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RESEARCH ARTICLE

DERMATOGLYPHIC BIOMARKERS & FUNCTIONAL HANDEDNESS IN MULTIPLE INTELLIGENCE: A UNIVERSITY BASED CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Recent progress has linked Dermatoglyphics with the Psycho-physiologic aspects of mental dimensions, thus being able to compare intellectual capacities of distinct groups. The current study expounded this linkage between the Dermatoglyphic parameters, handedness, and multiple intelligence scores.
Materials & Methods: The study followed a cross-sectional, random, and stratified cluster sampling procedure to select 100 sex matched students from each of the major colleges at the university. Multiple intelligences were based on Howard Gardner's model, while handedness assessment was based on the Waterloo Handedness Inventory.
Results: The current analysis has revealed that intelligence and fingerprint patterns are correlated, especially with patterns on the right middle fingers, left thumbs, left middle, and left ring fingers. In particular, linguistic intelligence was associated with loop patterns, musical intelligence with whorls, spatial/visual intelligence with arches, interpersonal intelligence with whorls, and total multiple intelligence with whorl patterns. Further studies involving higher sample sizes are recommended in order to come to more conclusive deductions.

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INTRODUCTION

The Multiple Intelligence Concept

One of the most commonly accepted and agreed upon definitions of intelligence is given as: "... a very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience" (Gottfredson 1997; Legg & Hutter 2006). Human intelligence is governed by a cumulative additive effect of multiple polymorphic genes sensitive to mutations and/or chromosomal disorders, with heritability indices ranging from 0.45 to 0.85 (Gottfredson 1997; Dickens and Flynn, 2001). Several contemporary theories have been described to encompass the broad scope of intelligence, in trying to practically link its definition with the actual mental capability of the individual.

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Thereof, such concepts as the general intelligence theory, or the g-factor, and multiple intelligence theories have been forwarded. The Multiple Intelligence Theory was proposed by Howard Gardner in 1983 to define the concept of intelligence. This theory extends traditional notions of the giftedness by defining various classes of intelligence (Table 1), namely: linguistic, musical, logical/mathematical, visual/spatial, bodily/kinaesthetic, intrapersonal, and interpersonal (Gardner, 1999).

Dermatoglyphics & Handedness in Intelligence: an overview

Recent progress has linked Dermatoglyphics with various aspects of human mental dimensions, thus being able to compare intellectual capacities of distinct groups of individuals. Distinguishing Dermatoglyphic manifestations related to innate intelligence has been a topic of research since its proposition in the 1820's (Parker 1971; Cesarik *et al*., 1996; Najafi 2009; Adekoya *et al*., 2013; Kumari *et al*., 2014; Offei *et al*., 2014; Rishi & Sharma 2014; Valdez & Pathak 2014). Plausible models forwarded to explain underlying mechanisms

linking Dermatoglyphics to intelligence predominantly attribute such correlations to the parallel neo-cortex (brain) & volar-development (parallel prenatal time frames), as well as the common ectodermal origins of both the brain and the volar pads from which Dermatoglyphics arise (Cesarik *et al*., 1996; Najafi 2009; Adekoya *et al*., 2013; Kumari *et al*., 2014; Offei *et al*., 2014; Valdez & Pathak 2014). Further, research has also revealed parallel differences in Dermatoglyphics in intellectually disabled (mentally retarded) groups (Rosa *et al*., 2001). Such models systematically integrate genetics, embryology, Dermatoglyphics and neural sciences with the multiple intelligence concepts.

Table 1. The seven classes of the Multiple Intelligence Model with their descriptive

Intelligence	Description
Linguistic	Smart in words & language (writing & speaking skills)
Logical - mathematical	Smart in logical thinking (detecting patterns, scientific reasoning, inferring deduction) and mathematical calculations
Musical	Smart in musical ability and recognition of tonal and rhythmic patterns
Bodily - Kinesthetic	Sports smart (physical agility)
Spatial - Visual	Interpretation and creation of visual images
Interpersonal	Perception of other people's feelings and a good ability to relate to others
Intrapersonal	Smart in self-awareness

The current report summarizes the findings of a university based cross sectional study done to analyze the polymorphisms of Dermatoglyphics & handedness with respect to multiple intelligences from a sample of students recruited from the University of Jigjiga, Ethiopia.

MATERIALS AND METHODS

Study Design

The study was conducted at the Jigjiga University, Jigjiga, Ethiopia from April to June 2015. The study followed a standard population descriptive clustered cross-sectional sampling methodology employed to sample to sample 100 sex matched Ethiopian students (50 males & 50 females) from the major colleges within the university.

