

A STUDY TO CORRELATE OCULAR DOMINANCE VIS-A-VIS HANDEDNESS AND FOOTEDNESS

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ABSTRACT

Background: Laterality refers to the relative difference in the structure and function of the two cerebral hemispheres. Handedness, footedness and ocular dominance individually and its various combinations have been used to determine the cerebral dominance. Since ocular dominance is presumed to be the most remotely related to the cerebral dominance, it has for long taken a back seat. The present study focuses on ocular dominance and its shift with changing handedness and footedness.

Aim: To identify ocular dominance as a useful index of laterality either with handedness and footedness alone or in different combinations.

Materials and Methods: A sample of 132 healthy young adults, all ranging between 18 – 25 years was selected from Department of Anatomy, Maharishi Markandeshwar University, Mullana, Haryana. Handedness was evaluated with the help of Raczkowski handedness questionnaire. Footedness was evaluated with the help of Waterloo footedness criteria. Ocular dominance was determined with the help of Miles test.

Result: A generalized right ward trend was observed in all the three lateralities, consistent with popular observation. 83.3% were right handed, 77.3% were right footed and 69.7% were right eyed. There was a significant correlation between handedness and footedness (p value < 0.001). However, no significant relation was found between handedness and ocular dominance, and footedness and ocular dominance.

Conclusion: There is a generalized right ward trend in ocular dominance with no specific shift in pattern with changing hand and foot. Female subjects showed a stronger inclination to left eyedness than males. Separate studies have shown higher incidence of psychosis in females and higher incidence of psychosis in Left ocular dominance. Hence further work needs to be done to find if there is some real association between left ocular dominance in females and psychotic disorders.

KEY WORDS: Laterality, Handedness, Footedness, Ocular dominance, Cerebral Dominance.

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Access this Article online

Quick Response code



DOI: 10.16965/ijar.2016.449

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 23 Oct 2016
Peer Review: 24 Oct 2016
Revised: 08 Nov 2016

Accepted: 28 Nov 2016
Published (O): 31 Dec 2016
Published (P): 31 Dec 2016

INTRODUCTION

The present study is undertaken to unravel some undiscovered relation between ocular dominance and handedness and footedness, individually and in different combinations of handedness and footedness. Since these laterality indices are indirectly associated with the structure and function of the cerebral hemisphere, associated abnormalities of cerebral dominance would be projected on these three indices. Understanding the trend of these lateralities in the normal might help us in provisionally isolating neurological pathologies. Approximately 90% of the population is right handed, representing the left cerebral dominance. The left cerebral hemisphere is the centre of learning, speech and language. It is also associated with positive emotion and pleasure seeking. So logically, the right hand would suggest a monopoly of the left cerebral hemisphere, as far as these functions are concerned. However handedness is also the most vulnerable to forced change, unlike the footedness which is often ignored. Klopel et al [1] found that forced right handedness at a very early age will bring about thinning of grey mater in the right hemisphere. On the other hand, most of us are not even conscious of our dominant eye. It is a general opinion that preferred hand is the best predictor of cerebral dominance [2]. Singh and Chhibber [3] however found left lower limb to be more developed regardless of which upper limb was dominant. So right handed individuals had more muscular right limb, which was not the case in left handed individuals who were forced to become right handers. The more developed (muscular) upper limb is the dominant one.

Jankowska and Edgley [4] in their work stated that injury to the contralateral corticospinal neurons or their projecting fibers is compensated by the ipsilateral neurons and their fibers of the normal hemisphere. Saada and Antonios [5] in their work stated that in some individuals, as many as 30% of the uncrossed corticospinal axons exists, explaining why quantitative motor examination of patients with a contralateral hemiparesis sometimes times reveal weakness in the ipsilateral limbs. Keeping in mind the variable and plastic nature of the corticospinal tracts

one might argue as to how handedness could be accepted as the reliable index of laterality.

Just like the dominant hand there is a dominant foot. Around 80% of the people are right footed. Elias and Bryden [6] found through their work that footedness is a better index of cerebral lateralization than handedness.

