

The Laterality of Handedness, Foot Preference and Foot Overlapping

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ABSTRACT

This study was aimed at the distribution, the frequencies and the correlation between the laterality of handedness, arm folding, digital interlocking, foot preference and foot overlapping. The subjects who were selected for this study were teenagers between the age group of 13 to 15 years. The study was conducted at Belgaum city which is situated in North Karnataka, India, during 2000. There is no relevant information in the literature regarding a similar study which was done in this part of the country. The population here exhibits a wide diversity in cultural and traditional lifestyles and hence this study was taken up. Personal data was collected from the subjects by providing them a questionnaire. Various tests were conducted to determine the handedness, the laterality of arm folding, digital interlocking, foot preference and

foot overlapping. The data which were collected were subjected to tabulation and statistical analysis and those were tested for statistical significance. The Chi square test was used with the paired 'T' test. Male subjects exhibited a highly significant correlation between handedness and digital interlocking ($P < 0.01$) Female subjects showed a highly significant correlation between handedness and digital interlocking ($P < 0.005$)

A highly significant correlation existed between digital interlocking and arm folding in both the sexes ($P < 0.0001$). A significant correlation was seen between handedness and foot overlapping ($P < 0.005$) in both males and females. Both females and males showed a significant correlation between foot preference and foot overlapping ($P < 0.01$).

Key Words: Laterality; Handedness; Foot preference; Cerebral dominance; Asymmetry

KEY MESSAGE

- Several studies regarding handedness have suggested that left-handers have higher than expected rates of neurological disorders including epilepsy, stuttering, dyslexia and other learning disabilities.
- Recent studies have also shown that left-handedness and non-right-handedness is associated with sudden cardiac death. This may be attributed to a sympathetic imbalance which results in ventricular arrhythmia.
- An association between left-handedness and immune diseases and migraine has also been studied.
- A link between inflammatory bowel diseases and left-handedness was also suggested.

INTRODUCTION

The phenomenon of lateral dominance has a close relationship with the structure and function in the animals of all Phyla. A study on children who were aged 11 years, which was conducted at London [1], concluded that non right handers had a significant association with the deficits of performance on certain standardized attainment and ability tests. Non right handedness was associated with "poor speech" as was assessed by teachers in schools. The teachers also reported that the non right handers had a "poor control of the hands". It has been commented that the incidence of left-handedness is more in males than in females [2]. It was also stated that the left-handedness was more in the younger age group than in the older adults. A study on foot overlapping (leg crossing) in German samples [3] concluded that 62% of the population were right leg crossers, 26% were left leg crossers and that 12% were ambilateral. Foot overlapping is correlated to some extent with footedness and handedness. Digital interlocking, arm folding and handedness have a place in human biology, far beyond

their possible uses in genetics and in population comparisons. They are easily determined manifestations of cerebral dominance. This is apparently a unique evolutionary development in man, which becomes clinically important in the diagnosis of strokes and aphasias.

MATERIALS AND METHOD

The volunteers for this study were selected from 1) Phoenix Public School and 2) Smt. Annapurnadevi Hiremath English Medium school of Belgaum city, who were between the ages of 13 to 15 years. The total number of subjects who were included in the study was 200. Care was taken to include only healthy subjects. Those with any disability or a deformity of the upper or lower limbs were excluded from the study. Out of them, 112 were boys and 88 were girls. The subjects were requested to answer a questionnaire which included questions about their personal information. Each subject had to mention the family history of left handedness and footedness in the questionnaire. Each subject was carefully

observed and the hand which was used by each one of them to pick up the questionnaire was noted. Various tests were conducted to determine the handedness, arm folding and digital interlocking, foot preference and foot overlapping and the observations were recorded.

TESTS FOR HANDEDNESS

The tests for handedness were as follows:

- (a) Picking up the pins and pinning them on the cushion
- (b) Cutting the paper with scissors
- (c) Hammering on a nail
- (d) Handwriting
- (e) Making a personal impression of one's own handedness.

THE TESTS FOR FOOT PREFERENCE

The subjects were asked to kick a football towards a goal, from a distance of 10 meters, in an attempt to make a score. An assessment was made on how accurately each subject aimed at the goal and how hard he/she kicked the ball. They were observed carefully to assess as to which foot was first preferred to kick the ball. After each one of them used both the legs, proper distinction was made between the dominant and non-dominant foot, by observing the comfort, accuracy and the hardness with which the ball was kicked by each foot.

THE TESTS FOR ARM FOLDING, DIGITAL INTERLOCKING AND FOOT OVERLAPPING

The subjects were demonstrated about the exercises i.e. arm folding, digital interlocking and foot overlapping and they were asked to mimic the exercise. The arm, digit or foot which was on top, was considered as the dominant one.

ETHICS

The study was conducted on teenage student volunteers in the local schools. The permission to conduct the study was granted by the heads of the institutions. The willingness of the parents of each student was taken into consideration before conducting the study.

