A Novel Technique for Determining Handedness in Primary School Children in FCT Abuja, Nigeria.

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Abstract

Handedness is the tendency to be more skilled and comfortable using one hand instead of the other for tasks such as writing and throwing objects. Society expects that most people should be right-handed but some are not. About 10-12.2% of Nigerians are left-handed. In certain cultures, people think that it is abnormal to be left-handed. It is therefore important to identify lefthanders in the population, support them and devise some methods of minimizing wrong social perceptions on the issue. A Descriptive Cross-sectional survey was utilized in this study. The population of this study were 190 primary school children between the ages of 5 -12 years selected from both a public and private school in Gwagwalada, Abuja after securing parental consent. Data was collected via direct observation and with the aid of a short questionnaire survey. The participants' pattern of "arm crossing", "hand clasping" and "feet crossing" were observed. Their hand preferences for performing certain tasks as well as the time they spent writing or drawing with both hands were recorded. There was a significant relationship between the pattern of "Feet crossing" and the handedness of the participants. This shows that "Feet crossing" can be used to determine handedness. However, the test showed a low specificity despite exhibiting a high sensitivity. No significant relationship was found between the pattern of "Arm crossing" and "Hand crossing" and the handedness of the participants. Reported hand preference was an actual indicator of the subjectively perceived handedness of the participants.

Key Words: Handedness, Children, Technique, Determining

INTRODUCTION

1.1 Background to the Study

Handedness is the tendency to be more skilled and comfortable using one hand instead of the other for tasks such as writing and throwing objects. An individual can be left-handed, right-handed or ambidextrous (if he/she can use both hands to perform said tasks). Researchers have shown that the determination of handedness in an individual is influenced by an interplay between genes and the external environment the individual is exposed to while growing up.

1.2 Statement of the Problem

Society expects that most people should be right-handed but some are not. About 10-12.2% of Nigerians are left-handed (Iyiola *et. Al.*, 2015; Oremosu et al, 2011). In certain cultures, people think that it is abnormal to be left-handed. It is therefore important to identify lefthanders in the population (optimally at an early stage in development), support them and devise some methods of minimizing wrong social perceptions on the issue.

1.3 Research Questions

1.   Can a simple technique be used to ascertain handedness in a given subject?
2.   Can a questionnaire survey determine handedness?

1.4 Research Objectives

1.   To establish a new and easy technique for determining handedness.
2.   To show that a questionnaire can be used to determine handedness.

1.5 Research Hypothesis (stated as null)

1.   A simple technique cannot be used to determine handedness in a given subject.
2.   A questionnaire survey cannot be used to determine handedness in a given subject.

1.6 Significance of the Study

A quick and easy technique to determine handedness will help those who are left-handed to overcome the psychological challenges associated with left-handedness and help to educate the community and advocate for them to be accepted as being normal or a variant of normal. The technique will help parents to ascertain the handedness of their children at an early stage, thereby making it easy for their children undergo a normal development.

1.7 Literature Review

1.7.1 Conceptual Issues

Ogah I. et al. (2012) showed that there was a correlation between the degrees of lateral preference for hand clasping and arm folding.

Tran U. S. et al. (2014) worked on two large Middle-European samples and found that right-handedness was associated with right hand clasping and left arm crossing while left and mixed –handedness with left hand clasping and right arm folding.

Looking at the work done by Marian A. (1972) & McManus et al (1992), it is expected that a combination of observation of hand clasping, arm folding and questionnaire survey should sufficient to determine handedness.

1.7.2   Theoretical Review

Marian Annett (1972) propounded the Right Shift theory which postulates that a hypothetical RS+ gene develops the motor cortex and speech processing systems of the left side of the brain, leading to a preference for the right side of the body – a "right shift". The RS- gene which is the other form is found in left-handers and is indifferent to the direction of both language and motor dominance.