Eye or ocular dominance, often referred to as eyedness, is the tendency to prefer to process visual input from one eye (the dominant eye) over the other. Jin et al [7] found that significantly thicker average macular ganglion cell inner plexiform layer (GC IPL) was present in the dominant eye tested by eye dominant tests. This information suggests that macular GC IPL thickness may provide an indicator of the relative dominance of an eye.

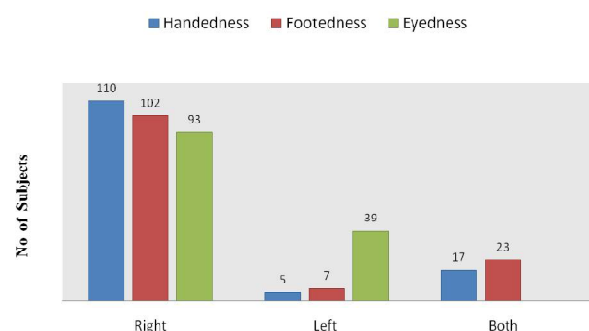
Bettina et al [8] through their work found, a significant correlation between ocular dominance and cerebral asymmetries. However Aswathappa et al [9] found no significant relation between dominant eye and dominant hand in his work. According to Khan and Crawford [10] ocular dominance appears to change depending upon direction of gaze, due to image size changes on the retinas.

MATERIALS AND METHODS

132 subjects in the age group 18- 25 years were selected from MMU University, Mullana, Haryana, including both males and females. Handedness was evaluated with the help of Raczkowski handedness questionnaire [11]. Footedness was evaluated with the help of Waterloo footedness criteria [12]. Ocular dominance was determined with the help of Miles test [13].

OBSERVATIONS

Graph 1: Showing the Dominant hand, foot and eye.



Majority of the cases are right handed (110), followed by right footedness (102) and right ocular dominance (93). Either handed and either footed are 17 and 23 respectively. Left handed (5) and left footed cases (7) are the minimum. The findings are shown in graph 1.

The following tables show that handedness (83.3%), footedness (73.3%) and ocular dominance (69.7%) all have a right ward bias. This is consistent with the observation that ~90% are right handed, ~80% are right footed and ~70% are right eyed.

Table 1: Handedness.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	E	17	12.9	12.9	12.9
	L	5	3.8	3.8	16.7
	R	110	83.3	83.3	100
	Total	132	100	100	

Table 2: Footedness.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	E	23	17.4	17.4	17.4
	L	7	5.3	5.3	22.7
	R	102	77.3	77.3	100
	Total	132	100	100	

Table 3: ocular dominance.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	L	40	30.3	30.3	30.3
	R	92	69.7	69.7	100
	Total	132	100	100	

Table 4: Showing the Footedness and Ocular Dominance.

			Ocular dominance				
Footedness	R		L		Total		P Value
	Count	Table N %	Count	Table N %	Count	Table N %	
E	16	12.10%	7	5.30%	23	17.40%	0.827
L	6	4.50%	1	0.80%	7	5.30%	
R	70	53.00%	32	24.20%	102	77.30%	
Total	92	69.70%	40	30.30%	132	100.00%	

Table 5: Showing the Handedness and Ocular Dominance.

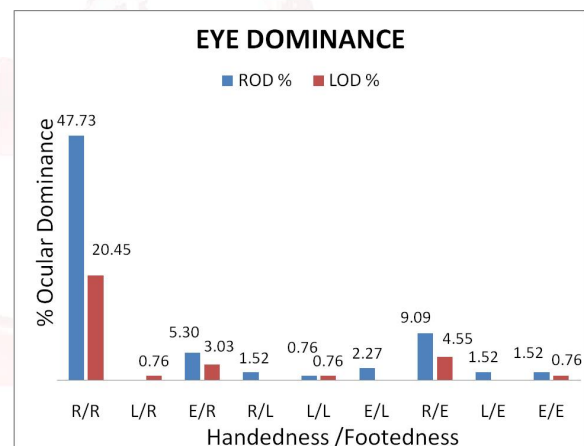
			Ocular dominance				
Handedness	R		L		Total		P Value
	Count	Table N %	Count	Table N %	Count	Table N %	
E	12	9.10%	5	3.80%	17	12.90%	0.274
L	3	2.30%	2	1.50%	5	3.80%	
R	77	58.30%	33	25.00%	110	83.30%	
Total	92	68.70%	40	30.30%	132	100.00%	

In the following tables handedness and footedness show a significant p value. There is no significant relationship between ocular dominance and handedness. There is no significant relationship between ocular dominance and footedness either.

