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Original Article

Lateral preferences and hemispheric language dominance in students in University of Port Harcourt, Rivers State, Nigeria

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ABSTRACT

Some humans may prefer to use their right hand in writing or drawing, while some may prefer to use their left foot to shoot football on a target. Lateral preference is known as the predilection for the use of one side of the body over the other in humans. This study was done to investigate the relationship between hand and foot preferences and language dominance, as well as their sex-related differences in both sexes among University of Port Harcourt students. One thousand 1000 apparently healthy adult subjects (500 males and 500 females), were randomly selected and recruited for the study. Foot preference was assessed using the Waterloo footedness Questionnaire-Revised (WFQ-R) and Hand preference was assessed using the Edinburgh handedness Inventory questionnaire (EHI). Language dominance was extrapolated from the established fact of left cerebral hemisphere dominance for several aspects of speech and perception in the majority of population. The sex-related differences in foot and hand preferences, and the association between foot preferences based on the hand preference were determined using the Chi- square analysis. All statistical analyses were performed with Statistical Product and Service Solution (SPSS) version 23.0 and the significance level was set at $p<0.001$. No significant sex- related difference was observed in the hand and foot preferences ($P>0.001$). It was observed that there was a statistically significant association between hand and foot preferences in males ($X^2=278.506$, $p<0.001$). There was also, a statistically significant association between hand and foot preferences in females ($X^2=182.387$, $P<0.001$). Language dominance was also associated with lateral preferences. This study has shown that gender may not necessarily affect lateralization, and the extent to which culture and ethnicity affect hand preference may vary from one community to the other, and hence the different incidences of hand and foot preferences that are seen.

Keywords:
Foot Preference, Hand Preference, Language Dominance, Students.

INTRODUCTION

The predilection for the use of one side of the body over the other in humans is referred to as lateral preference (Porac, 2019). Some persons may be left-handed or right-handed while others may be left or right-footed (Brenda, 2016). This may involve the primary use of the left or right hemisphere in the brain. Studies have shown that theoretical models have been used by various researchers to explain lateral preference in the genetic theory (Francks, 2017). Knowledge of Hemispheric language dominance (HLD) is very relevant as it serves as a basis for the evaluation of transhemispheric language restitution after stroke. Hemispheric language dominance HLD can be determined by intracarotid injection of amobarbital, but then, this is an invasive method (Wada, 2017). This technique carries a small but definite risk of fatal complications. Foot Preference is the natural preference of one's right or left foot for various purposes. While purposes vary, such as applying the greatest force in a certain foot to complete the action of kick as opposed to stomping. Footedness is most commonly associated with the preference of a particular foot in the leading position while engaging in foot or kicking-related sports, such as association football and kickboxing (Adams, 2018). Footedness means the foot a player uses to kick with the greatest skill and force. Most people are right-footed and they kick football with the right foot. Capable left-footed footballers are rare and therefore quite sought after. As rare are "two-footed" players, who are equally capable with both feet (Brenner, 2016). In neuroanatomy, handedness is an individual's preferential use of one hand, which is referred to as the dominant hand. This is due to it being stronger, better or faster in dexterity. Comparatively the weaker or less dexterous hand is referred to as the non-dominant hand (Holder, 2017). A genetic model which explained both hand usage and cerebral dominance has been

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has been formulated (Annett, 1964).

The relationship between the hemispheric dominance (HD) and English proficiency (EP) in the four macro skills of the college students of Western Mindanao State University has been studied (Ellis, 1985). It was hypothesized that students' HD would have a significant correlation with EP scores in each of the four macro skills of listening, speaking, reading and writing; with their global EP score; and with both the macro and global EP scores when respondents would be grouped according to age, gender and area of specialization. The study concluded that students' hemispheric dominance did not affect their English proficiency both in the four macro skills and global level; however, it did influence their English proficiency when they were categorized according to age and area of specialization.