McManus I. C. & Bryden M. P. (1992) propounded the Dextral/Chance theory which postulates that a "dextral" allele – D, which favors right-handedness and the control of speech towards the left cerebral hemisphere. An alternate gene "chance" allele – C, is presumed directionally neutral. The theory posits that DD genotype gives rise to right-handers, CC genotype gives rise to a random combination 50% right-handers & 50% left-handers, while the heterozygotic DC genotype produces 75% right-handers and 25% left-handers.

1.7.3   Theoretical Framework

Handedness can be seen as a phenotype, which means that its existence is dependent on a number of genes or more accurately, an interplay between some genes and the external environment. It's possible that the external environment in this case can have a greater influence than the gene.

A combination of the various methods outlined in this novel technique (hand clasping pattern, arms folding pattern and leg crossing pattern) coupled with the simple questionnaire survey (hand preference for writing, throwing objects, eating, brushing teeth, sharpening pencil) should be able to predict handedness in subject with all other factors being favorable.

1.7.4   Empirical Review

Koller, U. K. (2007) attempted to create and validate a test for measuring the handedness of pre-school children. The new test consists of 14 activities for checking different aspects of hand preference and was administered to 120 children from Vienna with ages ranging from 4 – 6.5 years. The handedness of the children in the study was assessed by administering a questionnaire to their parents, observing the hand they used while drawing and testing their visual-motor skills & level pf development with the aid of Viennese Development Test (WET, Kastner-Koller & Deimann, 2002). The test proved to be reliable (α=0.97).

Olfield, R. C. (1971). Published the Edinburgh Handedness Inventory which can be used by an observer assessing the subject or by the subject self-reporting hand preference. In this inventory, participants are given a list of tasks with adjacent columns labelled "left" and "right". They are expected to insert a "+" or "++" depending on either the left or right column or on both columns in response to the hand preference for the activity.

Veale J. F. (2013). Published a revised version of the Edinburgh Handedness Inventory dubbed "Edinburgh Handedness Inventory – Short form". It consisted of just 4 items – Writing, throwing, Toothbrush & Spoon and also boasted of brief and simpler instructions as compared to the original inventory.

Methodology

2.1   Research Design
This research utilized a descriptive, cross-sectional, questionnaire-based study design.

2.2   Population of the Study
The population of this study were primary school children between the ages of 5 -12 years. This population was chosen because, the study will be more beneficial to them if their handedness is discovered at this early stage.

2.3   Sample of the Study
All consenting children attending primary schools located in Abuja. Sample size was determined by using the following formula:

$$N = \frac{Z\alpha^2\,pq}{d^2}$$

N = Sample size
$Z\alpha = 1.96$

p = Prevalence of left-handedness in the population – 12.2% (Iyiola et al.)
q = 1 – p
d = degree of precision (0.05)

$$N = \frac{1.96^2 \times 0.122 \times 0.878}{0.05^2}$$

N = 164 + 16 (for non-response) = 180 individuals
N is rounded up to **200 individuals**

2.4   Sources of Data
Data was collected from school children with the support of their school authority and their parents. It was collected during school visits or during PTA meetings. Observation data, along with the Questionnaire survey were collected.

2.5   Methods of Data Collection
    1. Observation method
    2. Short Questionnaire survey

2.6   Techniques of Data Analysis
Data was analyzed using Microsoft Excel and SPSS. This was done for each specific objective (1-2)

Results

A total of 190 primary school students participated in this study, 85 (44.7%) of the study participants were female while 105 (55.3%) were male. Participants ethnicity indicate that 18.5% were Yoruba, 23.3% Hausa, 15.3% were Igbo, 1.1% were Gbagyi and other tribes accounted for 41.8% of the study participants as shown in Table 1 below. Concerning the parent handedness, 175 (92.6%) of the participants had fathers that were right-handed while 179 (94.7%) had mothers who were right-handed as shown in Table 1 below.

Table 1: General characteristics respondents

Biodata	Frequency (percentage)
Sex	
Female	85 (44.7)
Male	105 (55.3)
Ethnicity	
Yoruba	35 (18.5)
Hausa	44 (23.3)
Igbo	29 (15.3)
Gbagyi	2 (1.1)
Others	79 (41.8)
Handedness of father	
Right	175 (92.6)
Left	11 (5.8)
Don't know	3 (1.6)
Handedness of Mother	
Right	179 (94.7)
Left	6 (3.2)
Don't know	4 (2.1)

The youngest participant was 5 years old while the oldest was 15 years old. The primary school level of participants ranged from Primary 1 to Primary 5 as shown in the table 2 below.

