Fingerprinting through Genetics: A Review Article

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ABSTRACT

The workings of human genetics have always been a mystery to most, including scientists. In fact new relations with human genetics and everyday life are being discovered every day. This article reviews the research done to find a correlation between fingerprints and human genetics. Fingerprints have always been indicators of identity since everyone has a different fingerprint. This stays true when it comes to family members. The objective of the research is to find out if there is any correlation between human genetics and fingerprint patterns. The researcher hypothesizes that the genes passed down from parent to offspring help construct a unique fingerprint pattern.

Introduction

In order to go in depth of findings, the researcher first establishes what we know about fingerprints. Fingerprints are unique between people, including family members. Even, your closest relative has a different fingerprint pattern from you. For example, your identical twin's fingerprint will differ from yours. Along with that there are 3 different types of fingerprint patterns: loops, whorls, arches. Loops begin curving from the edge of the finger, to the middle, and then back around to the same edge. Whorls are circular ridges that start off large, but progressively get smaller as they reach the middle of the finger. Arches are hill/valley like curves that repeat uniformly from top to bottom.

The researcher's goal was to find a possible connection between human genetics and fingerprint patterns. In other words, finding similar fingerprint patterns throughout a single family. The researcher also wanted to find if fingerprint patterns would be more similar with closely related family members. The researchers hypothesized that human genetics plays a role for the creation of fingerprint patterns, and patterns increase in similarity between a pair of closely related family members.

Loops   Whorls   Arches
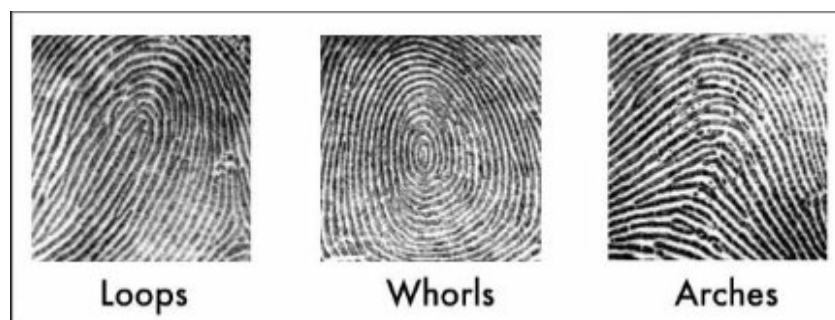
Methods & Materials

In order to prove the hypothesis, seven people, from one family, across three generations were tested. Each subject had fingerprints collected from both of their ring, and thumb fingers. In total, each subject gave 4 fingerprint copies. The fingerprints were collected from an ink filled ring that rolled across each finger. From there, each fingerprint was covered in ink, and would easily imprint on printer paper to observe the patterns. Each fingerprint was labeled according to the family member.

When observing the clearest sample would be used for observation under a microscope.The sample would be observed for different ridge features, to ultimately classify the type of fingerprint. However if multiple samples were eligible for examination, the dominant feature across the multiple samples, were used to classify the fingerprint.

To determine if fingerprint patterns appear more similar with genetically close relatives, three brothers were tested. Each brother gave their fingerprint sample using the same method. Since the ridges were tremendously small, the 1mm sheet was zoomed in until it reached 17mm. The ridges were always measured with the 17mm scale. To be classified as similar, there was a constant 1 mm boundary of error for each fingerprint. Additionally, a mm ruler was used to measure the outer and center ridges for each fingerprint.

Overall, the techniques used in the research were unique and practical for each subject. They had a small margin of error when measuring the ridges, and they used clever methods when multiple could be used. This allowed the results of the experiment to be as accurate and precise as possible.

Results

To display the results of finding a dominant fingerprint pattern, a pedigree was made. A pedigree is a model used to represent genetic traits passed down from generation to generation. Males are represented by squares, while females are represented by circles. From the pedigree above, 3 generations are represented, which each person labeled with their fingerprint patterns. From the pedigree, the researcher determined that the right loop trait was most dominant in the family. The trait commonly appeared on paternal and maternal sides of the family.

Another bar graph is shown to compare the average ridge measurements and features across the three brothers. As shown, very few differences were presented in ridge patterns. Student's T-tests and P-values were also shown to express the margin of difference. T tests are used to determine if the difference in data between multiple subjects is statistically significant. In other words, if you were to do the experiment a certain amount of times, how many times would you get the same margin of difference? For this experiment, a p value of 0.05 or 5% was calculated. This means that if the p value is under 0.05 when comparing ridge measurements, it is statistically significant. From the results, only 4 statistically significant t-tests appeared. This implies that there is little margin of difference between the fingerprint patterns across the three siblings.