Ethical Considerations

The study protocols were approved by the CNCS department of biology. The selected participants explained of the purpose, procedures, details, importance, and outcomes of the study. They were further explained that participation was fully voluntary, and that they had a full right to withdraw from the study at any time they pleased without any constraints. Strict confidentiality of all the personal data was also assured. All participants were aged 18 years and above. Prior to participation, the participants were formally asked to sign a consent form.

Dermatoglyphic Data

Fingerprints were obtained by employing the standard ink-and-paper method using high quality forensic ink, and the patterns were classified according to the standard Henry classification scheme into 3 types: Arches, Loops, & Whorls (Cummins & Midlo 1961). A questionnaire was further employed, which included items that asked for the presence of certain disorders in the participant or any of his/her close blood relatives, including those such as diabetes & schizophrenia, which have their own impact on Dermatoglyphic variations. Thus, data from such individuals were excluded from the final analysis.

Multiple Intelligence

The multiple intelligence section was based on Howard Gardner's MI model (Gardner, 1999), which included 70 items with a 1-4 scale of agreement for each item to be answered by the individual (1 = Mostly Disagree, 2 = Slightly Disagree, 3 = Slightly Agree, 4 = Mostly Agree). The test includes ten items each for the 7 intelligence categories.

Functional Handedness

The handedness section was based on the Waterloo Handedness Inventory (Steenhuis and Bryden, 1989), which included 32 items describing hand preferences of the individual on common day to day activities. It has a 1-5 scale for each item with 1= left always, 2= left usually, 3= equal (no preference), 4= right usually, and 5= right always. The questionnaire also included 2 miscellaneous items which assessed the if the individual's handedness is biased by culture, upbringing, or injury (if the person changed hand preference due to training or due to an injury that has forced the individual to prefer a specific hand). Data from individuals responding yes to these two items were excluded from the final analysis.

Data entry & analysis

Multiple intelligence scores were assessed according to the standard procedures (Gardner 1999), following which, the scores were standardized. As to the waterloo handedness inventory results, each item was scored in the range of -100 to +100 based on the respondent's selection, with 1 (left always) corresponding to -100, 2 scoring -50, 3 taken as 0, 4 considered as +50, and 5 scored as +100. The sum total of these was converted into standard laterality quotient. Individuals were classified into handedness categories using the cut-points standardized by Barnett and Corballis (2002). Accordingly, individuals with a laterality index between -100 and -28 were classified as left-handed, those between -28 and 28 were classified as mixed-handed, those from 28 to 46 were classified as weak right-handers, those from 46 to 64 as medium right-handers, those from 64 to 82 as strong right-handers, and those from 82 to100 as extreme right-handers.

Data was exported to SPSS version 16 for analysis. Analysis of Variance (One-Way ANOVA) at 95% confidence interval & significance level of $p=0.05$ was employed to assess the overall significance of the associations between the multiple intelligences, handedness classes, and pattern scores. Once a significant F value was observed, specific Post-Hoc tests (comparisons) were selected & employed following the standard procedure of testing the homogeneity of variance via the Levene Statistics (Olejnik *et al*., 1997).

RESULTS

Multiple Intelligence

The standardized score means & standard deviations of the intelligence classes & total MI are given in Table 2. For the study population, the highest form of intelligence is the intrapersonal intelligence (72.9 ± 11.77), followed by interpersonal intelligence (71.65 ± 13.89). In contrast, the lowest type of intelligence was musical intelligence (63.51 ± 16.52).

Table 2. Standardized score (out of 100) ranges, means and standard deviations (S.D.) of the intelligence classes & total MI

Intelligence Type	Min.	Max.	Mean	S.D.
Linguistic	42	100	69.76	11.869
Logical/Mathematical	42	95	69.10	9.932
Musical	25	98	63.51	16.519
Bodily/Kinesthetic	32	95	68.56	11.922
Spatial/Visual	50	90	68.88	10.263
Interpersonal	35	98	71.65	13.886
Intrapersonal	48	98	72.90	11.768
Total Multiple Intelligence	44	88	69.19	8.543

Fingerprint Pattern Distribution

Data from a total of 94 subjects was found to be complete & eligible (excluding 6 in which individual/familial disorders were recorded, as well as those with changed hand preferences). The distribution of fingerprint patterns is depicted in Table 3. The ulnar loops, whorls, arches, & radial loops were distributed in order of descending frequencies among the study population. Males scored higher for all fingerprint types except radial loops, which were more frequent among females.

