arm folding than non-mid-luteal females (see Table 3). In the pooled female data, no significant differences were found between strengths of preference in mid-luteal versus non-mid-luteal females when we considered only females who were, or only females that were not, taking hormonal contraceptives.

DISCUSSION

Relationship between hand clasping, arm folding, and handedness

Consistent with the findings of Bertoni and Kolski (1994), we found no relationship between the directions of preference for the three upper-limb lateralities. We did, however, observe a correlation between the strengths of preference for hand clasping and arm folding, although handedness was unrelated. Handedness is frequently involved in daily tasks and social communication. In contrast, hand clasping and arm folding are postures that are not assumed very often for functional purposes. The correlation that we observed between the strengths of preference for hand clasping and arm folding could be related to the fact that these lateralities may be associated with different brain areas than handedness (i.e., language-controlling versus non-language-controlling brain centres; Bertoni & Kolski, 1994).

Hand-clasping position preferences

A small trend was observed in the relative comfort of hand-clasping positions. It appears that if complete interdigitisation of the fingers occurs in the natural position, participants preferred to keep the fingers completely interdigitised and were indifferent to thumb positioning. We also found that if their natural position included incomplete interdigitisation, participants preferred for the

thumb positioning to remain the same regardless of finger positioning (i.e., they preferred positions that had the same dominant thumb as their natural position). However, this trend was not statistically significant due to few natural RHCI and LHCI clasps (13 and 8 respectively, out of 266). We were thus unable to determine if thumbs versus fingers were more important to one's comfort in a HC position. As such, we could not resolve how the varying levels of sensory input from the thumbs versus fingers affected laterality in HC.

We did, however, find a significant negative correlation ($r^2 = -.619$, $p = <.001$) between comfort ratings for LHC and RHC, which were the most common natural positions ($n = 154$ and 91 respectively). Further research into the effect of finger positioning, rather than thumb positioning, on the relative comfort of hand-clasping positions is required.

Menstrual cycling and the strength of preference

The participants that were surveyed twice were more consistent in their ratings for strength of handedness than in their ratings for strength of hand clasping and arm folding. This may reflect, to some degree, the reliability of the Waterloo Handedness Questionnaire that we used for handedness assessment. Also, participants were more consistent in their ratings for arm folding than in their ratings for hand clasping. This may be related to the fact that ratings for hand clasping are more subjective than ratings for arm folding because they are based on four possible positions, compared to two in arm folding.

Females' lower consistency in these ratings may be related to hormone levels. Mead and Hampson (1997) found that females with higher hormone levels showed lower consistency in strengths of turning bias.

In analysing our paired female data for trends related to hormone levels, the exclusion criteria for this analysis (see Method) left us with a low ($n = 14$) sample size. However, our analysis of unpaired data showed that non-mid-luteal females had stronger ($p = .025$) preferences for arm folding than mid-luteal females. This preference for a lateralised arm-folding posture is consistent with Mead and Hampson's (1997) findings about turning bias, where preference is weaker during the mid-luteal phase when oestrogen and progesterone levels are typically high.

In summary, our study suggests, as in previous studies, that hand clasping, arm folding, and handedness are independent. We observed that finger positioning was more important for comfort than thumb position for people who have complete interdigitisation of fingers during natural hand clasping. In contrast, thumb position seemed more important for comfort in people with incomplete interdigitisation of fingers during hand clasping.

However, these trends were not statistically significant and require further investigation.

Our study also shows a correlation between strengths of preference for hand clasping and arm folding, as well as a weaker strength of preference for arm folding in mid-luteal females versus non-mid-luteal females.

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