Table 2: Age and primary school distribution of respondents

	Range	Mean	Std. Deviation
Age	5-15	9.65	2.015
Primary School Class	1-5	3.79	0.920

Objective 1

In naturally performed tasks, 95 (50.6%) participants had their left forearm overlapping right forearm. When clasping their hands together, 102 (54.5%) participants had their left thumb overlapping right thumb while 148 (79.1%) had their right foot overlapping left foot while crossing their feet.

Table 3: Patterns of observed naturally performed tasks

Observed task	Right Overlap left (%)	Left overlap Right (%)
Crossing of Arms	92(49.2)	95(50.8)
Clasping of Hands	85(45.5)	102(54.5)
Crossing of Feet	148(79.1)	39(20.9)

The relationship between the different patterns of naturally performed tasks such as "Arm Crossing", "Hand clasping" and "Foot Crossing" were compared to the handedness of the participants to find a relationship. These relationships are demonstrated in tables 4-6 below. The tasks – "Arm crossing" and "Hand clasping" showed no significant relationship with the handedness of the participants but "Foot crossing" demonstrated a significant relationship with the handedness of the participants.

Table 4: Relationship between the pattern of "Arm crossing" and handedness of the participant

Arm crossing pattern	Actual handedness		Total	chi	p-value
	Right (%)	Left (%)			
"Right arm overlapping left arm" pattern	86(93.5)	6(6.5)	92		
"Left arm overlapping right arm" pattern	86(90.5)	9(9.5)	95	0.552	0.457

Table 5: Relationship between the pattern of "Hand Clasping" and handedness of the participant

Hand clasping pattern	Actual handedness				
	Right(%)	Left(%)	Total	chi	p-value
"Right hand overlapping left arm" pattern	80(94.1)	5(5.9)	85	0.966	0.326
"Left hand overlapping Right hand" pattern	92(90.2)	10(9.8)	102		

Table 6: Relationship between the pattern of "Feet Crossing" and handedness of the participant

Feet crossing pattern	Actual handedness				
	Right (%)	Left (%)	Total	chi	p-value
"Right foot overlapping left foot" pattern	140(94.6)	8(5.4)	148		
"Left foot overlapping Right foot" pattern	32(82.1)	7(17.9)	39	6.582	0.01

Since there was a significant relationship between the pattern of "Foot crossing" and the handedness of the participant. The validity of this pattern as a measure for handedness was ascertained. This test showed a high sensitivity but a low specificity with an accuracy of 98.6% as shown in Table 7 below.

Table 7: Validity of using the Pattern of "Crossed Feet" as a proxy for determining handedness.

	Cross Foot	[95 Confidence Interval]	
Prevalence Pr. (C)	79.00	73	84.7
Sensitivity Pr. (+C)	94.60	89.6	97.6
Specificity Pr. (-N)	17.90	7.54	33.5
ROC area (Sens. + Spec.)/2	0.563	0.499	0.626
Accuracy	78.6%		

The average time spent by the participants to write down a certain block of characters and trace the dots of an incomplete circle are represented in Table 8.

Table 8: Time spent writing with both the left and right hand and number of dots traced on the circle.

	Minimum	Maximum	Total	Mean	Std. Deviation
Time spent writing with Right Hand	5.17	57.00	2986.46	15.8854	7.41594
Time spent writing with Left Hand	10.00	107.00	7127.78	37.9137	14.87747
Trace this circle with RIGHT hand	0	8	622	3.31	1.333
Trace this circle with LEFT Hand	0	8	534	2.84	1.311

Objective 2

By using a questionnaire to assess hand preference, it was observed that 173 (92.5%) participants ate with their right hand, 171 (91.4%) responded that they wrote with their right hand, 162 (86.6%) brushed their teeth with their right hand, 152 (81.3%) threw objects with their right hand and 151 (80.7%) kicked a football with their right foot as shown in Table 9 below.

