

## Relationships between Dermatoglyphics and Multiple Intelligence among Selected Secondary School Students in Lagos State, Nigeria.

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**ABSTRACT:** The relationship between dermatoglyphics and multiple intelligences (MIs) were investigated in this study. 210 subjects from seven secondary schools in Lagos State, Nigeria were examined on heritable MIs; linguistic, logic/Math, intrapersonal, interpersonal, kinesthetic, musical and natural intelligences. The ten fingerprint patterns were captured with an automated scanner to reveal both fingerprint patterns and ridge count on each finger. Analyses revealed that whorl and ulnar loop were predominant on both right and left fingers. There was a significant correlation between the second fingers of both hands with logic intelligence; ulna loop being the most frequent pattern for those ranked "highly intelligent" in logic ( $P < 0.05$ ). There was also a significant relationship between mean ridge count of the left fingers and kinesthetic intelligence in male; higher ridge count corresponded with high kinesthetic intelligence. However, there was no significant correlation between fingerprint patterns and students' performance from different tribe ( $P > 0.05$ ). This study has revealed that the mean total ridge count of left fingers can indicate the level of kinesthetic intelligence in male and ulnar loop pattern on the second finger of both hands and consequently implies high heritable logic intelligence. Further studies with other forms of dermatoglyphic indices and larger sample size are recommended to unravel more association between dermatoglyphics and MIs.

**Keywords:** Lagos, Dermatoglyphics, Multiple intelligences, ulnar, whorl ridge count

### Introduction

Dermatoglyphics is the study of dermal ridges especially of the hands and feet (Aronso, 1997). They are formed during fetal development between the tenth and sixteen week of gestation (Najafi, 2009). Dermal ridges' configuration has been identified to develop alongside the central nervous system during prenatal development (Cvjeticanin and Polovina, 1999) and are therefore affected when central nervous system is also malformed, as apparent in the reports of investigators (Forastieri, 2002; Hartin and Barry 1979; Mavaluava and Tysiaczny 1991; Tornjova-Randelova, 1994). However, fingerprint patterns (whorl, arch, ulna loop and radial loop), fingers' ridge count, pattern intensity, ATD angle and palmer line creases comparison have been the most studied among dermal ridge configuration (Seema *et al.*, 2012).

Intelligence is a general mental capability which involves the ability to reason, think, solve both practical and abstract problems as well as learn from experience (Gottfredson, 1997). Gardner (1999) described eight forms of intelligence, part of which had been elucidated by Fuster (2003). They include verbal/linguistic, logic/mathematic, visual, kinesthetic, intrapersonal, interpersonal, musical and naturalistic intelligences. They are generally termed "multiple intelligences". Human intelligence is controlled by certain polymorphic genes (Bouchard, 1998; Plomin and Spinath, 2002) and can be influenced by mutational load or chromosomal disorder (Nachman and Crowell, 2000 and Crow, 2000), evident in schizophrenia (Byrne *et al.*, 2003) and other related syndrome (Tornjova-Randelova, 1994 and Mavaluava and Tysiaczny, 1991). However, the heritability index of human intelligence ranges from 0.45 to 0.85 (Deary and Bathy, 2007).

Senior Secondary School stage is a preparatory phase for tertiary learning in the educational system of Nigeria. Prior to admission into this phase of study, students are tested in various aspects of intelligences to determine the best area of study (science, commercial and art) that suit their cognitive abilities (Universal Basic Education Commission of Nigeria, 2013 and Imam, 2012). Hence, students tend to develop their innate abilities during this period of learning. Therefore public senior secondary school in Nigeria is a good platform to determine such innate intelligences as students are distributed according to their best abilities, into compatible areas of study.

Mental related syndromes like down syndrome, fragile X, Angelman syndrome, Praderwilli syndrome, *Cri du chat* and other X-linked syndromes like Coffin lowry syndrome have been reported to correlate significantly with dermatoglyphics (Sardool, 2005; Rosa *et al.*, 2001; Chakarborty *et al.*, 2001; Weinstein *et al.*, 1999; Gutierrez *et al.*, 1998; Fogle, 1990; Tiroshi *et al.*, 1987 and Hartin and Barry, 1979). Association between fingerprint patterns and intelligence quotient was reported by Najafi (2009) while preliminary studies on the relationship between dermatoglyphics and intelligence have been documented by Nanakorn *et al.* (2011). However, little or no work has been reported on such study from West Africa and Africa as a whole. This study is therefore aimed to provide a background study on the relationship between dermatoglyphics and multiple intelligences (MIs) in selected secondary school students of Lagos state, Nigeria.