Zinnur (2018) investigated the relationship among the hand, eye, and ear lateralizations and the sense of rhythm of the athletes who received training at different Departments in Ataturk University. They observed that, there was no significant relationship between the eye and ear lateralization of the athletes and their rhythm perception and application skills; however, it was found that the sense of rhythm of the left-handed individuals was better than the right-handed ones with respect to the handedness. According to Rochele (2019), the left hemisphere of the brain controls this process.

Despite the importance of knowledge of lateral preference and hemispheric language dominance among students in University of Port Harcourt, there is scarcity of literatures on lateral preference and hemispheric language dominance in students in University of Port Harcourt. This is the driving force behind this research. The aim of this study was to evaluate the relationship between lateral preference and hemispheric language dominance. The objectives were to determine the relationship between hand and foot preferences and language dominance. This study also seeks to determine if there are sex related differences in the use of hand and foot preferences. Finally, this study was done to determine the percentage of handedness and footedness among students in University of Port Harcourt.

MATERIALS AND METHODS

A total number of 1000 adult subjects (500 males and 500 females) were randomly selected and recruited for this study. They were students in University of Port Harcourt, Rivers State, Nigeria, with no evidence of hand or foot deformity/injury.

Hand preference determination

The Edinburgh Handedness Inventory Questionnaire (EHI) (Oldfield, 1971) was used to determine hand preference. The respondents were asked 10 different questions which include: hand preference for (1) writing, (2) drawing, (3) throwing, (4) using scissors, (5) a toothbrush (6) knife (without fork), (7) spoon, and such activities involving both hands as (8) using a broom, (9) striking a match, and (10)Opening a Box(holding the lid). In the column related to the hand that they used to carry out the task, that is, right hand column (RH) and left-hand column (LH), they were instructed to put "1" in the related column and where the preference was so powerful that they would never use the unconventional hand, except when compelled to do so, they were instructed to put "2" in the related column, and if indifferent, to put a 1 in each column (1/1).

The total of these points from each column was used to calculate the cumulative total (CT),(CT=RH+LH) and the difference (D),(D=RH-LH). The result (R) of Laterality Quotient was calculated using the formula R=D/CT×100 and interpreted as follows: Left Handed: R<-40; Ambidextrous:-40 ≥ R ≤+40); and Right Handed: R>+40).

Foot preference determination

The Waterloo Footedness Questionnaire (WFQ-R) (Elias *et al.,* 1998) was used to determine foot preference. The respondents were asked 10 different questions which include: (1) If you were asked to shoot a ball on target, which foot would you use to shoot the ball? (2) If you had to pick up marbles while standing and put them in a box which foot would you use? (3) If you had to stand on one foot, which foot would it be? (4) Which foot would you use to smooth sand while standing? (5) If you had to step up onto a chair, which foot would you place on the chair first? (6) Which foot would you use to stomp an insect while standing? (7) If you were asked to balance on a railway track, which foot would you use? (8) If you had to hop on one foot, which foot would you use? (9) Which foot would you use to help push a shovel into the ground? (10) During relaxed standing, people initially put most of their weight on one foot, leaving the other leg slightly bent. Which foot do you put most of your weight on first? The data in the questionnaire were graded as follows; (1) left-always, (2) left-usually, (3) equal, (4) right-usually, (5) right always, and were graded on a scale of -2 to +2. This provided a wide range of values from +20 for the most right-footed to -20 for the most left-footed. Then, following Elias *et al.* (1998), the subjects were grouped into three; right-footed (+7 to+20), left-footed (-7 to -20), and mixed-footed (-6 to+6).

Language dominance determination

Language dominance was extrapolated from the established fact of left cerebral hemisphere dominance for several aspects of speech and perception in the majority of the population (Hugdahi 2000; friederici and Alter 2004;Friederici 2011; Hugdahi 2011; Corballis 2012; Ockienburg *et al.,* 2014).

