

## Association between Finger Patterns of Digit II and Intelligence Quotient Level in Adolescents

Mostaf Najafi, MD

Department of Psychiatry, Shahrekord University of Medical Sciences, Shahrekord, IR Iran

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### Abstract

**Objective:** This study aimed at assessing the putative association between the fingertip patterns of right and left digits II and intellectual functioning.

**Methods:** The study involves the evaluation of dermatoglyphic patterns on right and left digits II in 342 adolescents (144 talented ones, 102 normal individuals and 96 subjects with learning disabilities) from the Shahrekord city in Iran. Comparisons between the frequencies of fingerprint patterns of each digit were made on the basis of two groups at a time employing Chi-square test.

**Findings:** The most frequent dermatoglyphic pattern was whorl on both fingers in the 3 groups. An observation of right digit II revealed that the normal adolescents in comparison to the talented ones had a greater number of the whorl patterns ( $P=0.02$ ), while the latter had more ulnar loops than the former ( $P=0.09$ ). Group comprising those with learning disabilities had more ulnar loops than the group composed of the normal adolescents ( $P=0.09$ ), and there was a predominance of radial loops among the talented subjects as opposed to those among the individuals with learning disabilities ( $P=0.002$ ). There was no significant association in the relative frequencies of different finger patterns on left digit II between the groups ( $P>0.05$ ).

**Conclusion:** Our results support an association between some dermatoglyphic patterns observed on right digit II with IQ level in adolescents. Further researches, needless to say, especially employing various quantitative dermatoglyphic indices and larger-sized samples are recommended.

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**Key Words:** Dermatoglyphic patterns; Fingerprints; Second digits; IQ level; Intelligence quotient; Adolescents

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#### \* Corresponding Author;

**Address:** Behavioral Sciences Research Center, Isfahan University of Medical Science, Isfahan, Iran

**E-mail:** najafimostafa@gmail.com

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## Introduction

Intelligence quotient (IQ) level has a very significant effect on individuals and on society. Individuals with low IQ level will have difficulties in thinking, acquisition and processing of new information and knowledge, hence their requiring additional care, education and medical services. In some cases, affected individuals will never achieve personal independence, and the need for care will persist throughout their lifetime. This condition is more than 50% prenatal in origin [1].

Dermatoglyphics (finger prints), also known as "epidermal ridge configurations" are the characteristics of the ridged skin on the fingertips, palms, toes and soles of primates (including human beings) and some other mammals [2]. They consist of the alignment of the sweat glands' pores and are shaped in the first trimester of gestation (between the tenth and eighteenth weeks of gestation) [3]. Figure 1 illustrates the shapes of digital pattern types [4].

Dermal ridges complete their development in about the 16th week of fetal life [5]. After that they remain unchanged except for an increase in size in parallel with general growth [3]. Dermatoglyphic alterations may be the result of early prenatal disturbances, which are thought to be implicated in the etiology of learning disabilities. Some previous studies by Rosa et al [6], Chakraborty et al [7], Weinstein et al [8], Cvjeticanin et al [9], Gutierrez et al [10],

Tornjova [11], Mavaluava and Tysiaczny [12], Tirosh [13], Kodama [14], Hartin and Barry [15], Tay [16], Dar [17], Kharitonov [18] and finally Bandyopadhyay [19] have demonstrated that dermatoglyphics may offer us new insights into mental characteristics. Table 1 presents a summary of the previous researches. To sum up, this study sought to study the putative correlation of digital dermatoglyphic patterns with IQ level.

## Subjects and Methods

**Study Sample:** To carry out this anthropological study, we utilized cluster sampling method and randomly selected 342 adolescents from schools for talented students (n=101), those for normal adolescents (n=146) and the ones for individuals with learning disabilities (n=95) in the Shahrekord city, Iran in the year 2002.

**Group definition:** Individuals were divided into 3 groups with different IQ level. The task was performed using Raven's Progressive Matrices, a non verbal intelligence and executive function test, whose validity has been previously confirmed [20]. Higher scores indicate higher IQ in subjects. Individuals who had IQ scores above 120, 70-120 and below 70 were considered as group 1 (talented individuals), group 2 (normal adolescents) and group 3 (subjects with learning disabilities), respectively.