### Materials and Methods

A total of 210 (105 males and 105 females) Senior Secondary (SS3) students in public schools of Lagos state, Nigeria were the subjects of this study. Seven schools were sampled and 10 students from each area of study (science, commercial and art as presented in the Nigerian curriculum for senior secondary school) partook in the test. Their age ranged from 15-19 years. The three major tribes in Nigeria (Yoruba (110), Igbo(64) and Hausa(26)) were the participants.

#### Sample collection

Prior to answering the multiple intelligence (MI) questionnaires and scanning of fingertips, consents were taken from the authorities of the participating schools while students were briefed about the test and its importance. The Multiple Intelligence questionnaires as described by Nanakorn *et al.* (2011) were administered with the assistance of a staff of each school while students answered the MI questionnaire by themselves.

Following Nanakorn *et al.* (2011), fingertips were scanned using *Secugen* fingerprint sensor coupled with its automated inkless fingerprint imaging software. The ten fingertips of each subject were directed on the touchpad of the fingerprint sensor, starting from the right fingers of

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thumb, index, middle, ring, and the little finger. Followed by left hand; thumb, index, middle, ring and little fingers. These fingertips' pattern images were stored on the hard-disk of a laptop and backed up on an external memory device.

**Data analyses**

Students were scored on each of the intelligence test and transformed to percentage. Types of fingerprint patterns were identified by the standard method as reported by Nanakorn *et al.*, (2011) and Najafi (2009). Fingers' ridge counts were also recorded following Holt (1979). Data were analyzed to check significant relationship between dermatoglyphics and multiple intelligences across students' sexes, tribes and areas of study using analysis of variances (ANOVA), chi-square and the independent sample t-test at 95% level of confidence using SPSS statistical package (version 20.0) (SPSS Inc. Chicago, IL, USA.).

**Results**

**Multiple intelligence test**

The general performance in the multiple intelligence test revealed that intrapersonal intelligence has the highest mean score (76.31±15.43) followed by interpersonal (69.15±13.81) and visual (68.96±13.81) intelligences. Verbal and logic intelligences have the means of 57.00±12.86 and 56.92±11.95 (Figure 1). Analysis of variance showed that there is a significant difference between the mean scores of the various intelligences at 5% level of significance  $F_{(209, 1463)} = 107.3$

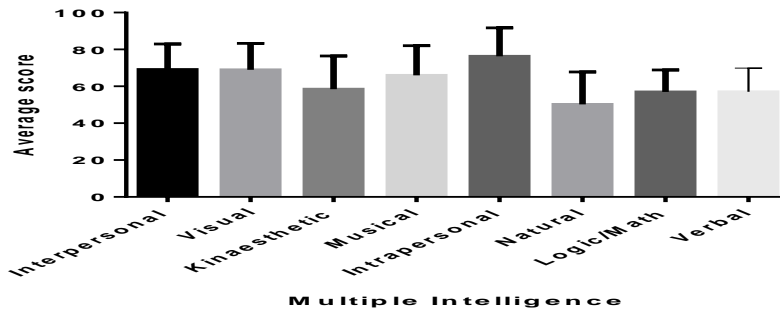


Figure 1: General average score in multiple intelligence tests

**Sex and Multiple intelligences**

Males rated themselves higher in verbal, logic, natural, intrapersonal and kinesthetic intelligences while females rated themselves higher in interpersonal, musical and visual intelligences (Table 1). The trend of intelligence ranking, however remains the same i.e. intrapersonal and interpersonal intelligences being the first and second while verbal, logic and kinesthetic ranked sixth, seventh and eighth respectively in the two sexes. Using t-test analysis, there was no significant difference between male and female performances in the multiple intelligence tests.

Table 1: Average score of males and females in MIs test

MIs	Sex	Score
		Mean ± SEM (N)
Verbal	Male	57.18 ± 1.25 (105)
	Female	56.80 ± 1.26 (105)
Logic/Math	Male	57.00 ± 1.05 (105)
	Female	56.83 ± 1.29 (105)
Natural	Male	50.62 ± 1.70 (105)
	Female	49.73 ± 1.74 (105)
Intrapersonal	Male	77.04 ± 1.45 (105)
	Female	72.87 ± 1.53 (105)
Musical	Male	65.00 ± 1.57 (105)
	Female	66.94 ± 1.56 (105)
Kinesthetic	Male	59.65 ± 1.82 (105)
	Female	57.14 ± 1.67 (105)
Visual	Male	68.36 ± 1.29 (105)
	Female	69.61 ± 1.51 (105)
Interpersonal	Male	60.77 ± 1.41 (105)
	Female	77.53 ± 1.26 (105)