Table 3. Fingerprint pattern frequencies and percentages for the study population

Gender	Loop			Whorl	Arch
	Radial	Ulnar	Total		
Male	4	294	298	187	35
	(0.77%)	(56.54%)	(57.31%)	(35.96%)	(6.73%)
Female	13	221	234	175	11
	(3.10%)	(52.62%)	(55.71%)	(41.67%)	(2.62%)
Total	17	515	532	362	46
	(1.81%)	(54.79%)	(56.60%)	(38.51%)	(4.89%)

Pattern Distribution in Multiple Intelligence

As can be summarized from Tables 4-11, Logical/ Mathematical, Bodily/Kinesthetic, and Intrapersonal intelligences failed to return any association with fingerprint patterns from both the right and left hand fingers. Further, there lies no relation between the intelligences & fingerprint distributions among the fingers of the right hand except for Interpersonal intelligence, which recorded a significant relationship with the fingerprint pattern types on the right middle finger.

On the left hands, it was recorded that linguistic intelligence was significantly associated with the thumb patterns, while musical intelligence was significantly associated with patterns on the thumb, index, middle, and the little fingers. Spatial/Visual intelligence was further found to be linked to the left ring fingers, while interpersonal intelligence recorded significant linkage with the pattern distributions on the right middle, left index, left middle, and the left index fingers. Finally, the total averaged multiple intelligence scores were found to be associated with the fingerprint patterns on the left index and left middle fingers.

Table 4. ANOVA results depicting mean square differences, F-statistics, & p-values for the group comparisons of linguistic intelligence & fingerprint patterns on all 10 fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Linguistic	Right Thumb	15.4940	0.6850	0.4100
	Right Index Finger	14.1650	0.6230	0.5380
	Right Middle Finger	38.5170	1.7360	0.1820
	Right Ring Finger	11.6710	0.5120	0.6010
	Right Little Finger	0.9490	0.0420	0.8390
	Left Thumb	83.0830	3.9170	0.0230*
	Left Index Finger	4.1020	0.1790	0.8370
	Left Middle Finger	7.9810	0.3490	0.7060
	Left Ring Finger	38.5060	1.7350	0.1820
	Left Little Finger	6.3570	0.2780	0.7580

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Table 5. ANOVA results depicting the mean square differences, F-statistics, and p-values for the group comparisons of logical/mathematical intelligence & fingerprints on all 10 fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Logical/ Mathematical	Right Thumb	0.0300	0.0020	0.9660
	Right Index Finger	44.4860	2.9360	0.0580
	Right Middle Finger	38.9770	2.5520	0.0830
	Right Ring Finger	4.9740	0.3110	0.7340
	Right Little Finger	11.6400	0.7350	0.3930
	Left Thumb	30.5320	1.9750	0.1450
	Left Index Finger	28.8790	1.8640	0.1610
	Left Middle Finger	12.6840	0.8000	0.4520
	Left Ring Finger	38.6560	2.5300	0.0850
	Left Little Finger	2.2200	0.1380	0.8710

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Table 6. ANOVA results depicting mean square differences, F-statistics, and p-values for group comparisons of musical intelligence & fingerprint patterns on the fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Musical	Right Thumb	14.9250	0.3390	0.5620
	Right Index Finger	10.9260	0.2460	0.7820
	Right Middle Finger	66.0000	1.5290	0.2220
	Right Ring Finger	13.1090	0.2960	0.7450
	Right Little Finger	41.8420	0.9580	0.3300
	Left Thumb	146.5990	3.5410	0.0330*
	Left Index Finger	176.9810	4.3450	0.0160*
	Left Middle Finger	131.1610	3.1420	0.0480*
	Left Ring Finger	56.8310	1.3100	0.2750
	Left Little Finger	137.0050	3.2930	0.0420*

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Table 7. ANOVA results depicting the mean square differences, F-statistics, and p-values for the group comparisons of Bodily/Kinesthetic intelligence & fingerprints on all 10 fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Bodily/ Kinaesthetic	Right Thumb	0.0910	0.0040	0.9500
	Right Index Finger	24.5340	1.0810	0.3440
	Right Middle Finger	10.0220	0.4350	0.6480
	Right Ring Finger	16.9110	0.7390	0.4800
	Right Little Finger	0.1870	0.0080	0.9280
	Left Thumb	19.8620	0.8710	0.4220
	Left Index Finger	34.8430	1.5500	0.2180
	Left Middle Finger	21.2350	0.9320	0.3970
	Left Ring Finger	16.7180	0.7310	0.4840
	Left Little Finger	2.9970	0.1290	0.8790

