STUDY OF FUNCTIONAL LATERALIZATION IN NIGERIAN ADULTS

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ABSTRACT

The aim of the present study is to assess the incidence of functional lateralization in Nigerian adult residing in Maiduguri. A total number of 200 normal and healthy adult individuals were randomly selected for the study, in which 115 were males and 85 were females. The data was collected through self – assessment questionnaires, which consist of 14 questions on the tasks of handedness, 4 tasks on footedness 1 task on ear and 1 task for chewing. The test for functional lateralization was carried out by chi – square test using SPSS version 18.0 software (IBM Corporation, USA). The result shows that there is no significant difference for the right and left sidedness between males and females sexes with $P = 0.6894$ for right side in males against right side in female and $p = 0.092$ for left side in males against left side in females, but the right sidedness is significantly greater than left sidedness in both males and females sexes with $P<0.0001$, in which for the handedness 84% prefer right, 11% prefer left and 5% prefer both, for footedness 75% prefer right, 17% prefer left and 8% prefer both, for hearing 74% prefer right, 16% prefer left and 10% prefer both, for chewing 62% prefer right, 17% prefer left and 21% prefer both. This study finds out that in every population 99% of them may be right sidedness and 1% of them may be left sidedness, this shows that the left cerebral hemisphere more dominant than right cerebral hemisphere.

Keywords: Functional, Lateralization, Incidence, Adult, Nigeria.

INTRODUCTION

Brain lateralization has been a substantial subject of study for many years (Szaflarski*et al.,* 2006; MacNeilage *et al.,* 2009; Prieur *et al.,* 2017). An increasing number of scientific studies of different species from different area of studies supported the hypothesis that behavioral lateralization would have been selected, because it would provide significant advantages at both the individual and population levels (Ghirlanda andVallortigara, 2004; Vallortigara and Rogers, 2005; Szaflarski *et al.,* 2006; Prieur *et al.,* 2017). The lateralization at the individual level enhanced brain efficiency and at the population level it favoured social coordination between asymmetrical organisms (Vallortigara and Bisazza, 2002; Rogers *et al.,* 2004; Prieur *et al.,* 2017). The lateralization at the population level would be more prominent for social species than for solitary species (Bisazza *et al.,* 2000; Bisazza *et al.,* 2002; Prieur *et al.,* 2017). Social pressures would therefore have shaped laterality through natural selection, as recently supported by gestural studies done on chimpanzees, gorillas and humans (Szaflarski *et al.,* 2006; Prieur, 2015; Chapelain *et al.,* 2015; Prieur *et al.,* 2016).

Human brains were reported to be laterally structured first for language-related functions (Broca, 1865; Wernicke 1911; Szaflarski *et al.,* 2006; Prieur *et al.,* 2017).Since then, the evidences increase by neuroanatomical studies that spoken language is lateralized in the left cerebral hemisphere (Szaflarski *et al.,* 2006;Price, 2010; Prieur *et al.,* 2017). In addition, a close relationship between speech and gestures has been shown that the gestural communication involves brain regions similar to those involve in the processing spoken language for instance the Broca's and Wernicke's areas, respectively, responsible for speech production and for understanding speech (Horwitz*et al.,* 2003; Szaflarski *et al.,* 2006;Xu*et al.,* 2009; Prieur*et al.,* 2017). Correlatively, reports evidence that manual gesture production involves the preferential use of the right hand. Studies concern some gestures such as pointing and symbolic gestures produced by infants and children (Szaflarski *et al.,* 2006; Cochet and Vauclair, 2010; Prieur *et al.,* 2017), other gestures cannot be distinguished accompanied by speech from adult speakers (Saucier and Elias, 2001; Prieur *et al.,* 2017) as well as sign language by deaf adult speakers (Szaflarski *et al.,* 2006; Prieur *et al.,* 2017). Although left-brain specialization seems well admitted to gestures, only few types of gestures have been considered (Szaflarski *et al.,* 2006; Prieur *et al.,* 2017).