**Multiple Intelligence, Sex and Fingerprint patterns**

In males whorl on the second finger has the highest frequency (42.7%) for the right hand, followed by ulna loop on the second finger (41.8%). Radial loop has no count on the second, forefinger and ring fingers. On the left hand, whorl has the highest frequency (49.1%) on the little finger followed by ulna loop (42.2%) on the second finger (Figure 2a-b). Among females, whorl has the highest frequency on the little finger (50%). Ulna loop's highest frequency was found on the ring finger (45%) and arches on the thumb (22%) for the right hand. Whorl also has the highest frequency (45%) on the left fingers of females followed by ulna loop (41%) on the little finger. Arch has its highest frequency on the ring finger (24%) and radial loop on the ring and little finger (3% each) (Figure 3a-b). Analyses also revealed that whorl and ulna loop were predominant in both males and females that scored above 60% in each aspect of multiple intelligence test except in musical intelligence where arch pattern was predominant in males (Table 2).

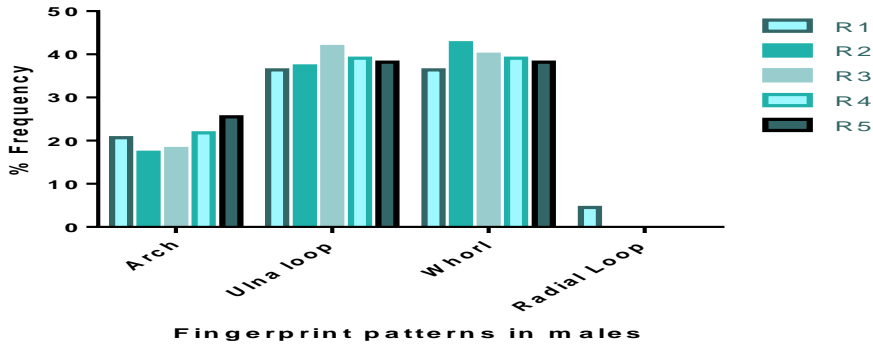


Figure 2a: Frequency of fingerprint patterns in the right hands of males

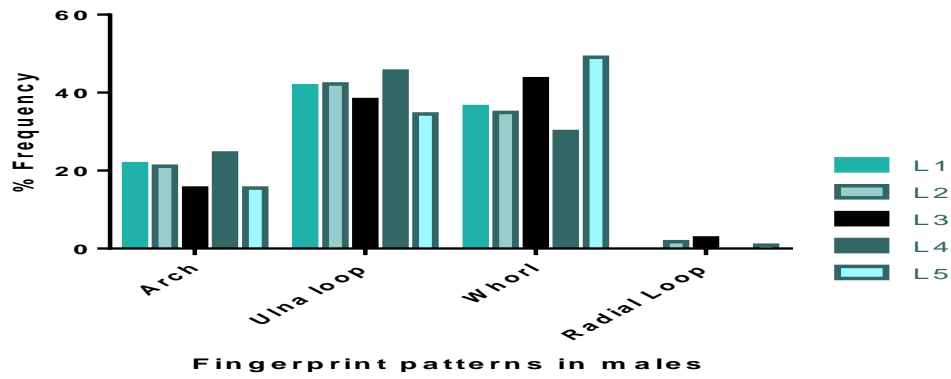


Figure 2b: Frequency of fingerprint patterns on the left fingers in males

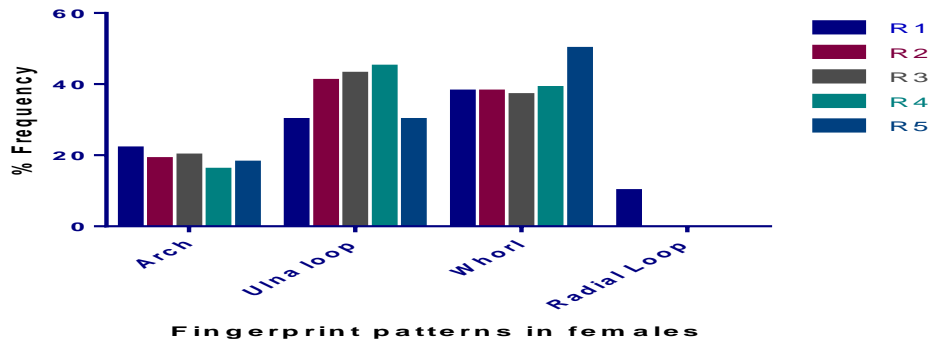


Figure 3a: Frequency of fingerprint patterns on the right fingers in females

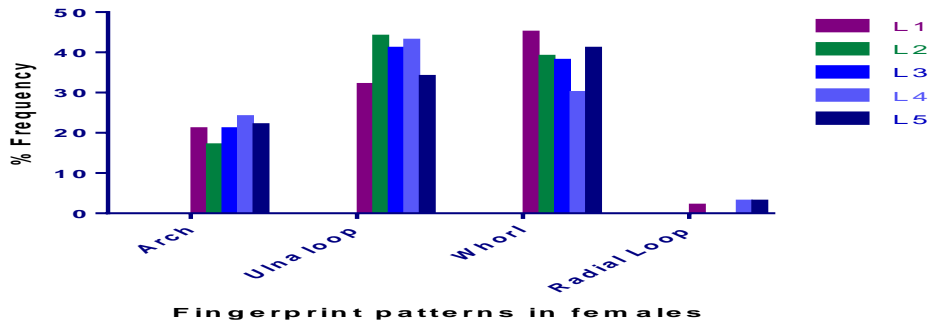


Figure 3b: Frequency of fingerprint patterns on the left fingers in females

Legends R1: Right thumb finger L1: Left Thumb finger  
 R2: Right index finger L2: Left Index finger  
 R3: Right middle finger L3: Left middle finger  
 R4: Right ring finger L4: Left ring finger  
 R5: Right little finger L5: Left little finger

Table 2: Frequency (%) of fingerprint patterns among high performers (M ≥ 65) in MIs test

MIs	Males				Females			
	W	UL	RL	A	W	UL	RL	A
Verbal	42.1	37.8	3.0	17.1	40.2	36.4	0.7	22.7
Logic/Math	37.3	49.7	0.7	12.3	41.6	50.2	2.4	15.8
Kinesthetic	44.2	37.3	3.2	15.3	31.7	42.6	3.1	22.6