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Table 8. ANOVA results depicting the mean square differences, F-statistics, and p-values for the group comparisons of Spatial/Visual intelligence & fingerprints on all 10 fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Spatial /Visual	Right Thumb	4.9350	0.2910	0.5910
	Right Index Finger	10.7070	0.6300	0.5350
	Right Middle Finger	36.8090	2.2430	0.1120
	Right Ring Finger	5.9020	0.3450	0.7090
	Right Little Finger	0.3210	0.0190	0.8910
	Left Thumb	25.3810	1.5230	0.2240
	Left Index Finger	14.0590	0.8310	0.4390
	Left Middle Finger	34.4030	2.0890	0.1300
	Left Ring Finger	52.2390	3.2500	0.0430*
	Left Little Finger	6.4450	0.3770	0.6870

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Table 9. ANOVA results depicting the mean square differences, F-statistics, and p-values for group comparisons of Interpersonal intelligence & fingerprints on the fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Interpersonal	Right Thumb	117.1620	3.9170	0.0510
	Right Index Finger	71.7280	2.3950	0.0970
	Right Middle Finger	164.6090	5.8980	0.0040**
	Right Ring Finger	13.9680	0.4470	0.6410
	Right Little Finger	96.3920	3.1980	0.0770
	Left Thumb	15.7730	0.5060	0.6050
	Left Index Finger	160.4170	5.7290	0.0050**
	Left Middle Finger	156.3530	5.5660	0.0050**
	Left Ring Finger	73.2070	2.4470	0.0920
	Left Little Finger	57.1410	1.8880	0.1570

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Based on the 11 identified significant ANOVA results from 4 of 7 intelligence categories and also the total MI, the homogeneity of variance (HOV or Levene statistic) was initially assessed prior to post-hoc comparisons. Applying the appropriate post-hoc comparisons, the significant differences for each of the fingers with respect to the dependent variable (intelligence) type was estimated, depicted in Table 12.

Table 10. ANOVA results depicting the mean square differences, F-statistics, and p-values for group comparisons of Intrapersonal intelligence & fingerprint patterns on all 10 fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Intrapersonal	Right Thumb	14.7370	0.6630	0.4180
	Right Index Finger	9.0500	0.4030	0.6690
	Right Middle Finger	40.1460	1.8450	0.1640
	Right Ring Finger	40.9360	1.8830	0.1580
	Right Little Finger	1.0150	0.0450	0.8320
	Left Thumb	33.6580	1.5370	0.2210
	Left Index Finger	2.6170	0.1160	0.8910
	Left Middle Finger	57.8300	2.7060	0.0720
	Left Ring Finger	15.5510	0.6970	0.5010
	Left Little Finger	16.9410	0.7610	0.4700

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Table 11. ANOVA results depicting mean square differences, F-statistics, and p-values for the group comparisons of total multiple intelligence & fingerprint patterns on all 10 fingers

Intelligence Type	Finger	ANOVA Results		
		Mean Square Difference	F	p-value
Total MI	Right Thumb	85.7850	0.1490	0.7010
	Right Index Finger	639.5480	1.1210	0.3310
	Right Middle Finger	1535.2360	2.7860	0.0670
	Right Ring Finger	29.0740	0.0500	0.9510
	Right Little Finger	318.6520	0.5540	0.4580
	Left Thumb	154.1120	0.2650	0.7680
	Left Index Finger	1708.1600	3.1220	0.0490*
	Left Middle Finger	1793.7360	3.2890	0.0420*
	Left Ring Finger	1308.5200	2.3540	0.1010
	Left Little Finger	587.1640	1.0270	0.3620

* Significant at the 0.05 level; ** Significant at the 0.01 level; *** Significant at the 0.001 level

Based on the results of the homogeneity of variance test results as well as the post-hoc comparisons made (Table 12), the following important points can be summarized:

1) Individuals with higher Linguistic intelligence have frequently more loop than whorl patterns on their left thumbs.
2) Individuals with higher Musical intelligence have frequently more whorl patterns than loop patterns on their left thumbs, index, middle, and their little fingers.
3) Individuals with higher Spatial/Visual intelligence have frequently more loop patterns than arch patterns on their left ring fingers.
4) Individuals with higher Interpersonal intelligence have frequently more whorl patterns than loop patterns on their right middle fingers, left index fingers, and left middle fingers.
5) Individuals with higher average total multiple intelligences have frequently more whorl patterns than loop patterns on their left index and left middle fingers.