RESULTS AND TABULATIONS

SL No.	Function No.	No. Tested	No. RD	%RD	No. LD	%LD	No. AL	% AL
1.	Handedness	112	108	96.45	4	3.55	-	-
2.	Foot preference	112	110	98.20	2	1.80	-	-
3.	Arm folding	112	85	75.90	27	24.10	-	-
4.	Digital interlocking	112	98	87.50	14	12.50	-	-
5.	Foot overlapping	112	85	75.90	27	24.10	-	-

[Table/Fig-1]: Frequencies of Male subjects with distribution of lateral dominance for each of the parameters studied

SL No.	Function No.	No. Tested	No. RD	% RD	No. LD	% LD	No. AL	% AL
1.	Handedness	88	83	94.30	5	5.70	-	-
2.	Foot preference	88	84	95.50	4	4.50	-	-
3.	Arm folding	88	62	69.30	27	30.70	-	-
4.	Digital interlocking	88	71	80.70	17	19.30	-	-
5.	Foot overlapping	88	27	64.77	31	35.23	-	-

[Table/Fig-2]: Frequencies of Female subjects with distribution of lateral dominance for each of the parameters studied

		Males				Females			
		RD	%	LD	%	RD	%	LD	%
Digital interlocking	RD	97	86.7	1	0.8	70	79.5	1	1.2
	LD	11	9.9	3	2.6	13	14.8	4	4.5
Arm folding	RD	83	74.1	2	1.8	59	67.04	3	3.5
	LD	25	2.3	2	1.8	24	27.3	2	2.3
Foot overlapping	RD	84	75	1	0.8	58	65.9	1	1.1
	LD	24	21.5	3	2.7	25	28.4	4	4.6
Foot preference	RD	108	96.4	2	1.7	83	94.3	1	1.1
	LD	0	0	2	1.2	0	0	4	4.6

[Table/Fig-3]: Comparison of Handedness and its paired distribution with the other variables studied

		Males				Females			
		RD	%	LD	%	RD	%	LD	%
Handing	RD	97	86.6	1	0.9	70	79.5	1	1.1
	LD	11	9.8	3	2.7	13	14.8	4	3.6
Arm folding	RD	81	72.4	4	3.5	55	62.5	5	5.7
	LD	17	15.2	10	8.9	16	18.2	12	13.6
Foot overlapping	RD	73	65.2	12	10.7	48	54.6	10	11.4
	LD	25	22.3	2	1.8	23	26.1	7	7.9
Foot preference	RD	97	86.6	1	0.9	71	80.6	1	1.1
	LD	13	11.6	1	0.9	13	14.1	3	3.5

[Table/Fig 4]: Comparison of Digital interlocking and its paired distribution with the other variables

		Males				Females			
		RD	%	LD	%	RD	%	LD	%
Hand	RD	83	74.1	25	22.3	59	67	24	27.3
	LD	2	1.8	2	1.8	3	3.4	2	2.3
Digital interlocking	RD	81	72.3	17	15.2	55	62.5	16	18.2
	LD	4	3.6	10	8.9	5	5.7	12	13.6
Foot overlapping	RD	73	65.2	12	10.7	45	51.1	16	18.2
	LD	12	10.7	15	13.4	13	14.8	14	15.9
Foot preference	RD	84	75	26	23.2	60	68.1	24	27.3
	LD	1	0.8	1	0.8	3	3.4	1	1.2

[Table/Fig 5]: Comparison of Arm folding and its paired distribution with other variables studied

		Males				Females			
		RD	%	LD	%	RD	%	LD	%
Hand	RD	84	75	24	21.4	58	65.9	25	28.4
	LD	1	0.9	3	2.7	1	1.1	4	4.6
Digital interlocking	RD	73	65.2	25	22.3	48	54.6	23	26.1
	LD	12	10.7	2	1.8	10	11.4	7	7.9
Arm folding	RD	73	65.2	12	10.7	45	51.2	16	18.2
	LD	12	10.7	15	13.4	13	14.8	14	15.9
Foot preference	RD	86	76.8	24	21.4	58	65.9	26	29.5
	LD	0	0	2	1.8	1	1.1	3	3.5

[Table/Fig 6]: Comparison of Foot overlapping and its paired distribution with the other variables studied

		Males				Females			
		RD	%	LD	%	RD	%	LD	%
Hand	RD	108	96.4	0	0	83	94.3	0	0
	LD	2	1.7	2	1.7	1	1.1	4	4.5
Arm folding	RD	84	75	1	0.8	60	65.9	3	3.4
	LD	26	23.2	1	0.8	24	27.2	1	2.2
Digital interlocking	RD	97	86.6	1	0.8	71	79.54	1	1.1
	LD	13	11.6	1	0.8	13	14.77	3	3.4
Foot overlapping	RD	86	76.7	0	0	58	65.9	1	1.1
	LD	24	21.41	2	1.7	26	27.2	3	3.4

[Table/Fig 7]: Comparison of Foot preference and its paired distribution with the other variables studied