Visual	50.3	34.7	1.7	13.3	45.7	32.1	4.1	18.1
Intrapersonal	34.6	47.2	0.8	17.4	34.9	40.4	1.7	23.0
Interpersonal	42.3	33.4	1.3	23.0	32.1	47.4	0.3	20.2
Musical	28.5	38.6	3.2	29.7	37.7	35.3	0.9	26.1
Natural	34.2	54.0	0.8	11.0	36.3	51.7	1.7	10.3

W: whorl UL: ulna loop RL: radial loop A: arch

**Total ridge count, Sex and Multiple intelligences**

The average total ridge count (ATRC) on the right fingers of male students was 40.52±0.97 while female’s was 40.09±1.01. ATRC was 41.44±0.97 and 41.30±0.81 in male and female students respectively for the left fingers (table 3). There was no significant difference between the total ridge count of males and those of females for both hands. However, considering the average total ridge count in each of the intelligence category, ATRC of left fingers in males revealed a significant difference (P>0.05) among the three level of performance in kinesthetic intelligence. High performers (65-100%) have high ATRC, followed by average (50-64%) and low (below 50%) performers respectively (Table 4).

Table 3: Average total ridge count (ATRC) of male and female students

Ridge count	Sex	ATRC (Mean ± SEM)
Left ridge count	Male	40.52 ± 1.01 (105)
	Female	40.09 ± 1.01 (105)
Right ridge count	Male	41.44 ± 1.00 (105)
	Female	41.30 ± 0.81 (105)

Table 4: Male ATRC of left fingers in kinesthetic intelligence

Level of performance	ATRC (Mean SEM)
(65-100) %	51.46 ± 0.45
(50-64) %	43.25 ± 0.67
(0-49) %	26.85 ± 0.43

**Multiple intelligence and Areas of study**

Science department has the highest mean score in logic, 67.14±1.02; natural, 51.31±1.94; intrapersonal, 76.54±1.93 and interpersonal intelligence, 71.09±1.95 while Art department has the highest mean score in verbal (55.43±1.53), musical (69.49±1.90), kinesthetic (58.66±2.11) and visual (68.04±1.70) intelligences (table 5). There was a significant difference (P<0.05) between students’ performance from the three areas of study in logic test. Science department has a significantly higher mean score than others. Other form of intelligences showed no significant differences among the three areas of study.