Furthermore, relatively few data are available for human adults (Prieur *et al.,* 2017). Therefore, to enhance our understanding of human laterality various types of gestures with large samples and many datapoints per subject must be taken into consideration (Szaflarski *et al.,* 2006; Prieur *et al.,* 2017).The easiest observable laterality pattern of everyday life expressed by humans at the population level is the use of their right hand for distinct non-communication activities related to manipulation(Szaflarski *et al.,* 2006; Prieur *et al.,* 2017). For example, 90% of individuals preferentially use their right hand for complex tasks such as writing, bimanual coordinated actions and tool use (Annett, 1985; Fagard, 2004; Faurie and Raymond, 2004; Szaflarski *et al.,* 2006; Prieuret *al.,* 2017). This right-handedness is consistent across time and across cultures, though the proportion of left-handed people varies from 0 to 27% (Faurie, 2004; Raymond and Pontier, 2004; Faurie *et al.,* 2005; Szaflarski *et al.,* 2006; Prieur *et al.,* 2017).

This variation may be the consequence of disparities between methods used in assessing the manual laterality and the laterality index (LI), the cut-offs used in categorizing individuals as ambidextrous, mixed right- or left-handed or strong right- or left-handed (Szaflarski *et al.,* 2006; Prieur *et al.,* 2017). A valid, fast and reliable way for assessing the manual laterality of a large population is to implement a laterality questionnaire (Cavill and Bryden, 2003; Szaflarski *et al.,* 2006; Papadatou-Pastou *et al.,* 2013; Prieur*et al.,* 2017) and to apply the LI cut-offs criteria recently defined by Fagard *et al*. (2015). However, it must be noted that hand preference at both the individual and group levels measured by self-reported questionnaires has been shown to be potentially sensitive to the format of the questionnaire, which may be dependent on the kind of items to be used with the type and number of answers to be given (Prieur *et al.,* 2017). Some studies also showed that hand preference measurement using questionnaires could sometimes be impacted by multiple factors like genetic factors, demographic factors, age, gender, cultural factors, environmental factors, regional factors, performance ability and physical impairments(Vuoksimaa*et al.,* 2009; Caliskan and Dane, 2009; Nicholls *et al.,* 2013; Suzuki and Ando, 2014; Espírito-Santo *et al.,* 2017; Prieur *et al.,* 2017). Therefore, the studies using questionnaire has to be carefully done by taking into account the multiple potentially influential factors on laterality and to assess the effect of a particular on a particular function in order to avoid biases that may yield to ambiguous results.

Many studies have been conducted on the functional lateralization on different species and different human population, the study of functional lateralization has been done on different age, sex and racial/ethnic groups in certain geographical zones, as there are no reference values for the functional lateralization on the adults from Borno State, Nigeria. So, there is need to carry out this study in order to fill this gap. This study was aimed to assess the incidence of functional lateralization in Nigerian adult who are residing in Maiduguri Borno State by investigating human's manual laterality for the manipulation of various types of gestures.

MATERIALS AND METHODS

Participants

The data was collected by distribution of self- assessment questionnaires to 200 randomly selected normal, healthy individuals, who have the ability to perform different task using different parts of their body, among the selected individuals 115 were males and 85 were females.

Questionnaire

The human manual laterality for non-communication functions was assessed using the main handedness questionnaires by following the standard questionnaires recommended by the Annett, 1970, Edinburgh, 1971, Healey *et al.,* 1986 and Waterloo, 1989.

The present study assesses human's manual laterality by designing a questionnaire that consist of about 20 questions on items related to daily activities, in which 14 question are on hands activities, 4 questions are on feet activities, 1 question on ears activities and 1 question on mouth activities.

Statistical Analysis

All the recorded data were expressed as percentage. All the recoded variables in males and females were tested for significant different using chi-square test. The data analysis was carried out using SPSS version 18.0 software. The P-value less than 0.05 ($P < 0.05$) was considered significant.

RESULTS

The result shows that there is significant difference for the right and left sidedness in both males and females, in which 84% prefer right hand in all the tasks, 11% prefer left hand in all the tasks and 5% prefer both left and right hands in all the tasks.

For feet activities 75% prefer right foot for all the tasks, 17% prefer left foot for all the tasks and 8 percent prefer both left and right feet for the entire task. For the ear activities 74% prefer the right ear for the task, 16% prefer the left ear and 10% prefer the both left and right ear for the task. For the mouth activities 62% prefer the right side of the mouth for the task, 17% prefer the left side, while 21% prefer both left and right side for the task.