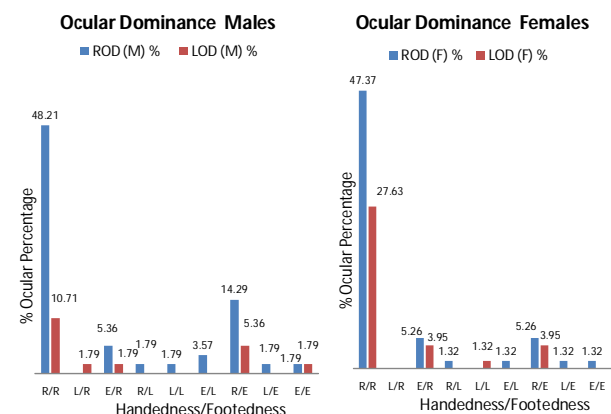
Table 6: Showing the Handedness and Footedness Dominance.

Handedness			Footedness						
	R		L		E		Total		P Value
	Count	Table N %	Count	Table N %	Count	Table N %	Count	Table N %	
R	90	68.20%	2	1.50%	18	13.60%	110	83.30%	<.001
L	1	0.80%	2	1.50%	2	1.50%	5	3.80%	
E	11	8.30%	3	2.30%	3	2.30%	17	12.90%	
Total	102	77.30%	7	5.30%	23	17.40%	132	100.00%	

Bar graph 1: Showing various combinations of handedness and footedness along X axis and ocular dominance (L) and (R) along Y axis. 47.73% of ROD cases are R/R and 20.45% of LOD cases are R/R. The rest of the ROD and LOD cases are staggered among various combinations of handedness-footedness.



Bar Graph 2: Showing comparison between male and female Ocular Dominance.



DISCUSSION

There is a generalized right ward trend of ocular dominance. However there is no significant relation between ocular dominance and

handedness and footedness. Similar right trend of ocular dominance is seen in males as well. This probably explains why maximum cases of ROD are seen in RR individuals. The rest of the cases of ROD are scattered randomly among rest of the handedness/footedness pairs.

However in females the right ward tendency of ROD is not as significant as in males. In RR pair and R/E pair the difference in the number of ROD and LOD cases is much less compared to that in males. There is not a single case in L/R pair, whereas the number of LOD cases in E/R pair has risen to almost double compare to male E/R. This phenomenon can probably be explained on the basis of socio-cultural pressures, particularly on females, pushing L/R cases into E/R cases, LOD remaining the same. Further, L/L cases in males are all ROD whereas in case of female they are all LOD.

The proportion of LOD vis-a-vis ROD has significantly increased in females compared to males. Hence there is a rising trend of LOD in females. Goodarzi et al [14] found increased incidence of LOD in psychiatric and depressive disorders but less common in bipolar disorders. Further, Seeman [15] described the cyclic nature of estrogen secretion from puberty to menopause and its subsequent withdrawal responsible for the mood and anxiety disorders in women. So the present study hints towards a higher prevalence of LOD and psychosis and depression in women.

CONCLUSION

Since the majority of the individuals are right handed, right footed and right eyed, it is assumed that there is some association between the three lateralities. The study does not show any shift in ocular dominance with changing handedness and footedness. However, there is a significant relation between handedness and footedness.

The prevalence of LOD is higher in females compared to males. Higher LOD and higher incidence of psychosis and depression could be associated. If proven this association could be of great clinical importance in early identification and management of neurological diseases.

Conflicts of Interests: None

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