DISCUSSION

Somatic asymmetry is well known and widespread in the animal kingdom. It was suggested by some authors that sex hormones may affect the growth of the two sides of the body differentially. It was reported that in right-handers, the right foot was more often larger in males, while the left foot was larger in females [4]. There was a great enthusiasm and interest regarding this measure by other authors, which arose from a possibility that the brain hemispheres followed a parallel pattern. Somatic asymmetry appears early in foetal life, thus suggesting a prewiring of the brain for one pattern or another before birth. A study reported that the testicular or breast volume asymmetry were significantly different in human males and females. Among the males, there was a higher frequency of right-larger individuals, while among the females, there were more left-larger subjects [5]. Earlier researchers had suggested that there was a generalized dimension of motor laterality, at least among the males, from the inference of a study, where a majority of the people exhibited a right dominance for variables like handedness, footedness and eyedness [6]. The current study shows an ipsilateral correlation between handedness and foot preference. [Tables/ Fig 1 & 2] show the correlation of handedness with the different parameters. Left handed females showed a 20% tendency of using the right foot. Right footed females had a 98.8% chance of using the right hand. Left footed females had a 100% chance of using the left hand. Left handed males had a 50% chance of using the right foot. Left footed males had a 50% chance of using the right hand. Both males and females showed a significant correlation between handedness and foot preference ($P < 0.001$). A difference of opinion on this matter was indicated in the study on the foot and eye preference in adults, their relationship with the hand, sex and age [7]. There is a higher proportion of crossed hand-foot preference in men than in women. It has been asserted that cross-dominance is advantageous in sports which require side-on-stances, for eg: base-ball, cricket, golf [8]. However, a recent South African study found that cricketers were not more likely to have cross-dominance than the normal population [9]. Cultural pressures determine the socialization of handedness in many societies. More often, females are compelled towards the conformity of right handedness. The explanation of the laterality of digital interlocking, arm folding, foot preference and foot overlapping is a controversial topic. There is merely a partial genetic control of digital interlocking and arm folding [10]. When individuals clasp their hands by entwining the fingers in a natural way (digital interlocking), they can be termed as 'R' individuals, if the fingers of the right hand remain above that of the corresponding ones of the left hand. Others are called 'L' individuals if the fingers of the left hand remain above that of

the right hand. "Cerebral dominance is a distinctive biological attribute of man, and as far as it is known, it is either absent or poorly developed in any other mammal" [11] The comparison of the frequencies of handedness and digital interlocking in [Table/ Fig 3] shows that the right handed male tends to be 89.8% right dominant for digital interlocking. 25% of the left handed males tend to be right dominant for digital interlocking. 98.8% of the males who were right digital interlocking, were right handed. 78.57% of the left digital interlocking males were also right handed. Among the right handed females, 84.3% tended to be right digital interlocking and among the left handed females, 20% tended to be right digital interlocking. 98.5% right digital interlocking females were right handed and 76.4% of the left digital interlocking females were right handed. Both males and females showed a highly significant correlation between handedness and digital interlocking ($P < 0.01$ and $P < 0.005$ respectively). Handedness and digital interlocking exhibited some correlation, according to others [12]. Others differed from this opinion. They found that there was no correlation between digital interlocking, arm folding and handedness [13]. The present study did not find any correlation between handedness and armfolding in either of the sexes. ($P > 0.1$). Some have argued that the lateralization of the function enhances the cognitive capacity and the efficiency of the brain, thus countering the ecological disadvantages of the lateral biases of behaviour [14]. There was a suggestion of a link between left handedness and the risk of inflammatory bowel diseases [15]. The asymmetry of the thyroid lobe volume in three dimensional ultrasound images showed that there was an association between the handedness of the subjects and the position of the oesophagus [16]. Some workers contended that there was a correlation between digital interlocking and armfolding [17]. The same findings were obvious in the present study as well. [Table/Fig 4] depicts the comparison of the frequencies of digital interlocking with various parameters. Both males and females exhibited a highly significant correlation ($P < 0.0001$). On the contrary, there is no correlation between digital interlocking and foot overlapping in both the sexes. Both males and females combined together, showed a significant correlation between digital interlocking and foot preference ($P < 0.001$). [Table/ Fig 5] shows the comparison of armfolding with the frequencies of various parameters and this shows a significant correlation between arm folding and foot overlapping in both males and females ($P < 0.001$). On the other hand, there was no correlation between arm folding and foot preference in both the sexes. [Table/Fig 6] shows foot overlapping and its correlation with different parameters. It was observed that neither males nor females showed any correlation between foot overlapping and foot preference. In [Table/Fig 7], the comparison of foot preference with various parameters showed no correlation between foot preference and foot overlapping. A high prevalence of left handedness has been revealed in geniuses like Julius Caesar, Napoleon, Leonardo da vinci, Michaelangelo, Picasso, Chaplin, Lewis Carroll, Benjamin Franklin, several famous comic actors and four presidents of the United States. In a research paper, it was concluded that the area of handedness was filled with grey spots- there were no definite conclusions nor any definite proof of anything. The only fact was that for some reason, 10% of the world's inhabitants preferred to use the left hand over the right. In trying to explain this, the reasoning behind handedness centers around protection, convenience, genetics, environment, brain hemisphere dominance, the birthing process and the effect of the body's chemical levels. Which one is the right one? At this point, it is hard to tell [18].

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