Fig 1: Shapes of digital pattern types

**Table 1:** A summary of previous researches investigating dermatoglyphic in some mental or psychological statuses

| subjects                                                                                   | Dermatoglyphic variables                                                                                                                                                                                                        | result                                                                                                                                                                                                                                                         | Reference                    |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| Subjects with idiopathic learning disabilities                                             | ****                                                                                                                                                                                                                            | ****                                                                                                                                                                                                                                                           | Rosa et al 2001              |
| Subjects with bipolar mood disorder, controls                                              | Epidermal ridges and the patterns formed by them were studied.                                                                                                                                                                  | The radial loops increased in bipolar mood disorder                                                                                                                                                                                                            | Chakraborty et al 2001       |
| Subjects with schizotypal personality disorder or other personality disorders and controls | ****                                                                                                                                                                                                                            | The group with schizotypal personality disorder showed more dermatoglyphic asymmetries than the normal comparison group.                                                                                                                                       | Weinstein et al 1999         |
| Children with central nervous system lesion and controls                                   | Eighteen variables of epidermal ridge count were examined: ten on the fingers of the either hand, and four on either palm, and on a-b, b-c and c-d triradii, at atd angle.                                                      | Statistically significant differences were found for five variables in the group of patients with severe lesion, ie on the second finger of the right hand, between a-b and b-c triradii of the right palm, and between a-b and c-d triradii of the left palm. | Cvjeticanin et al 1999       |
| Patients with chronic bipolar illness and controls                                         | Assessment of congenital Dermatoglyphic malformations (ridge dissociation (RD), abnormal features (AF)), two metric dermatoglyphic traits [total finger ridge count (TFRC) and total a-b ridge count (TABRC)] were carried out. | Bipolar cases showed a significant predominance of RD and AF when compared with controls                                                                                                                                                                       | Gutierrez et al 1998         |
| Children with visual, auditory or mental insufficiencies and controls                      | Relative frequencies of the pattern types on the digits were recorded.                                                                                                                                                          | Significant differences were observed in the relative frequencies of the pattern types on the second and fourth digits.                                                                                                                                        | Tornjova 1994                |
| ****                                                                                       | ****                                                                                                                                                                                                                            | ****                                                                                                                                                                                                                                                           | Mavaluava & Tysiaczny (1991) |
| Mentally retarded subjects                                                                 | ****                                                                                                                                                                                                                            | A statistically significant relationship was demonstrated between unusual dermatoglyphics and mental retardation, multiple hair whorls and more than two dysmorphic features.                                                                                  | Tivosh 1987                  |
| Patients with severe mental and physical handicaps and controls                            | Several dermatoglyphic characteristics, including simian creases, fingertip patterns, mean a-b ridge count, thenar/first interdigital pattern, hypothenar pattern and hallucal pattern were observed.                           | The incidence of inv (9) (p11q13) in the patients was 4.2 times higher than that in the general Japanese population.                                                                                                                                           | Kodama 1982                  |
| Autistic children, retarded children and normal children                                   | The distribution of dermal patterns and ridge line disruption were studied and a total mean ridge count was performed.                                                                                                          | Significant differences were found between the autistic and normal children in the distribution of dermal patterns and ridge line disruption.                                                                                                                  | Hartin and Barry 1979        |
| Subjects suffering from febrile convulsion                                                 | ****                                                                                                                                                                                                                            | ****                                                                                                                                                                                                                                                           | Tay 1979                     |
| Children with psychomotor retardation and controls                                         | A dermatoglyphic and palmar crease analysis was carried out.                                                                                                                                                                    | Certain unusual features were found to be twice as common in the retarded children                                                                                                                                                                             | Dar et al. 1978              |
| Patients with seizure                                                                      | ****                                                                                                                                                                                                                            | There were more transversal sulci but less symmetry in digital patterns in the group comprising epileptic patients compared to that composed of normal individuals.                                                                                            | Kharitonov et al 1978        |
| Mentally retarded subjects                                                                 | ****                                                                                                                                                                                                                            | ****                                                                                                                                                                                                                                                           | Bandyopad-<br>yay 1969       |

**Dermatoglyphic patterns:** The different steps taken in order to obtain fingerprints were as follows: first, both hands were cleaned with alcohol (98° GL), and then a 2:1 mixture of glycerin and ink was applied to the tip of the right and left digits. Any excess of ink was avoided. Finally, the impressions were collected on writing paper.

The digital dermatoglyphics were categorized as: arches, radial loops, ulnar loops and whorls. This standard classification was based upon Cummins and Midlo<sup>[21]</sup>. We analyzed the finger patterns of digit II in view of the fact that Cvjeticanin et al<sup>[9]</sup> and Tornjova et al<sup>[11]</sup> recommended digit II as the best finger for dermatoglyphic studies for the detection of any association between fingerprints and mental statuses (Table 1).

While different observers were recruited in some previous studies<sup>[22,23,24]</sup>, the prints were analyzed by a single observer in our study so as to avoid inter-observer variation. All the assessments were carried out at the schools where the subjects were studying. The examiner of the fingerprints was the staff of fingerprint department of Shahrekord branch of the Iranian Police Academy. He was blind to the intellectual functioning of the participants.

