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A Study on Relationship between Ocular Dominance and Laterality of Hand and Ear

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ABSTRACT: The purpose of this study was to determine the relationship between eye dominance, handedness and ear preference and to establish the consistency in the lateral preferences of the eye, hand and ear among the study population. Two hundred and ten (210) volunteer subjects, both male and female between the ages of 18-25 years were selected from the University of Benin, Ugbowo campus. The miles test, hand preference test and ear preference test were used to test for the dominant eye, hand and ear respectively. The Lateral Preference Questionnaire was also used to subjectively determine the functional laterality in the preferences of the eye, hand and ear. The data collected were subjected to tabular and statistical analysis and tested for statistical significance using Chi-Square. The studied population exhibited a highly significant correlation ($P < 0.05$) between ocular dominance and laterality of hand and ear. Therefore it should be taken into account that functional lateralization which occurs in paired organs of the body arises from hemispheric specialization and the cerebral dominance characteristics of the human brain, therefore, the dominant eye, hand and ear are closely related.

Keywords: Laterality, Ocular dominance, Handedness, Ear preference.

Introduction

Laterality is a term that refers to the preference human exhibits for one side of the body over the other. It may also refer to the primary use of the left or right hemisphere in the brain. There are several examples of laterality in human's physiological behaviors which include left-handedness/right-handedness, left/right-footedness and ocular dominance. In essence, laterality can be described as crossed when there is a disagreement while using one of these parts, such as eating with the right hand and kicking with the left foot, and it can also be described as undefined when there is no preference between right or left handedness in the case of ambidextrous individuals. When there is a harmonic specialization among the body parts, laterality is classified as complete left dominance and right dominance, for example, left hand writing, left foot kicking and right hand writing, right foot kicking. Studies have shown that lateral dominance establishment occurs at about six years of age, which underscores the importance of its definition before the child starts school (Rosa Neto *et al.*, 2013). Handedness can be described as the hand that one prefers to use, regardless of performance, or the hand most skillful at performing a task. In human population, about 90 percent of adults are right handed, about 80 percent being right footed, about 70 percent being right eyed and about 60 percent being right eared by preference (Saudino and McManus, 1998). There is higher incidence of left handedness in variety of group including epilepsy, mental retardation, autism and dyslexia (Hirnstein and Hugdahl, 2014). Papadatou-Pastou *et al.* (2008), reported that left handedness seem to be more common among men than women and the dominant hand is expected to perform better than non dominant hand.

Combined data from many studies suggest that familial trends in handedness being the most studied form of lateralization exist and those trends have been explained by the genetic models of Saudino and McManus (1998).

Ear preference is defined as the preferential orientation of one ear towards a sound source or the preferential positioning of a sound source so that it stimulates one ear rather than the other. Ear preference by this definition is comparable to handedness which is the consistent use of one hand in manual tasks, and to eye dominance (in the sense of sighting dominance) being the consistent use of one eye in monocular tasks (Portal and Romano, 1998).

Ocular dominance was first described by Giovanni Battista Porta (1953). It is sometimes called eye dominance or eyedness is the tendency to prefer visual input from one eye to the other (Aswathappa *et al.*, 2011). It somehow corresponds to the laterality of right or left-handedness. However, according to Porac and Coren, (1975), the side of the dominant eye and the dominant hand do not always match because both brain hemispheres control both eyes, but each one takes charge of a different half of the field of vision, and therefore a different half of both retina. Therefore, there is no direct analogy between handedness and eyedness as lateral phenomena. In addition, people are conscious of using right or left eye just as one is conscious of using left or right hand, however, one does not see the world from left or right eye but from a single so called cyclopean eye, which combines information from both eyes (Aswathappa *et al.*, 2011).

From the previous studies it is revealed that approximately two-thirds of the population is right-eye dominant and one-third left-eye dominant; however in a small segment of the population neither eye is dominant (Aswathappa *et al.*, 2011). Dominance does appear to change depending upon direction of gaze due to image size changes on the retina (Cary and Adams, 2003). The prevalence of left-eye dominance appears to be higher in those with Williams–Beuren syndrome and possibly in migraine sufferers as well (van Strien *et al.*, 2005). In the case of anisometropic myopia, the dominant eye has been found to be the eye with more myopia (Cheng *et al.*, 2004). Considering the subjects with normal binocular vision, the widespread notion that the individual's better-sighted eye would tend to be the dominant eye has been challenged as lacking empirical basis (Vincent *et al.*, 2011).