Table 1: The Chi-square test for right side against the left side

Variables	Both Sexes (n=200)			DF	*p*-value
	R	L	B		
Handedness	84%	11%	5%	1	< 0.0001
Footedness	75%	17%	8%	1	< 0.0001
Ear	74%	16%	10%	1	< 0.0001
Mouth	62%	17%	21%	1	< 0.0001

Key:- N= number of samples, R= right side, L= left side, B= both sides, DF= degree of freedom, Chi-square= 52.84

This result has no significant difference between males and females as the P-value for the tasks using right side in males against the tasks using right side in females is P=0.6894, likewise for the tasks using left side in males against tasks using left side in female is P=0.092.

Table 2: Chi-square test for right side in males against right side in females

Variables	RM against RFM
Chi-square	0.1597
Degree of freedom	1
P-value	0.6894

Key:- RM= right side in males, RFM= Right side in females.

Table 3: Chi-square test for left side in males against the left side in females

Variables	LM against LFM
Chi-square	2.767
Degree of freedom	1
P-value	0.0962

Key: LM= left side in males, LFM= left side in females

DISCUSSION

The interesting finding emerge from the present study was the difference between the right and left side in both males and females, which did not show any sex variation. The current study finds out that majority of the people prefer using right side in doing many tasks, although it may not go to be dominant as some may prefer the combination of both left and right side. This shown that there is right side bias in performing activities related to daily tasks like throwing, tooth brush, opening box, using tools (pen, hammer, broom, scissors), kicking a ball picking a stone with toe and stepping on chair. This is in agreement with the previous findings by Fagard *et al.,* 2015; Prieur *et al.,* 2017, which reported that there is a right-hand bias at the population level for distinct non-communication activities related to complex everyday manipulation tasks such as tooth brushing, tool using (e.g.

hammering) and throwing (Fagard *et al.,* 2015; Prieur *et al.,* 2017).

This study also finds that there is right side bias at the population level for ear and mouth activities, which is in agreement with previous findings by Güntürkün, 2003; Barrett *et al.,* 2006; Ocklenburg and Güntürkün, 2009; Chapelain *et al.,* 2015; Prieur *et al.,* 2017, who reported that for modern societies. Indeed, a right-side bias has been showed for hearing and chewing and cheek kissing (Güntürkün, 2003; Barrett *et al.,* 2006; Ocklenburg and Güntürkün, 2009; Chapelain *et al.,* 2015; Prieur *et al.,* 2017).

CONCLUSION

In every given population those with dominant left cerebral hemisphere are more than 99%, so there is >99% chances of them been right sided and those with dominant right cerebral hemisphere are less than 1%, so there is <1% chance of them been left sided. This is because the left cerebral hemisphere controls the activities of the right side of the body and right cerebral hemisphere control the activities of the left side of the body. Although this is not absolute because one may have dominant left cerebral hemisphere in his upper part of the body and dominant right cerebral hemisphere in his lower part of the body and vice versa.

REFERENCES

Barrett D, Greenwood J. G, McCullagh J. F. (2006). Kissing laterality and handedness. *Laterality,*11, 573–579.

Bisazza A, Cantalupo C, Capocchiano M, Vallortigara G. (2000). Population lateralisation and social behaviour: a study with 16 species of fish. *Laterality*5, 269–284.

Bisazza A, De Santi A, Bonso S, Sovrano V. A. (2002). Frogs and toads in front of a mirror: lateralisation of response to social stimuli in tadpoles of five anuran species. *Behav. Brain Res.* 134, 417–424.

Caliskan E, Dane S. (2009). Left-handedness in blind and sighted children. *Laterality,*14, 205–213.

Cavill S, Bryden P. (2003). Development of handedness: comparison of questionnaire and performance-based measures of preference. *Brain.Cogn.,*53, 149–151.

Chapelain A, Pimbert P, Aube L, Perrocheau O, Debunne G, Bellido A, Blois-Heulin C. (2015). Can population-level laterality stem from social pressures? Evidence from cheek kissing in humans. *PLoS ONE* 10, e0124477.

Cochet H, Vauclair J. (2010). Features of spontaneous pointing gestures in toddlers. *Gesture,*10, 86–107.

Espírito-Santo H, Pires C. F, Garcia I. Q, Daniel F, Silva A. G. D, Fazio R. L. (2017). Preliminary validation of the Portuguese Edinburgh Handedness Inventory in an adult sample. *Appl. Neuropsychol. Adult,*24, 275–287.

Fagard J, Chapelain A, Bonnet P. (2015). How should 'ambidexterity' be estimated? *Laterality,*20, 543–570.

Fagard J. (2004). *Droitiers/gauchers, Des asymmetries danstous les sens*. Marseille, France: Solal Editeurs.