**Sample size:** Sample size of 273 adolescents (91 in each group) seemed to be sufficient to detect a difference of 20% between groups in the relative frequency of each finger pattern with 80% power and a 5% significance level, by using the formula for the sample size for comparison of 2 proportions.

**Statistical Analysis:** In order to compare the relative frequencies of the fingerprints of the right and left digits, we conducted a cross tab and Chi-square test between the relative frequencies of each pattern among the members of the groups on the basis of two

groups being compared to each other at a time. The analysis was carried out with the statistical package SPSS for windows.

## Findings

**Participants:** Drawing on the results of Raven's Progressive Matrices, we categorized 144, 102 and 96 adolescents as talented subjects, normal individuals and those with learning disabilities respectively. The distribution of age and sex is presented in table 2, and the IQ levels of the subjects at different sampling locations are demonstrated in table 3.

**Digital Pattern Types:** Table 4 presents the relative frequencies of digital patterns on right and left digits II between the 3 groups. The range of variation was from 4% to 13.5% for arches; from 0.5% to 13.2% for radial loops; from 26.4% to 47.2% for ulnar loops and from 40.2% to 54.9% for whorls. The most frequent dermatoglyphic pattern in the 3 groups was whorl on both right and left fingers.

A close study of right digit II revealed that the normal adolescents in comparison with the talented ones possessed a greater number of the whorl patterns ( $P=0.02$ ), whereas the latter had more ulnar loops than the former ( $P>0.05$ ). Another comparison between the group comprising subjects with learning disabilities and that composed of the normal adolescents yielded the same difference ( $P>0.05$ ), and there was a predominance of radial loops among the talented subjects when contrasted to those among the ones with learning disabilities ( $P=0.002$ ). There was no significant association between the relative

**Table 2:** Sex and age distribution of the 3 groups

|                       | Group 1    | Group 2    | Group 3    |
|-----------------------|------------|------------|------------|
| Male (%)*             | 49 (34)    | 50 (49)    | 76 (77.6)  |
| Mean age ( $\pm$ SD)* | 13.1 (0.7) | 13.2 (0.7) | 12.4 (1.5) |

\* There is a significant difference between sex and age in groups.

**Table 3:** IQ levels of subjects at different sampling locations

|                                                    | IQ level |         |     | Total |
|----------------------------------------------------|----------|---------|-----|-------|
|                                                    | >120     | 70 -120 | <70 |       |
| Schools for talented adolescents                   | 94       | 7       | 0   | 101   |
| Schools for normal adolescents                     | 50       | 95      | 1   | 146   |
| Schools for adolescents with learning difficulties | 0        | 0       | 95  | 95    |
| Total                                              | 144      | 102     | 96  | 342   |

frequencies of different finger patterns on left digit II between the groups ( $P>0.05$ ), nor was there any significant association between the frequencies of each pattern among the males and females ( $P>0.05$ ) as determined by Chi-square test.

## Discussion

"Lack of any correlation between fingerprint and intelligence" was the null hypothesis of our study. As a result, this study sought to rule out the hypothesis by detecting differences between the relative frequencies of finger patterns between the 3 groups of adolescents enjoying different levels of IQ. Support for this correlation came from the observations that a significant proportion of learning difficulties is

the concomitant of trisomy 21 (Down syndrome), Fragile X syndrome, other chromosomal disorders such as Angelman syndrome (15q 11.2-12), Prader Willi syndrome (15q1-13) and Cri-du-Chat syndrome (5p-) and finally some other X linked syndromes like Coffin-Lowry syndrome<sup>[1]</sup>. Some of the above-mentioned syndromes have been recognized as having abnormal dermatoglyphic characteristics.

The dermal ridges are thought to be related to fetal development<sup>[25]</sup>, which in part includes the development of the central nervous system. Furthermore, during fetal development, dermal ridges are influenced by such factors as maternal psychological stress, anticonvulsants<sup>[26]</sup> or alcohol<sup>[27]</sup> ingested by the pregnant mother. Therefore, it can be concluded that dermatoglyphic may be different in adolescents with various IQ level.