Statistical method of analysis

The sex- related differences in hand and foot preferences and the association between foot preferences based on the hand preference were determined using the chi-square analyses and was carried out with Statistical Product and Service Solutions (SPSS) version 23.0 and the significance level was set at $p<0.001$.

RESULTS

The result of the percentage handedness is shown in table 1. In males, 76.4% of the male subjects were right handed, 10.2% were left handed, 13.4% were Ambidextrous. In females, 79.60% of the

subjects were right handed, 5.2% were left handed, 15.2% were Ambidextrous. The result of the percentage footedness is shown in Table 2. In males, 71.6% of the subjects were right footed, 9.4% were left footed, 19% were mixed footed. In females, 76.8% of the subjects were right footed 6.4% were left footed, 16.8% were mixed footed. Table 5 shows the Foot preference distributions based on the hand preference for male subjects. It was observed that there was a significant difference P<0.001. Table 6 shows the Foot preference distributions based on the hand preference for female subjects. It was observed that there was a significant P<0.001

Table 1: percentage handedness of Males and Females

	N (%)	
	Males	Females
Right Handedness	382 (76.4)	398 (79.6)
Left Handedness	51 (10.2)	26 (5.2)
Ambidextrous	67 (13.4)	76 (15.2)
Total	500 (100)	500 (100)

Table 2: percentage footedness of Males

	N (%)	
	Males	Females
Right footedness	358 (71.6)	384 (76.8)
Left footedness	47 (9.4)	32 (6.4)
mixed Footedness	95 (19)	84 (16.8)
Total	500 (100)	500 (100)

Table 3: Foot preference distributions based on the hand preference of Males

Male	Right footedness N (%)	Left Footedness N (%)	Mixed Footedness N (%)	Total N (%)	X^2-Value	P-Value
Right Handedness	323(84.56)	6(1.57)	53(13.87)	382(100)	278.506	0.001
Left Handedness	7(13.72)	34(66.67)	10(19.61)	51(100)		
Ambidextrous	28(41.79)	7(10.45)	32(47.76)	67(100)		

Table 4: Foot preference distributions based on the hand preference of females

Female	Right footedness n(%)	Left Footedness n(%)	Mixed Footedness n(%)	Total n(%)	X^2-Value	P-Value
Right Handedness	345(86.68)	13(3.27)	40(10.05)	398(100)	182.387	0.001
Left Handedness	5(19.23)	14(53.85)	7(26.92)	26(100)		
Ambidextrous	34(44.74)	5(6.58)	37(48.68)	76(100)		

DISCUSSION

There is a correlation between brain morphology and functional diversity of the brain (McManus and Bryden 1993; McManus *et al.,* 2009). This has a genetic, embryological and neuroanatomical bases (McManus and Bryden 1993; McManus *et al.,* 2009). Studies have shown that there is a pyramidal decussation that occurs in the corticospinal tract which brings about contralateral brain activities in the upper and lower limbs of humans (Nielsen *et al.,* 2002). The hand and foot preferences in children aged 3 to 5 years have been studied (Gabbard, 1992). It was observed that 67% of the subjects were mixed footed and of the ambidextrous subjects, 32% were right-footed, 8% were left footed and 60% mixed footed. The present study differs with that of Gabbard (1992) in terms of the age of subjects.

Barut *et al.*(2007) studied the foot preferences in relation to hand preferences and observed that 75.5% were right-footed, 7.1% left-footed, and 17.4% mixed footed in the right male handers, whereas in the ambidextrous male subjects, 44.0% were right footed ,28.0% left-footed, and 28.0% mixed footed. In the present study, it was observed that, 84.56% were right-footed, 1.57% left-footed, and 13.87% mixed footed in the right male handers, whereas in the ambidextrous male subjects, 41.79% were right footed, 10.45% left-footed, and 47.76% mixed footed. Barut *et al.* (2007) observed in their study, that in the male left-handers 32.3% were right footed, left-footed (56.9%) , and mixed footed (10.8%) .In the female right-handers, 89.9% were right-footed, 1.2% left-footed, 8.9% mixed footed, whereas in ambidextrous women, 50.0% were right-footed, left footed (12.5%), and mixed footed (37.5%). In the present study, it was observed that, for the male left-handers 13.72% were right footed, left-footed (66.67%), and mixed footed (19.61%) .