Moreover, the eye preferred for sighting may not indicate handedness neither suggests ear preference since each eye projects to both cerebral hemispheres whereas each hand and ear is represented mainly in the opposite hemisphere. Therefore this study aims to determine the relationship between ocular dominance and the laterality of hand and ear in healthy young adults.

Materials and methods

This study was carried out in 2017 which included 210 healthy subjects that were students from the University of Benin, Benin City, Edo state, age ranging between 18 to 25 years. The consents of the subjects were indicated. Those with any disability or a deformity of the upper or lower limbs were excluded from the study. Those with hearing problem were also excluded from the study using pure tone audiometric test in which sound of different frequencies were played through the headphones and a button was pressed when they were heard. By questionnaire method eye preference, hand preference and ear preference were first determined and subsequent tests were then carried out on the subject to ascertain the findings.

Hand dominance was assessed by questionnaire method, where each subject was asked, which hand he/she prefers to write, eat, draw, throw a ball, hold a tooth brush, knife to cut things, eraser to erase and holds the thread when one threads a needle. The responses were noted.

In addition to administering of questionnaires, the dominant eye was determined by miles test where the subjects were asked to extend both arms, and bring them together in front of the face creating a small opening at the middle of the arms. Then with both eyes open, they were asked to view a distant object through the opening and then see the object alternately closing one of the eyes to determine which eye is viewing the object as described by Aswathappa *et al.* (2011).

Also each subject was asked to perform two manipulative tests to determine ear preference. In determining ear preference the patients were asked to listen to someones heartbeat and the tickling of the wrist watch and the ear used for these tasks was selected as the dominant ear. These tests were conducted four times to ascertain the laterality. The data collected were subjected to tabular and tested for statistical significance using Chi-Square ($p < 0.05$).

Results

A total of 210 subjects from the University of Benin were used for this study, of which 57.1% were females and 42.9% were males (Fig 1). Males were found to be more right handed (83.3% vs. 75.0%), right eared (50.0% vs. 42.5 %) and right eyed (66.6% vs. 65.0%) than females as seen in Tables 1 and 2.

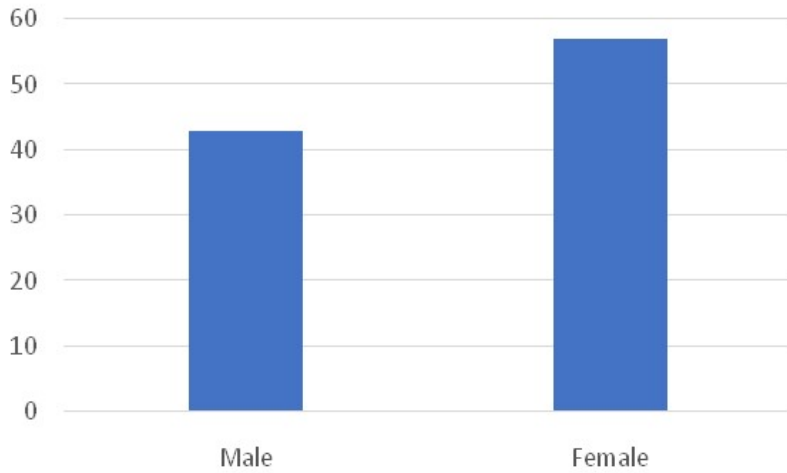


Figure 1: Bar chart depicting the gender of subjects' percentage.

Table 1: Frequencies of Male subjects with distribution of lateral dominance for each of the parameters studied

S/N	Laterality	No. Tested	No. RD	%RD	No. LD	%LD	ND	ND%
1	Ocular dominance	90	60	66.6	30	33.3	0	0
2	Handedness	90	75	83.3	15	16.7	0	0
3	Ear Preference	90	45	50	27	30	18	20

RD: Right Dominance, LD: Left Dominance, ND: No Dominance

Table 2: Frequencies of Female subjects with distribution of lateral dominance for each of the parameters studied

S/N	Laterality	No. Tested	No. RD	%RD	No. LD	%LD	ND	ND%
1	Ocular dominance	120	78	65	42	35	0	0
2	Handedness	120	90	75	24	20	6	5
3	Ear Preference	120	51	42.5	33	27.5	35	20

RD: Right Dominance, LD: Left Dominance, ND: No Dominance

Table 3 shows the relationship between handedness and eye dominance with the calculated Chi -Square value of 44.29 which is more than the table value (3.84) at 5% level of significance for one degree of freedom. This indicates there is a significant relationship between ocular dominance and handedness.