**Table 4:** Number (%) of finger patterns on right and left second digits II

|                    | Whorls<br>No (%) |              | Ulnar loops<br>No (%) |              | Radial loops<br>No (%) |              | Arches<br>No (%) |              |
|--------------------|------------------|--------------|-----------------------|--------------|------------------------|--------------|------------------|--------------|
|                    | Right            | Left         | Right                 | Left         | Right                  | Left         | Right            | Left         |
| Group 1<br>(n=144) | 58<br>(40.3)*    | 66<br>(45.8) | 53<br>(36.8)          | 41<br>(28.5) | 19<br>(13.2)           | 15<br>(10.4) | 14<br>(9.7)      | 22<br>(15.3) |
| Group 2<br>(n=102) | 56<br>(54.9)     | 44<br>(43.1) | 27<br>(26.5)          | 33<br>(32.3) | 8<br>(7.8)‡            | 13<br>(12.7) | 11<br>(10.7)     | 12<br>(11.7) |
| Group 3<br>(n=96)  | 45<br>(46.9)     | 39<br>(40.6) | 36<br>(37.5)          | 33<br>(34.4) | 2<br>(2.1)             | 6<br>(6.2)   | 13<br>(13.5)     | 18<br>(18.8) |

\*  $\chi^2$  test ( $P=0.02$ )

‡ Fisher's exact test ( $P=0.002$ )

In our study, the most frequent dermatoglyphic patterns seen on different fingers were ulnar loop and whorl. Despite the fact that the frequencies of the digital patterns in the normal population as established by various studies differ around the world, it has also been reported that ulnar loops and whorls are the most common finger patterns<sup>[28]</sup>, which confirms the results of our study.

Much as the dermatoglyphic patterns on various fingers are widely different in our study, they keep the likely pattern distribution on the same fingers between the 3 groups. A correlation between dermato-glyphics and mental statuses has already been reported<sup>[6,9,11-15,17,19]</sup>. Our results support an association between some dermato-glyphic patterns seen on the right digit II with IQ level. Tornjova-Randelova<sup>[11]</sup> also reported a significant difference in the relative frequencies of pattern types on the second and fourth digits among children with visual, auditory and mental insufficiency and controls. The authors suggested that the restriction of this association to these two digits could be related to the differing evolutionary histories of the different digits and differences in their innervations. Another study demonstrated the importance of abnormal dermato-glyphics as the marker of prenatal disturbance in learning difficulties of unknown etiology. Increased arches, a simple fingerprint pattern, and increased radial loops, an unusual pattern, have been found in children, particularly boys, with learning difficulties more commonly than in healthy controls. A significant increase in abnormal flexion creases has also been identified in individuals with learning difficulties. It has been previously concluded that some fingerprints are indelible markers of impaired fetal development at different stages of pregnancy<sup>[1]</sup>.

Kodama showed significant differences in several dermatoglyphic characteristics, including simian creases, fingertip patterns, mean a-b ridge count, thenar/first interdigital patterns, hypothenar patterns and hallucal patterns in severely handicapped patients in

comparison to healthy subjects<sup>[14]</sup>. Although an association between dermatoglyphics and some mental statuses are reported, the traits and methods used have varied widely among investigators<sup>[9,11-14,17]</sup>. Such methodological variations may produce results that cannot be appropriately compared with one another and those in our study. Table 1 presents a summary of previous studies. In some cases, subtle abnormalities in fingerprints have been reported to be the only indicator of the cause of the learning disability<sup>[1,28]</sup>. In order to prevent the development of risk symptoms in children with the presence of risk factors, Cvjeticanin and Polovina<sup>[9]</sup> recommended that palmar and fingerprints be taken in the immediate postnatal period. Another study concluded that unusual features might indicate an "at risk" infant if dermatography was performed during the routine examination of the newborn<sup>[17]</sup>. The results of that study testify a certain diagnostic and prognostic value of dermatoglyphic features.

Having drawn upon the above-mentioned results, we arrived at the conclusion that dermatoglyphics should be used in conjunction with the physical examination rather than as an independent diagnostic test.

The strength of our study in the analysis of fingerprints lies in the fact that it circumvents inter-observer variations by making use of a single researcher. Our study had some limitations. First this is the first attempt, to our knowledge, to assess the putative correlation between IQ and dermatoglyphics with the inclusion of talented individuals as a group. Secondly our results may still be biased on account of the small size of the samples.

Nevertheless, the sample size in our study was such that a slightly more than 10% difference in the relative frequency of each finger print was considered as significant.

Thirdly confirmation of any association between IQ and dermatoglyphics will be difficult, and the use of different indices as digital dermatographics (including various quantitative dermatographic indices) in further studies – especially with a focus on digit II – can confirm the hypothesis of this study more powerfully. Fourthly, many other

factors may have some effects on the fingerprint patterns; the differences detected in this study may be under influence of other factors such as maternal psychological stress which the authors did not control.

## Conclusion

Our results support an association between some dermatoglyphic patterns observed on right digit II with IQ level in adolescents. We need more studies with a group of students with learning difficulties (reading, writing and mathematics problems) using specific measures for learning disorders detection in future. Further researches, needless to say, especially employing various quantitative dermatoglyphic indices and larger-sized samples are recommended.

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