Center Ridge Left Thumb vs. Central Ridge Right Thumb	Center Ridge Left Thumb vs. Central Ridge Left Ringfinger	Center Ridge Left Thumb vs. Central Ridge Right Ringfinger	Center Ridge Left Thumb vs. Outer Ridge Left Thumb	Center Ridge Left Thumb vs. Outer Ridge Right Thumb	Center Ridge Left Thumb vs. Outer Ridge Left Ringfinger	Center Ridge Left Thumb vs. Outer Ridge Right Ringfinger	Center Ridge Right Thumb vs. Center Ridge Left Ringfinger	Center Ridge Right Tumb vs. Central Ridge Right Ringfinger	Center Ridge Right Tumb vs. Outer Ridge Left Thumb
p-value 0.04	0.45	0.68	0.01	0.07	0.11	0.12	0.30	0.03	0.35
Statistically Significant Yes	No	No	Yes	No	No	No	No	Yes	No

Center Ridge Right Thumb vs. Central Ridge Right Thumb	Center Ridge Right Thumb vs. Central Ridge Left Ringfinger	Center Ridge Right Thumb vs. Central Ridge Right Ringfinger	Center Ridge Right Thumb vs. Outer Ridge Left Thumb	Center Ridge Right Thumb vs. Outer Ridge Right Thumb	Center Ridge Right Thumb vs. Outer Ridge Left Ringfinger	Center Ridge Right Thumb vs. Outer Ridge Right Ringfinger	Center Ridge Left Thumb vs. Center Ridge Left Ringfinger	Center Ridge Left Tumb vs. Central Ridge Right Ringfinger	Center Ridge Left Tumb vs. Outer Ridge Left Thumb
p-value 1.00	1.00	0.67	0.54	0.11	0.35	0.39	0.51	0.01	0.07
Statistically Significant No	No	No	No	No	No	No	No	Yes	No

Center Ridge Right Ringfinger vs. Outer-Ridge Left Ringfinger	Center Ridge Right Ringfinger vs. Outer-Ridge Ridge Ringfinger	Outer Ridge Left Thumb vs. Outer Ridge Right Thumb	Outer Ridge Left Thumb vs. Outer Ridge Left Ringfinger	Outer Ridge Left Thumb vs. Outer Ridge Right Ringfinger	Outer Ridge Right Thumb vs. Outer Ridge Left Ringfinger	Outer Ridge Right Thumb vs. Outer Ridge Right Ringfinger	Center Ridge Left Ringfinger vs. Outer Ridge Right Ringfinger
p-value 0.11	0.12	0.47	0.54	0.24	1.00	0.71	0.74
Statistically Significant No	No	No	No	No	No	No	No

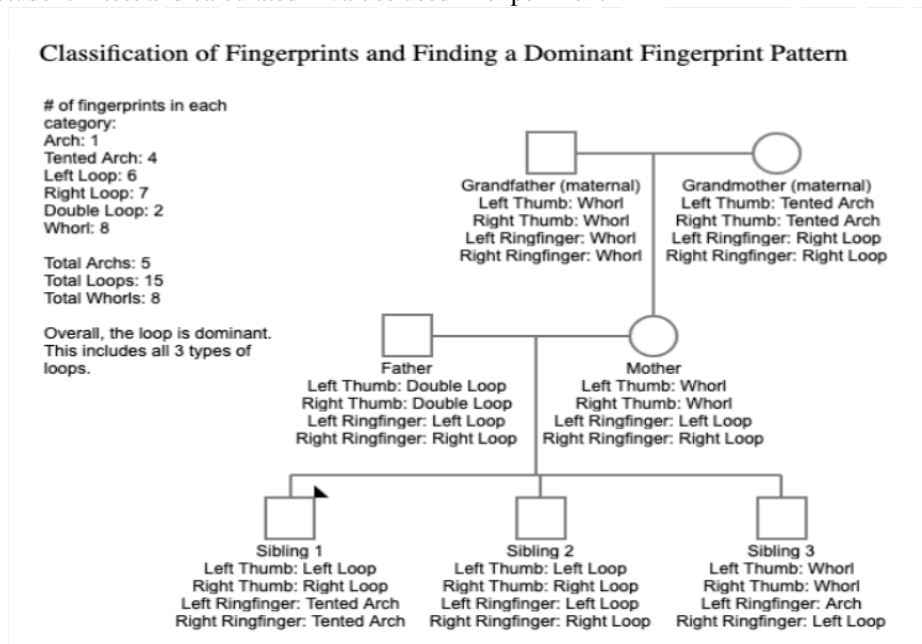**Figure 1.** Student T test and calculated P values used in experiment

Figure 2. Pedigree depicting passing of fingerprint traits

Discussion

From the above findings, both parts of the hypothesis were correct. Fingerprint patterns appeared to be similar among family members, and even more so with siblings. This assures that aspects of fingerprint patterns are genetically inherited. Furthermore, fingerprint patterns appear more similar with genetically close individuals. The p values proved that there is little difference that appears between closely related individuals like siblings.

With this in mind, everyone still possesses a unique fingerprint pattern. For this reason law enforcement, and other fingerprint recognition technologies should be commended more for developing unique algorithms and innovating today's technology. Despite p values deeming the differences in fingerprints as insignificant, it is very significant when it comes to justice and lifestyle. It is also expressed in the paper that the formation of fingerprint patterns are due to human genetics, and environment during gestation. This is what is known as multifactorial traits, this means that fingerprint patterns are multifactorial traits.

Although this experiment was done in a home setting, with a simple experimental design, the research was able to collect and provide valuable data regarding fingerprint patterns by finding a linkage between fingerprints and genetics. Of course, with a home experiment limitations are inevitable. For this experiment the study was only limited to related people of one family. Overall, this unique study adds to the deep realm of what human genetics is. It goes to show that human genetics is an important factor of what makes every individual unique.

Acknowledgments

References

O'Brien, Gabriel, and Kristen Murphy. "Fingerprint Patterns through Genetics."
    Fingerprint Patterns through Genetics. Originally published in
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