Table 9: Participant hand preference in performing everyday activities

Everyday activity	Right (%)	Left (%)	Both (%)
Preferred hand to eat	173(92.5)	5(2.7)	9(4.8)
Preferred hand to write	171(91.4)	15(8)	1(0.5)
Preferred hand to brush	162(86.6)	14(7.5)	11(5.9)
Preferred hand to throw	152(81.3)	18(9.6)	17(9.1)
Preferred foot to kick	151(80.7)	20(10.7)	16(8.6)

As shown in Table 10 below, the relationship between the reported hand preference and the handedness of the participant was analyzed. The low p value ($p < 0.0001$) indicate a significant relationship. This implies that, reported hand preference can be used in determining the actual handedness of the child.

Table 10: Hand preference and Actual hand edness

Hand preference	Actual handedness				
	Right (%)	Left (%)	Total	chi	p-value
Right	165(97.6)	4(2.4)	169		
Left	1(9.1)	10(90.9)	11	110.13	<0.0001
Both	6(85.7)	1(14.3)	7		
Total	172	15	187		

In Table 11, the validity of reported hand preference as a tool for determining handedness was examined. The sensitivity of the reported hand preference is 97.6% while specificity is 90.9% with accuracy of 97.2% this shows that it has good ability in determining the handedness of a child.

Table 11: Validity o f using reported hand preference for daily routine activities as a proxy for determining handedness

	Hand preference for daily activities	[95 Confidence Interval]	
Prevalence Pr (B)	94.00	89	96.9
Sensitivity Pr (+B)	97.60	94.1	99.4
Specificity Pr(-N)	90.90	58.7	99.8
Accuracy	97.2%		

The relationship between the handedness of the parents and the handedness of the participants were compared as shown in Table 12 and 13. There was no significant relationship observed between the handedness of the parents and that of the child.

Table 12: Relationship between handedness of Father and handedness of participant

father	Actual				
	Right (%)	Left (%)	Total	chi	p-value
Right	161(92.5)	13(7.5)	174		
Left	9(81.8)	2(18.2)	11	1.88	0.39
Don't	2(100)	0(0)	2		

Table 13: Relationship between handedness of Mother and handedness of participant

mother	Actual				
	Right (%)	Left (%)	Total	chi	p-value
Right	163(91.6)	15(8.4)	178		
Left	6(100)	0(0)	6	0.916	0.633
Don't	3(100)	0(0)	3		

Discussion

The participants in this study were selected from Primary school levels of 1-5, the majority of them are males and the Hausa ethnic group had more representation. The majority of the parent of the participants were right-handed. A greater part of the participants was right-handed and this was in tandem with the trend previously reported in the works of Iyiola et al., on the "prevalence of Left-handedness in Nigeria" (Iyiola et al., 2015) and the works of Ademola *et. al.* on the "prevalence of left-handedness among medical students in University of Lagos" (Ademola et al., 2011).

No significant relationship was found between the pattern of "Arm crossing" and "Hand crossing" and the handedness of the participants. This is similar to the results gotten by Ogah et al. in 2012 (Ogah et al., 2012) and by Forrai & Bankovi in 1969 while examining children of Hungarian descent (Forrai & Bánkövi, 1969). Lutz also reported a similar finding earlier on (Lutz, 1908). However, Tran et al. reported a relationship between certain patterns of "Arm crossing", "Hand clasping" and handedness (Tran et al., 2014).

There was a significant relationship between the pattern of "Feet crossing" and the handedness of the participants. This shows that "Feet crossing" can be used to determine handedness. However, the test showed a low specificity despite exhibiting a high sensitivity. A study conducted by Eligar in India and published in 2011, also reported a similar finding and showed a correlation between "foot overlapping" and handedness among the participants observed (Eligar, 2011).

