

Original Research Paper**ASSOCIATION BETWEEN LATERALITY MARKERS (HAND, FOOT, EYE AND EAR) IN SOUTH INDIAN POPULATION****Authors:****Doni. R. Praveen Kumar¹ Sudha Srivastava², C. S. Janaki³**¹Ph.D Scholar, Index Medical College, Hospital & Research Center, Malwanchal University, Indore, Madhya Pradesh²Professor, Department of Medical Anatomy, Index Medical College, Hospital & Research Center, Malwanchal University, Indore, Madhya Pradesh³Professor, Bharat Medical College, Chennai, Tamilnadu

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ABSTRACT:

Hand is the well established and studied marker of brain lateralisation. 90% of world population is right handed while 10% is left handed. There individuals with dominant right or left hand differ in certain behavioural and habitual patterns which can be observed in terms of preferential use of eye, ear and foot. Hence in this study an attempt was made to determine the association between hand preference with the preference to eye, ear and foot. This study included 300 participants (150 right handed and 150 left handed). The handedness, footedness, eyedness and earedness were determined by Edinburg Handedness Inventory, Chapman Foot preference Inventory, Miles test and Lateral Preference Inventory respectively. It was found that hand preference was significantly associated with foot preference and eye preference but not with ear preference. In case of gender, significant association was observed only in case of foot preference.

Key words: Eye, ear, hand, foot, gender, association

INTRODUCTION:

In human laterality is exhibited by organs present in pairs like eye, ear, hand and foot. However non paired organs which are arranged similarly may also demonstrate lateral dominance [1]. When there is harmonic use of body parts of same side either right or left, then it is considered complete right dominance or complete left dominance respectively [2]. Additionally crossed dominance can be observed in some individuals which implies that the dominant organs for carrying out different tasks are not on the same side. As for example, an individual may prefer write hand for one task (writing) and left foot for other task (kicking) [3]. The prevalence of right hand dominant individual is 90% while that of right foot, right eye and right ear dominant individuals are 80%, 70% and 60% respectively. Likewise the prevalence of individuals with left sided dominance for hand, foot, eye and ear is respectively 10%, 20%, 30% and 40% [4]. According to the previous studies, in 20% of the individuals the dominant hand and eye are present on the opposite sides. Further, 1.5-6% of individuals with dominant right hand have dominant left foot while 20-50% of the

individuals with dominant left hand have dominant right foot [5]. Human brain exhibits functional symmetries derived often from central (direct) or peripheral (indirect) measures that differ in perceptual and motor level responses. Hand and foot come under motor responses while eye and ear represent central measures involved in perceptual responses [6]. Hand, till date has been the most widely studied marker for brain asymmetry while researches involving foot, eye and ear are still in the phase of latency. Hence this study was designed with an aim to determine foot, eye and ear preference with respect to hand preference. This study also highlights the association of these laterality markers with gender.

MATERIAL AND METHODS:

This is a cross sectional study comprising 300 participants of which 150 each were left and right handed. After the institutional ethical committee approval, the study was initiated. All the participants were explained about the research and informed consent were obtained. The participants were divided into four categories as:

- Group A: 3-7 years
- Group B: 8-11 years
- Group C: 12-15 years
- Group D: 16-20 years

Inclusion criteria:

The individuals fulfilling following criteria were included:

- Age between 3-20 years
- No history of serious illness
- Absence of trauma in head neck region, developmental disorders, psychiatric disorders

Exclusion criteria:

The following participants were excluded:

- Any illness affecting the intelligence
- Children with visual, hearing and speech impairment
- Participants with any gross congenital or physical deformity
- Individuals not consenting to take part

Assessment of handedness:

Handedness was determined based on the Edinburg Handedness Inventory [7]. Ten questions pertaining to use of hand in carryout various activities were included. The questionnaire included questions related to: Brushing teeth, Handling eraser, Match sticking, Hammering, Throwing, Opening a lid, Using spoon, Using Scissor, Holding knife and Holding broom. Scores ranging from +1 (right hand response), 0 (either hand response) and -1 (left hand response) was given as per ASAI. The range of scale is +10 to -10 [8]. The participant is:

- Right handed: score between -4 to +7
- Left handed: score between -10 to -5

Assessment of footedness:

Footedness was assessed using Chapman foot preference inventory [9]. The following questions were asked regarding the dominant foot: Step upon stool, Kicking a ball, Pick up object, Step on spade, Step forward, Hop, Stamp on object, Uppermost leg on crossing, Put on first shoe, Put on first stocking and Stand on one foot. Scale ranges from 11 to 33. Scores ranging from +1 (right leg response), 2 (either leg response) and +3 (left leg response) was given as per ASAI. The participant is:

- Right footed: score between 11 to 16
- Left footed: score between 28 to 33

Assessment of eyedness:

It was evaluated by using Miles test [10]. The participants were asked to look into an object placed at a distance of 6 meter. The participants were instructed to make a small triangle with the first knuckle and thumbs of hand and look into the object through triangle, first with both eyes open. Then they were instructed to close left eye and observe. If the object can be viewed, dominant eye is right. If the hands move off the objects to the left, then dominant eye is left.

Assessment of earedness:

For determining ear dominance 4 questions of lateral preference [11] were asked to each participant as follows:

- Which ear is preferred against a closed door to listen a conversation?
- Which ear is preferred if there is only one ear phone available in a portable device?
- Which ear is preferred against chest of an individual to hear heartbeat?
- Which ear is preferred against a box to check if the box contains ticking clock in it?

RESULTS

Table 1: Association between Hand and Foot preference

Hand	Foot		Total	Chi-square (χ^2)	Df	p-value
	Right	Left				
Right	112	48	160	36.59	1	<0.001**
	65.8%	32%	50%			
Left	58	102	160			
	34.2%	68%	50%			
Total	170	150	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; **→ Statistically significant (p<0.01 at 99% of CI)

Table 2: Association between Hand and Eye preference

Hand	Eye		Total	Chi-square (χ^2)	Df	p-value
	Right	Left				
Right	120	40	160	50.17	1	<0.001**
	67.8%	28%	50%			
Left	57	103	160			
	32.2%	72%	50%			
Total	177	143	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; **→ Statistically significant (p<0.01 at 99% of CI)

Table 3: Association between Hand and Ear preference

Hand	Ear		Total	Chi-square (χ^2)	Df	p-value
	Right	Left				
Right	114	46	160	0.015	1	0.902 ^{NS}
	50.2%	49.5%	50%			
Left	113	47	160			
	49.8%	50.5%	50%			
Total	227	93	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; NS→ Statistically insignificant (p>0.05)

Table 4: Association between Hand preference and Gender

Hand	Gender		Total	Chi-square (χ^2)	Df	p-value
	Male	Female				
Right	85	75	160	0.113	1	0.736 ^{NS}
	49.1%	51%	50%			
Left	88	72	160			
	50.9%	49%	50%			
Total	173	147	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; NS→ Statistically insignificant (p>0.05)

Table 5: Association between Foot preference and Gender

Foot	Gender		Total	Chi-square (χ^2)	Df	p-value
	Male	Female				
Right	86	84	170	1.762	0.184	0.002**
	49.7%	57.2%	53.1%			
Left	87	63	150			
	50.3%	42.8%	46.9%			
Total	173	147	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; **→ Statistically significant (p<0.01 at 99% of CI)

Table 6: Association between Eye preference and Gender

Eye	Gender		Total	Chi-square (χ^2)	Df	p-value
	Male	Female				
Right	97	80	177	0.087	1	0.767 ^{NS}
	56%	54.4%	55.3%			
Left	76	67	143			
	44%	45.6%	44.7%			
Total	173	147	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; NS→ Statistically insignificant ($p>0.05$)