**Table 5: Mean score of students from different department in MIs test**

Multiple Intelligences	Department	Score (Mean $\pm$ SEM)
Verbal	Science	55.43 $\pm$ 1.52
	Arts	58.50 $\pm$ 1.40
	Commercial	57.07 $\pm$ 1.67
	Total	57.00 $\pm$ 0.88
Logic/Math	Science	67.14 $\pm$ 1.02
	Arts	53.00 $\pm$ 1.05
	Commercial	50.61 $\pm$ 1.30
	Total	56.92 $\pm$ 0.82
Natural	Science	51.31 $\pm$ 1.94
	Arts	49.43 $\pm$ 2.22
	Commercial	49.84 $\pm$ 2.16
	Total	50.20 $\pm$ 1.21
Intrapersonal	Science	76.54 $\pm$ 1.92
	Arts	74.19 $\pm$ 1.70
	Commercial	74.43 $\pm$ 1.90
	Total	75.05 $\pm$ 1.06
Musical	Science	63.03 $\pm$ 1.90
	Arts	69.49 $\pm$ 1.90
	Commercial	65.26 $\pm$ 1.91
	Total	65.92 $\pm$ 1.11
Kinesthetic	Science	58.66 $\pm$ 2.11
	Arts	58.86 $\pm$ 2.10
	Commercial	57.86 $\pm$ 2.27
	Total	58.46 $\pm$ 1.24
Visual	Science	68.04 $\pm$ 1.70
	Arts	69.46 $\pm$ 1.64
	Commercial	69.37 $\pm$ 1.81
	Total	68.96 $\pm$ 0.98
Interpersonal	Science	71.09 $\pm$ 1.94
	Arts	68.14 $\pm$ 1.28
	Commercial	68.21 $\pm$ 1.65
	Total	69.15 $\pm$ 0.95

**Multiple intelligences, Areas of study and Fingerprint patterns**

Whorl and ulna loop had the highest frequency among science students (45% each), the two patterns were found on the second finger of the right hands while ulna loop has the highest frequency (48% on the index finger) for the left hand. Among commercial students, whorl has the highest frequency (48.6%) on the ring and little fingers of the right hands while on the left hand, whorl on the little finger has 47.4%. However, among art students, ulna loop has the highest frequency (42.4%) on the index of right fingers and whorl (44.0%) on the index of the left fingers.

Following the significant high performance in logic/math intelligence test from science department, fingerprint pattern of science students that scored above 65% in logic were analyzed. There was a significant difference ( $P < 0.05$ ) between the frequencies of fingerprint patterns at 5% level of significance for the right and left fingers. Ulna loop has the highest frequency (51.8% and 49.0%) on the second finger of both right and left hands respectively.

**Ridge count, multiple intelligences and Areas of study**

The average total ridge count (ATRC) on the right fingers of science students was 41.93 $\pm$ 1.10, Commercial; 39.67 $\pm$ 1.10 and art; 42.52 $\pm$ 1.08. Art department also has the highest ATRC (41.63) on the left fingers as shown in Table 6. However, there was no significant difference between ATRC of the three areas of study.

**Multiple intelligences and Tribe**

The highest mean score in intrapersonal (69.4%), natural (58%), musical (62%) and visual (63.1%) intelligences were recorded for Yoruba tribe. Hausa has the highest mean score in logic (57.3%) and verbal (59.1%) intelligences test while Igbo has the highest mean score in kinesthetic (59.1%) and interpersonal (78.9%) intelligences (Figure 4). However, there was no significant difference in the multiple intelligence scores between the ethnic groups.