Hand preference was an actual indicator of the subjectively perceived handedness of the participants. This corresponds with the findings of Koller et al., that hand preference tests can be used to predict handedness in children (Koller *et al*., 2007).

The handedness of the mother or father of the participant was a poor predictor for the handedness of the participant as they had no significant relationships when compared to the actual handedness. This is similar to the result obtained by Shugaba et al., where the "relation between the handedness of first-degree relatives and footballers" were compared (Shugaba et al., 2013).

Conclusion

Self-reported hand preference for performing certain tasks and pattern of "feet crossing" are good indicators of handedness in primary school children in Abuja. Patterns of "hand clasping" and "arm crossing" did not prove to be good indicators for determining handedness. This implies that self-reported hand preference questionnaire and pattern of "feet crossing" can be used as tools for determine handedness in children. Further studies are needed to understand why pattern of "feet crossing" is a good indicator of handedness in children.

References

Oldfield R. C. (1971). The assessment and analysis of handedness: The Edinburg Inventory. *Neuropsycholagia.* 9, 97-113.

Koller U. K., Deimann P. & Bruckner J. (2007) Assesing handedness in pre-schoolers: Construction and initial validation of a hand preference test for 4-6 year – olds. *Psychology Science.* Volume 49(3): pg 239-254.

Marian Annett (2006). The Right Shift Theory of Handedness and Brain Asymmetry in Evolution Development and Psychopathology. *Cognition, Brain, Behavior (Cognitie, Creier, Comportament).* 10, 235-250

Rapin I. & Segalowitz S. J. (1992): Handbook of Neuropsychology, Vl6: Child Neuropsychology> *Elsevier Science Publishers.* Pg 115-144.

Ogah I., Stewart E., Treleaven M. & Wassersug R. J. (2012). Hand clasping, arm folding, and handedness: relationships and strengths of preference. *Laterality.* 17(2): 169-79

Tran U. S., Koller I., Nader I. W., Pietschnig J., Schild H. E., Stieger S., Zeilinger E. L. & Voracek M. (2014): Lateral preferences for hand clasping and arm folding are associated with handedness in two large-sample latent variable analyses. *Laterality.* 19:5 602-614.

Shugaba, A. I., Umar, M. B. T., Uzokwe, C. B., Akeem, A. A., Rabiu, A. M., & Mathew, R. M. (2013). Handedness and Footedness in Footballers in Jos, Nigeria. *Irepos.unijos.edu.ng*.

Ogah, I., Stewart, E., Treleaven, M., & Wassersug, R. J. (2012). Hand clasping, arm folding, and handedness: relationships and strengths of preference. *Laterality*, *17*(2), 169–179.

Forrai, G., & Bánkövi, G. (1969). Relations of Hand Clasping and Arm Folding to Handedness in Hungarian Children. *Acta Geneticae Medicae et Gemellologiae: Twin Research*, *18*(2), 166–174.

Lutz, F. E. (1908). The Inheritance of the Manner of Clasping the Hands. *The American Naturalist*, *42*(495), 195–196.

Tran, U. S., Koller, I., Nader, I. W., Pietschnig, J., Schild, A. H. E., Stieger, S., Zeilinger, E. L., & Voracek, M. (2014). Lateral preferences for hand clasping and arm folding are associated with handedness in two large-sample latent variable analyses. *Laterality: Asymmetries of Body, Brain and Cognition*, *19*(5), 602–614.

Eligar, R. (2011) The laterality of Handedness, Foot Preference and Foot Overlapping. *Journal of Clinical and Diagnostic Research*.5(3):421–4.

Iyiola, O. A., Anifowoshe, A. T., & Oyeyemi, B. F. (2015). Incidence and Prevalence of Left handedness in a Nigerian sub-population. *Ilorin Journal of Science*, *2*(2), 441–454441–454.

Ademola, O., Bassey, R., Kofoworola, O., Omotayo, O., Rosemary, B., Dolapo, D., & Edidiong, A. (2011). The Prevalence of Left-Handedness among Medical and Dental Students in the University of Lagos-Nigeria. *Middle-East Journal of Scientific Research*, *8*(1), 288–293.