Table 7: Association between Ear preference and Gender

Ear	Gender		Total	Chi-square (χ^2)	Df	p-value
	Male	Female				
Right	127	100	227	1.117	1	0.29 ^{NS}
	73.4%	68%	70.9%			
Left	46	47	93			
	26.6%	32%	29.1%			
Total	173	147	320			
	100.0%	100.0%	100.0%			

Df= Degree of freedom; NS→ Statistically insignificant ($p>0.05$)

DISCUSSION:

Table 1 shows that foot preference is significantly associated with handedness ($p<0.01$). 65.8% of right hand dominant participants preferred right foot while 34.2% preferred left foot. Similarly, 68% of left hand dominant participants preferred left foot while 32% preferred right foot. Table 2 shows that eye preference is significantly associated with handedness ($p<0.01$). 67.8% of right hand dominant participants preferred right eye while 32.2% preferred left eye. Similarly, 72% of left hand dominant participants preferred left eye while 28% preferred right eye. Table 3 shows that ear preference is insignificantly associated with handedness ($p>0.05$). 50.2% of right hand dominant participants preferred right ear while 49.8% preferred left ear. Similarly, 50.5% of left hand dominant participants preferred left ear while 49.5% preferred right ear. The result of present study was in accordance to that of Rai R *et al* and David SJ *et al* who showed significant association of handedness with eye and foot preferences [12, 13]. In contrast to the study of David SJ *et al* the present study did not document any association between hand and ear preference. According to the previous studies, performance of an

individual is better when the dominant hand and foot are on the same side (right hand-right foot or left hand-left foot) [14]. Another study showed that 88% and 8.4% of right hand dominant individuals show preference to right foot and left foot respectively while in case of left hand dominant individuals, 37.1% and 62.9% showed preference to right foot and left foot respectively [15]. Table 4 shows that hand preference is insignificantly associated with gender ($p>0.05$). 49.1% of males were right hand dominant while 50.9% were left hand dominant. Similarly, 51% of females were right hand dominant while 49% were left hand dominant. Table 5 shows that foot preference is significantly associated with gender ($p<0.01$). 49.7% of males were right foot dominant while 50.3% were left foot dominant. Similarly, 57.2% of females were right foot dominant while 42.8% were left foot dominant. Table 6 shows that eye preference is insignificantly associated with gender ($p>0.05$). 56% of males were right eye dominant while 44% were left eye dominant. Similarly, 54.4% of females were right eye dominant while 45.6% were left eye dominant. Table 7 shows that ear preference is insignificantly associated with gender ($p>0.05$). 73.4% of males were

right ear dominant while 26.6% were left ear dominant. Similarly, 68% of females were right ear dominant while 32% were left ear dominant. As per Syuichi O *et al*, the females with left hand dominance show 20% tendency to right foot preference while females with right foot dominance show 98.8% tendency to prefer right hand. Likewise, males with dominant left hand show 50% tendency to prefer right foot. The authors reported significant correlation between hand and foot preference with respect to gender [16]. Similar to the study of Syuichi O *et al*, another study of Singh M *et al* showed significant gender based difference in hand and foot preference which was in contrast to the present study [17].

CONCLUSION:

The present study showed significant association of hand preference with preference to eye and foot but not with ea, thus indicating eye and foot to be more evident laterality markers compared to ear. The limbs (hand and foot) are involved in motor control while eye and ear control sensory functions. The information collected from external environment via eye and ear are harmonised with motor functions of limbs to achieve better completion of tasks, Hence, knowledge on association of motor domains with the sensory domains in a group of people may help in their social and intellectual development. It must be noted that preference to hand, foot, eye and ear may be influenced by social, cultural and ethnic factors among various communities and the present study adds some light to such preference in population residing in South India.

Conflict of interest: Nil

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