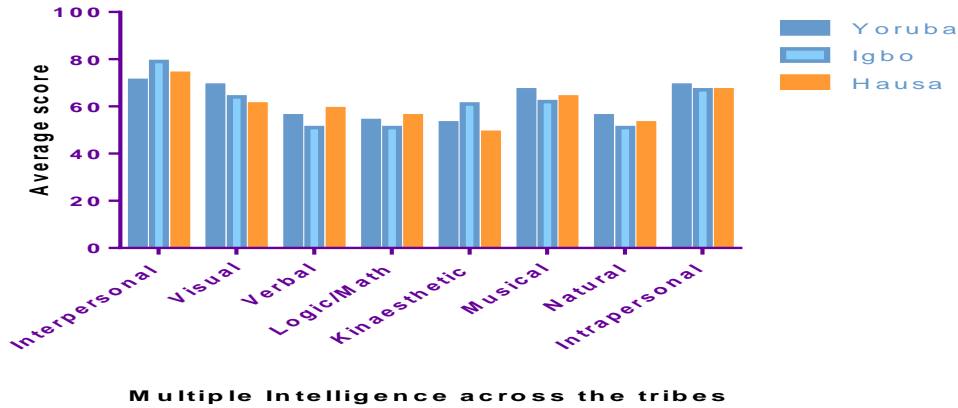


Figure 4: Average score in the multiple intelligence tests among Nigerian tribes

**Association between fingerprint patterns and tribes**

Across the right fingers, ulna loop has the highest frequency of (66.0%) among Hausa found on the ring finger while whorl was more predominant among Yoruba (48.4%) and Igbo (57.4%) found on the little and middle fingers respectively. For the left fingers, Yoruba had 48.4% for ulna loop on the ring finger while Igbo and Hausa had 50% and 66% of whorl, found on the little and middle fingers respectively. Arch pattern ranges from 12% to 29% across the three tribes while radial loop was very rare between 0% and 3%. However there was no significant difference ( $P>0.05$ ) in the fingerprint patterns across the three tribes.

**3.11 Association between Total ridge count and the three tribes**

Hausa has the highest average total ridge count (ATRC) for the right fingers ( $43.67 \pm 1.67$ ) followed by Yoruba ( $41.41 \pm 0.76$ ). Igbo has an ATRC value of  $40.65 \pm 1.39$  for the left fingers, following Hausa with a value of  $44.33 \pm 7.06$  (Figures 5a & b). However, analysis of variance between ATRC of the tribes showed no significant difference at 5% level of significance.

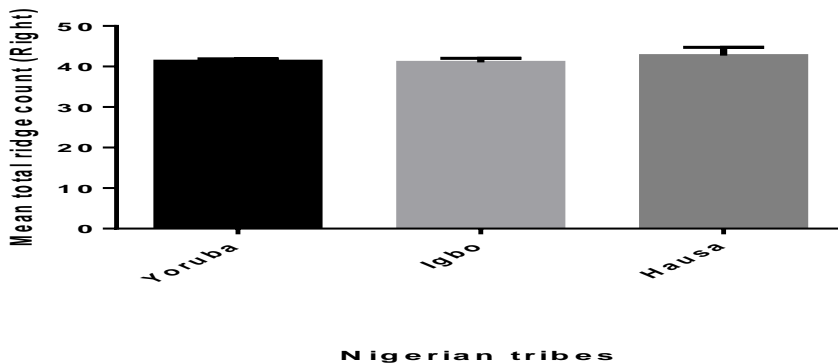


Figure 5a: Average total ridge count on the right fingers among Nigerian tribes

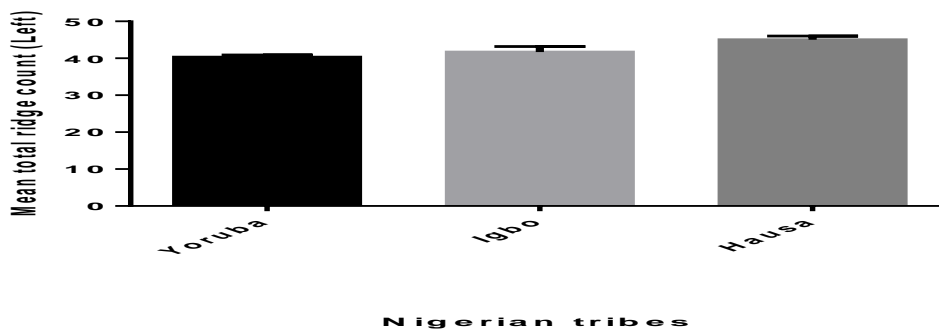


Figure 5b: Average total ridge count on the left fingers among Nigerian tribes

## Discussion

Dermatoglyphics has been reported to have a remarkable relationship with mental related syndromes (Sardool, 2005; Rosa *et al*, 2001; Chakarborty *et al*, 2001; Weinstein *et al*, 1999 and Gutierrez *et al*, 1998) and intelligent quotient of adolescents (Najafi, 2009). This study focused on dermatoglyphics as a measure of strength and weakness in various heritable intelligences in adolescents. The result of this study shows that interpersonal intelligence has the highest mean score of  $76.31 \pm 15.43$  followed by visual and intrapersonal intelligences. Verbal and logic have the means of  $57.00 \pm 12.86$  and  $56.92 \pm 11.95$  making the sixth and seventh position of the multiple intelligences. This study differs from that of Nanakorn *et al*. (2011) who reported that logic intelligence has the highest mean score. This discrepancy could be due to the focus of their study on students from only Science and Technology Department which as they noted tend to have high logic intelligence. Unlike that study, this study involved students from different areas of study; commercial, sciences and art. There was also a marked difference between males (60.77) and females (77.53) in interpersonal intelligence as also reported by Nanakorn *et al*. (2011). This could be related to early reproductive maturity in female than their male counterparts which as opined by Lynn and Kanazawa (2011) is a natural phenomenon that tends to make females more conscious of the environment earlier than their male counterparts.