Table 3: Relationship between eye dominance and handedness

		Ocular Dominance				Total	%
		RD	%	LD	%		
Handedness	RD	138	65.7	27	12.9	165	78.5
	LD	0	0	39	18.6	39	18.6
	ND	6	2.9	0	0	6	2.9
	Total	144	68.6	66	31.5	210	100

$\chi^2 = 44.29$

Table 4 shows the relationship between eye dominance and ear preference with the calculated Chi -Square value of 13.37 which is more than the table value (3.84) at 5% level of significance for one degree of freedom. This indicates there is a significant relationship between ocular dominance and ear preference.

Table 4: Relationship between eye dominance and ear preference

		Ocular dominance					
		RD	%	LD	%	Total	%
Ear Preference	RD	96	45.7	21	10	117	55.7
	LD	24	11.4	36	17.1	60	28.6
	ND	24	11.4	9	4.3	33	15.7
	Total	144	68.5	66	31.4	210	100

$\chi^2 = 13.37$

Discussion

Laterality refers to the preference most humans show for one side of their body over the other. Laterality of the motor and sensory control has been subject of a recent intense study and review. In earlier studies, it was suggested by some authors that there was a generalized form 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 ocular dominance (Brown and Taylor, 1988). Few studies have also investigated the relationship between hand and eye preference. About 10% of the general population had left hand dominance and ocular dominance was thought to be related with hand dominance. Right eye dominance is much more common than left eye dominance. Approximately 2/3 of the population is right eye dominant (Aswathappa *et al.*, 2011.)

This present study indicates that there is a relationship in laterality between the eye, hand and ear. Male subjects were found to have higher preference for the use of the right hand (83.3%), right eye (66.6%) and right ear (50%) than females, this is in agreement with a study by Dargent-Pare *et al.* (1992) on foot and eye preference in relation to handedness, it was found that males are more right handed and right eye dominant than females although there was no assessment of the relationship between ear preference in the study (Dargent-Pare *et al.*, 1992).

Majority of the subjects were right eye dominant 66.2%, right handed 78.6% and right ear dominant 45.7%. This agrees with studies done by Porac and Corenin (1978) and Catagay *et al.*, (2008), been explained by cerebral dominance, the left cerebral hemisphere of the brain controls the right side of the body and it is dominant over the right in most humans because in 90 - 92% of humans, the left hemisphere is the language hemisphere.

Most of the subjects were right handed (78.6%), only 18.6% were left handed while 2.7% ambidextrous during the testing. This may be due to the fact that the study was carried out in an academic environment and also the effect of cultural influence on right handedness especially in this part of the world. A study done by the department of Neurology at Keeler University suggests that forced laterality may be part of the reasons that left handed people decreases with higher age group due to the pressure over right handedness (Ellis *et al.*, 1998). Also, according to Susie *et al.*, (2017), research has also shown that in the non- western cultures, the prevalence of right handedness was higher compared to the Western cultures. However, there is a high association between right eye dominance, right handedness, and right ear preference. According to the study of Portal and Romano in 1998, the pattern of eye hand dominance appears to be related to athletic proficiency for base ball. It was reported that pitchers in baseball who were uncrossed eye hand dominance were slightly more successful than crossed. While batters who were crossed eye hand dominance were slightly more successful than uncrossed. Base on this growing knowledge concerning the relationship between the ocular dominance and patterns of eye hand dominance in sports like cricket, golf and baseball, one can guide an athlete to which sport to concentrate on (Aswathappa *et al.*, 2011).

Although much study have not been done to determine eye dominance and ear dominance, there is a strong relationship between which side of the brain is dominant and which side of the ear is used to listen. Also there is a strong indication that the hand frequently used during phone call has a great influence on the ear dominance. It has been observed that there is a significant strong relationship between the hand use to hold the phone and the ear which the phone is placed; the right hand was observed to be used more frequently to hold a mobile phone and it was more frequently placed on the right ear.

In conclusion, the findings in this study suggest that right eye dominants are more likely to show right hand dominance and right ear dominance while left eye dominants are more likely to show left hand dominance and left ear dominance. It is important to know that ocular ear hand dominance could serve as a factor in athletes or guiding young players in sports such as archery, darts or shooting sport. It may also be used in assessment of learning disabilities and predicting patient satisfaction with mono vision correction in cataract surgery and contact lens wear.

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