Faurie C, Raymond M. (2004). Handedness frequency over more than ten thousand years.*Proc. R. Soc.Lond., B* 271, 43–45.

Faurie C, Schiefenhvel W, leBomin S, Billiard S, Raymond M. (2005). Variation in the frequency of left-handedness in traditional societies 1. *Curr.Anthropol.,*46, 142–147.

Faurie C. (2004). L'évolution du polymorphisme de latéralitédans les populations humaines. Doctoral dissertation, Université de Montpellier.

Ghirlanda S, Vallortigara G. (2004). The evolution of brain lateralization: a game-theoretical analysis of population structure. *Proc. R. Soc. Lond. B* 271, 853–857.

Güntürkün O. (2003). Human behaviour: adult persistence of head-turning asymmetry. *Nature*, 421, 711.

Horwitz B, Amunts K, Bhattacharyya R, Patkin D, Jeffries K, Zilles K, Braun A. R. (2003). Activation of Broca's area during the production of spoken and signed language, a combined cytoarchitectonic mapping and PET analysis. *Neuropsychologia,*41, 1868–1876.

MacNeilage P. F, Rogers L. J, Vallortigara G. (2009). Origins of the left and right brain.*Sci. Am.* 301, 60–67.

Nicholls M. E, Thomas N. A, Loetscher T, Grimshaw G. M. (2013). The Flinders Handedness survey (FLANDERS): A brief measure of skilled hand preference. *Cortex,*49, 2914–2926.

Ocklenburg S, Güntürkün O. (2009). Head-turning asymmetries during kissing and their association with lateral preference. *Laterality,*14, 79–85.

Papadatou-Pastou M, Martin M, Munafò M. R. (2013). Measuring hand preference: a comparison among different response formats using a selected sample. *Laterality* 18, 68–107.

Pika S, Bugnyar T. (2011) The use of referential gestures in ravens (*Corvuscorax*) in the wild. *Nat. Commun.* 2, 560.

Price C. J. (2010). The anatomy of language: a review of 100 fMRI studies published in 2009. *Ann. NY Acad. Sci.* 1191, 62–88.

Prieur J, Barbu S, Blois-Heulin C. (2017). Assessment and analysis of human laterality for manipulation and communication using the Rennes Laterality Questionnaire. *R. Soc. open sci.* 4: 170035.

Prieur J, Pika S, Barbu S, Blois-Heulin C. (2016). A multifactorial investigation of captive chimpanzees' intraspecific gestural laterality. *Anim. Behav.* 116, 31–43.

Prieur J. (2015). Chimpanzees' and gorillas' intraspecific gestural laterality: a multifactorial investigation. Doctorate thesis. University of Rennes 1, Rennes, France.

Raymond M, Pontier D. (2004) Is there geographical variation in human handedness? *Laterality,*9, 35–51.

Rogers L. J, Zucca P, Vallortigara G. (2004). Advantages of having a lateralized brain. *Proc. R. Soc. Lond. B*271, S420–S422.

Saucier D. M, Elias L. J. (2001). Lateral and sex differences in manual gesture during conversation. *Laterality,*6, 239–245.

Suzuki K, Ando J. (2014). Genetic and environmental structure of individual differences in hand, foot, and ear preferences: a twin study. *Laterality,*19, 113–128.

Szaflarski J. P, Scott K. H, Vincent J. S, Anna W. B. (2006). An fMRI study of language lateralization in children and adults. *Hum Brain Mapp*, 27(3): 202–212.

Vallortigara G, Bisazza A. (2002). How ancient is brain lateralization? In *Comparative Vertebrate Lateralization* (eds RJ Andrew, LJ Rogers), pp. 9–69. Cambridge, UK: Cambridge University Press.

Vallortigara G, Rogers L. J. (2005). Survival with an asymmetrical brain: advantages and disadvantages of cerebral lateralization. *Behav. Brain Sci.* 28, 575–589.

Vuoksimaa E, Koskenvuo M, Rose R. J, Kaprio J. (2009). Origins of handedness: a nationwide study of 30161 adults. *Neuropsychologia,*47, 1294–1301.

Xu J, Gannon P. J, Emmorey K, Smith J. F, Braun A. R. (2009). Symbolic gestures and spoken language are processed by a common neural system. *Proc. Natl Acad. Sci. USA* 106, 20 664–20 669.