Multiple intelligences investigated across the departments revealed that Science students performed relatively better in logic, natural and intrapersonal intelligence with the mean score of  $67.14 \pm 1.02$ ,  $51.31 \pm 1.94$  and  $76.54 \pm 1.93$  respectively while Art students showed a marked high ranking in verbal, musical, kinesthetic and visual intelligences. This report is in line with Gardner's (1999) description of the various intelligences. He described logic and natural intelligences as science oriented intelligences while verbal, musical and visual as art related intelligences. It is also noteworthy that Science department showed a significantly high mean score in logic than other departments ( $P < 0.5$ ).

Analysis of the frequency of fingerprint patterns from this study showed that whorl and ulnar loop were the most occurring patterns followed by arch and radial loop. This trend was recorded across the sexes, departments and tribes. This is in consonance with the reports of Oladipo *et al*. (2009), Najafi (2009) and Nanakorn *et al*. (2011). However, arch pattern occurred more than whorl among males that scored above 65% in musical intelligence, suggesting a relationship between musical intelligence and arch pattern especially on the index finger as observed. There was also a significant difference between the frequencies of fingerprint patterns among science students that scored above 65% in logic ( $p < 0.05$ ). Ulnar loop on the second finger of both hands (right and left) had the highest frequency. This agrees with the report of Tornjova-Randelova (1994) and Najafi (2009) who reported a strong association between digit II of both hands with intelligence quotient. Ulna loop on digit II of both hands can therefore indicate high logic intelligence in children before being extremely influenced by environmental factors.

Fingers ridge count in relation with multiple intelligences has not been previously reported. From this study, the average total ridge count (ATRC) of males were  $40.52 \pm 0.97$  and  $41.44 \pm 0.97$  on the left and right fingers respectively; being higher than that of females;  $40.09 \pm 1.01$  and  $41.30 \pm 0.81$  for left and right fingers. There was no significant difference between ATRC of both sexes. However, there was a significant difference between ATRC of the three hierarchy of performance among males for kinesthetic intelligence. This assumes a significant relationship between sport smartness and total ridge count in male.

Art department has the highest average total ridge count on both right and left fingers ( $39.67 \pm 1.10$  and  $42.51 \pm 1.09$  respectively). Science department also has higher mean count than the commercial for right and left fingers. However, these differences were not significant. Among the tribes, Hausa has the highest ridge count on the right and left fingers but the counts were not significantly different from that of the other tribes.

## Conclusion

This study revealed that ulna loop pattern on the second digit of both right and left hands could indicate high logic intelligence while high frequency of arch pattern especially on index finger is indicative of high musical intelligence. The hierarchy of kinesthetic intelligence also correlated with the average total ridge count on the left fingers of males. It has therefore shown that dermatoglyphics has significant relationship with multiple Intelligence. More studies on the relationship between dermatoglyphics and multiple intelligences with larger sample size should still be embarked on, to unravel different association that could exist between these parameters, if any.

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## References

- Aronson J. (1997). When I use a word...Fingerprints. *British Medical Journal*; 315(7113): 10
- Bouchard, T. J. (1998). Genetic and environmental influences on adult intelligence and special mental abilities. *Human Biology*; 70: 257-279.
- Byrne, M., Agerbo, E., Ewald, H., Eaton, W.W. and Mortensen, P.B. (2003). Parental age and risk of schizophrenia: A case-control study. *Archives of General Psychiatry* 60: 673-678.
- Chakarborty, D., Mazumdar, P., Than, M. and Singh R. (2001). Dermatoglyphic analysis in Malay subjects with bipolar mood disorder. *Medical Journal of Malaysia*. 56 (2):223-6.
- Crow, J. F. (2000) The origins, patterns and implications of human spontaneous mutation. *Nature Reviews Genetics* 1: 40-47.
- CvJaicanin, M. and Polovina, A. (1999). Quantitative analysis of digitopalmar dermatoglyphics in male children with central nervous system lesion by quantification of clinical parameters of locomotor disorder. *Medical Croatica* 53(1): 5-10.
- Deary, I.J. and Bathy, G.D. (2007). Cognitive epidemiology. *J. Epidemiol. Comm. Health* 1(5): 378-384
- Fogle, T. (1990). Using dermatoglyphics from down syndrome and class populations to study the genetics of a complex trait. *Association for Biology Laboratory Education (ABLE)* 11:129-150.
- Fuster, J. M. (2003). *Cortex and Mind. Unifying Cognition*. Oxford, New York: Oxford University Press. 294pp
- Gardner, H. (1999). *Intelligence reframes: multiple intelligences for the 21st century*. New York: Basic Books. 304pp