Multiple Intelligence & Handedness

The mean laterality indices of the handedness categories are given in Table 13. The results of ANOVA of the hand preference in multiple intelligences, as depicted in Table 14, show that there lies no significant association between these variables.

Table 12. Post-hoc comparison results

Intelligence	Finger	HOV**	Post Hoc Comparison			
		p-value	Method	Patterns (I Vs J)	M (I-J)***	P
Linguistic	L. Thumb	0.872	Bonferroni	Loop Vs Whorl	2.550*	0.028
Musical	L. Thumb	0.539	Bonferroni	Loop Vs Whorl	-3.430*	0.037
	L. Index Finger	0.364	Bonferroni	Loop Vs Whorl	-3.464*	0.045
	L. Middle Finger	0.378	LSD	Loop Vs Whorl	-3.823*	0.020
	L. Little Finger	0.453	LSD	Loop Vs Whorl	-3.504*	0.023
Spatial/Visual	L. Ring Finger	0.512	Bonferroni	Arch Vs Loop	-4.823*	0.037
Interpersonal	R. Middle Finger	0.030	Tamhane's T2	Loop Vs Whorl	-4.412*	0.002
	L. Index Finger	0.495	Bonferroni	Loop Vs Whorl	-3.846*	0.004
	L. Middle Finger	0.530	Bonferroni	Loop Vs Whorl	-4.248*	0.006
Total MI	L. Index Finger	0.284	LSD	Loop Vs Whorl	-11.266*	0.030
	L. Middle Finger	0.107	LSD	Loop Vs Whorl	-14.992*	0.012

* The mean difference is significant at the 0.05 level
** Homogeneity of variance (Levene Statistics)
*** Mean Difference

Table 13. Mean laterality Quotients of the handedness categories

Variable	Left	Mixed	Weak-Right	Medium-Right	Strong-Right	Extreme-Right
Mean Laterality Quotient	-56.25	15.11	37.79	56.69	71.49	91.21

Table 14. ANOVA results depicting the p-values for the group comparisons of multiple intelligences & handedness categories

Intelligence Type	Left	Mixed	Weak-Right	Medium-Right	Strong-Right	Extreme-Right	ANOVA p-Values
Total Multiple Intelligence	60.36	69.25	69.49	69.59	70.98	64.73	0.783
Linguistic	50	68.7	71.31	70	72.5	65.62	0.415
Logical/Mathematical	65	70.09	68.45	70.71	68.28	65.31	0.745
Musical	60	68.33	60	61.55	66.25	56.56	0.68
Bodily/Kinaesthetic	57.5	66.39	69.17	68.93	73.59	64.69	0.412
Spatial/Visual	57.5	68.15	69.29	66.9	73.75	67.19	0.731
Interpersonal	67.5	72.5	73.57	73.69	68.12	65.94	0.954
Intrapersonal	65	70.56	74.64	75.36	74.38	67.81	0.776

DISCUSSION

The fingerprint pattern distribution for the study population was found to be in agreement with the expectations based on the findings of another study done from another part of the same country (Yohannes & Bekele 2015). Apart from that, the current analysis has revealed that intelligence and fingerprint patterns are correlated, especially for patterns on the left hand fingers. This is in concordance with earlier reports such as Adekoya *et al*. (2013), Cesarik *et al*. (1996), and Offei *et al*. (2014). The specific fingers associated with the intelligences have been narrowed down to the right middle fingers, left thumbs, left middle, and left ring fingers. In particular, the association found on the left index fingers is very significant statistically. This has been highlighted by previous reports of Najifi (2009), who ascertained a very strong genetic linkage between intelligence quotients and the left index finger quantitative or qualitative parameters.

In contrast, no significant association between multiple intelligences & handedness patterns have been found. This could possibly be due to low sample sizes, or due to the cultural & religious influences prevalent in the country, with a common tradition of parents training their siblings early during childhood to prefer the right hand instead of the left one for various daily activities including eating, as evidenced by the fact that the frequency of left handed individuals in the sample was less than 15%.

Conclusion

It has been observed that linguistic intelligence is associated with loop patterns on the left thumbs, musical intelligence with whorl on the left thumb, index, middle, and little fingers, spatial/visual intelligence with arch patterns left ring fingers, interpersonal intelligence with whorl on the right middle, left index, and left middle fingers, while the total multiple intelligence was associated with whorl patterns on the left index and left middle fingers. We recommend that further studies involving higher sample sizes to be undertaken in order to come to conclusive deductions.

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