Barut *et al.*(2007) also studied female subjects and observed that, In the female right-handers, 89.9% were right-footed, 1.2% left-footed, 8.9% mixed footed, whereas in ambidextrous women, 50.0% were right-footed, left-footed(12.5%), and mixed footed(37.5%). In the female left-handers, right footed was 8.8%, left-footed (79.4%), mixed footed (11.8%). There was a significant relationship between these percentages in both sexes.

In the present study, it was observed that, the female right-handers, 86.68% were right-footed, 3.27% left-footed, 10.05% mixed footed, whereas in ambidextrous women, 44.74% were right-footed, left-footed (6.58%), and mixed footed (48.68%). In the female left-handers, right footedness was 19.23%, left-footed (53.85%), mixed footed (26.92%). There was a significant relationship between these percentages in both sexes. The result in the present study have shown that there is a variation in the percentages of right footedness of the male and female right-handers, left- footedness of male and female right-handers, mixed footedness of male and female right-handers, mixed footedness of both male and female left-handers and ambidextrous when compared to the values reported by (Barut *et al.,* 2007). The disparity between the two studies may stem from ethnic and genetics reasons.

However, it is not out of place to suggest that right-handed individuals were more likely to show right foot preference and the converse is true for the left-handed individuals. When compared with the present study, Kang and Harris (2000) observed that out of the 88.8% of the right-handed individuals 8.4% were right-footed, 2.7% mixed footed and 8.4% left-footed, whereas in the left-handed individuals 37.1% were right-footed, 62.9% left-footed and that 100% of the ambidextrous were left footed. There were no reports documented concerning sex difference.

Hatta *et al*. (2005), studied 329 right-handed individuals, 0.3% were left-footed, 79.3% right-footed 20.4% mixed-footed, while out of 8 left handed individuals, 12.5% were right footed, 50% left footed and 37.5% were mixed footed. The findings were inconsistent and the discrepancies seen could be attributed to the composition of the groups, cultural differences between the populations, and the sample size employed. It is interesting to note that, culture and other environmental factors do not alone suffice for the explanation of observations from this study. Embryologically, there are other variables that influences the neuroanatomic arrangement in the brain even early in life (Hepper *et al.*1998). This may be possible explanation to human laterality. Geschwind and Galaburda (1985) opined that exposure to a higher rate of testosterone before birth can lead to a suppressed right handedness such that a left-handed child is born. According to their report, variation in the level of testosterone during pregnancy can shape the foetal brain development such that neurons in the left hemisphere of the cerebrum are suppressed in growth and the neurons in the right hemisphere of the cerebrum is well developed, take over the predominant functions of the cerebrum; thus making the person become left-handed person (Geschwind and Galaburda, 1985). This means that prenatal testosterone plays a significant role in brain organization (Elkadi *et al.*1999). Some authors have worked on relationship between language dominance, handedness and footedness in different countries (Elias and Bryden 1998; Knecht *et al.*, 2000; Perlaki *et al.,* 2013). They observed that, about 95% of right-handers show typical left-hemispheric language dominance (Elias and Bryden 1998; Knecht *et al.,* 2000; Perlaki *et al.,* 2013). In the present study, majority of the respondents were right handed and right footed, and this implies left hemispheric cerebral language dominance.

Conclusion: This study has provided reference data for handedness and footedness in students in University of Port Harcourt. It will be useful to the neuroscientist, Anatomists and Biomedical Anthropologist.

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