- Gottfredson, L. S. (1997). Mainstream science on intelligence: an editorial with 52 signatories, history, and bibliography. *Intelligence* 24:13– 23.
- Gutierrez, B., Van O. J., Vallesc, V., Campilloc, M. and Fanansa, L. (1998). Congenital dermatoglyphic malformations in severe bipolar disorder. *Psychiatric Resources* 78(3):133-40.
- Hartin, P. J., and Barry R. J. (1979). A comparative dermatoglyphic study of autistic, retarded, and normal children. *Autism Development Disorder* 9(3):233-46.
- Holt, S.B. (1979). Dermatoglyphics. *Collegium Anthropologicum* 3(1): 97-106
- Imam, H. (2012). Educational Policy in Nigeria from the Colonial Era to the Post-Independence Period. *Italian Journal of Sociology of Education* 1:181-204
- Lynn, R. and Kanazawa, S. (2011): A longitudinal study of sex differences in intelligence at ages 7, 11 and 16 years. *Personality and Individual Differences* 51: 321–324
- Mavalauva, J. and Tysiaczny, C.A. (1991). A rare dermatographic finger pattern in a Canadian kindred. *Anthropology* 49(4):355-60.
- Najafi, M. D. (2009) Association between finger Patterns of Digit II and intelligence quotient level in adolescents. *Iranian Journal of Pediatrics* 19(3): 277-284
- Nachman, M. W. and Crowell, S.L. (2000) Estimate of the mutation rate per nucleotide in humans. *Genetics* 156: 297-304.
- Nanakorn, S., Honark, N., Ungpansattawong, S., Chaisiwamongkol, W., Maneesriwongul, W., Suwanwerakamtorn, R., Raksataya, S. and Chusilp, K. (2011). Fingerprint Pattern and Multiple Intelligence: a Preliminary Study. *KKU Science Journal*. 39(1): 105-112
- Oladipo, G. S., Sapira, M. K., Ekeke, O. N., Oyakhire, M., Chinwo, E., Apiafa, B. and Osogba, I. G. (2009). Dermatoglyphics of prostate cancer patients. *Current Research Journal of Biological Sciences* 1(3): 131-134
- Plomin, R. and Spinath, F.M. (2002). Genetics and general cognitive ability (g). *Trends in Cognitive Science* 6: 169-176.
- Rosa, A., Gutierrez, B., Guerra, A., Arias, B. and Fananas, L. (2001). Dermatoglyphics and abnormal palmar flexion creases as markers of early prenatal stress in children with idiopathic intellectual disability. *Intellectual disability research* 45: 416-423.
- Sardool, S. (2005). Dermatoglyphics of schizophrenics, patients with down's syndrome and mentally retarded males as compared with Australian Europeans using multivariate statistics. *American Journal of Physical Anthropology* 42(2):237 – 240
- Seema, M. A., Gandhi, D. and Singh, M. (2012). Dermatoglyphics - Study and Review of literature. *Novel Science. International Journal of Medical Science* 1(6): 191-198
- Tirosh E, Jaffe M, Dar H. (1987). The clinical significance of multiple hair whorls and their association with unusual dermatoglyphics and dysmorphic features in mentally retarded Israeli children. *European Journal of Pediatric* 146(6):568-70.
- Tornjova-Randelova, S. G. (1994). Some aspects on the dermatoglyphics of normal and defective children in Bulgaria. *Anthropology* 52(4):351-5.
- Universal basic education commission of Nigeria (2013). <http://ubeconline.com/index2.html>. Accessed on 13-01-2013
- Weinstein, D. D., Diforio, D., Schiffman, J., Walker, E. and Bonsall, R. (1999). Minor physical anomalies, dermato-glyphic asymmetries and cortisol levels in adolescents with schizotypal personality disorder. *American Journal of Psychiatric* 156(4):617- 23.