

## LogBook for science fair

**Jan 21, 2021**

- Being curious to learn more about fingerprints, I decided to start a project on fingerprint analysis and genetics.
- I did some background research, and found the following information:
  - There are 3 basic fingerprint patterns which are whorl, loop and arches
  - Study showed that no 2 people have ever been found to have the same fingerprints—including identical twins. Also, no single person has ever had 2 fingers sharing the same fingerprints.
  - Also, a person's fingerprints remain unchanged throughout their lifetime.
  - Pattern types are often genetically inherited, but the individual details such as breaks, forks and islands in the ridges are not.
  - Pattern types are often inherited from either the mother or father.
- The resources I used are:

<https://medlineplus.gov/genetics/understanding/traits/fingerprints/#:~:text=Like%20many%20other%20complex%20traits,the%20soles%20of%20the%20feet>

<https://www.mcgill.ca/oss/article/did-you-know/you-inherit-part-your-fingerprint-your-parents>

<https://www.scientificamerican.com/article/are-ones-fingerprints-sim/>

<https://academic.oup.com/lpr/article/18/2-3/177/5576153>

**Jan 28, 2021**

- Today, I formed my question for this project as “How do genetic variation affect fingerprints?” as it will be interesting to research more about how fingerprint patterns vary.

- I started brainstorming ideas for my hypothesis.

### **Feb 03, 2021,**

- I was able to finalize my hypothesis as “ The farther related the two people are, the fewer will be the similarities in fingerprint patterns and positions between them since fingerprint size, shape and spacing are primarily related based on genetic factors.
- Specifically, parents and children will have similar fingerprint patterns rather than siblings, as one sibling might inherit his/her fingerprints from one parent and the other might inherit it from the other parent.

### **Feb 10, 2021**

Today I identified the three variables and the control design as:

#### **Independent variable:**

- o Different relationships.
- o Different people.

#### **Dependent variable:**

- o Which category the fingerprint patterns fall under.

#### **Controlled variables:**

- o Same hand.
- o Same fingers.

#### **Control design:**

- o My control design will be the comparison between person's thumb.

**Feb 11, 2021**

Today, I planned and noted the procedure for capturing the fingerprints as:

1. Collect the fingerprint of the right thumb of one person and compare it with their left thumb, and then parent/child, sibling and first cousin.
2. Repeat the same procedure with different families.
3. Steps to collect fingerprints:
  1. Press the pad of your finger against an inkpad and press it gently on a piece of paper.
4. Once all the fingerprints from different families are collected, create a table specific for a family.
5. Once all the fingerprints have been added to the table, analyze the matching patterns between different fingerprint combinations.

I also started collecting fingerprints today.

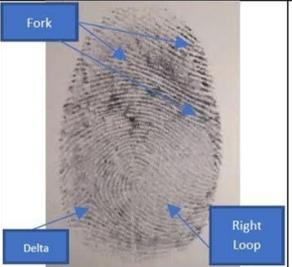
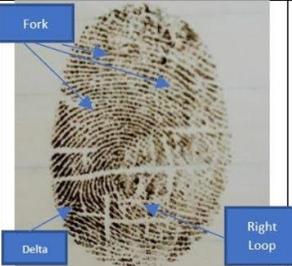
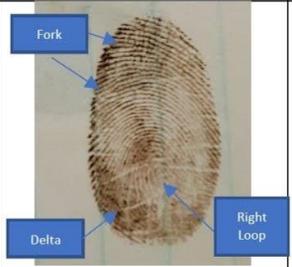
Feb 12, 2021

Today, I started the observations section of my project. I started comparing the right thumb fingerprint of a person with their own left thumb, their parent/child's right, their sibling's right thumb and their cousin's right thumb. I was able to do this comparison for sample 1's family.

Sample 1 Fingerprint Comparison Analysis			
	Sample 1 Right Thumb	Sample 1 Left Thumb	Observations
Sample 1 (Self Comparison)			<ul style="list-style-type: none"> <li>• Sample 1's right and left thumbs both have loop as their fingerprint pattern but in the opposite direction</li> <li>• Eventhough the fingerprint pattern is similar, the fork position is different</li> <li>• Both left and right thumb have 1 delta but in opposition direction</li> </ul>
	Sample 1 Right Thumb	Sample 1's child Right Thumb	
Sample 1 (Parent Child Comparison)			<ul style="list-style-type: none"> <li>• Sample 1 and their child share the same fingerprint pattern which is right loop</li> <li>• They both have forks but with different counts and positions</li> <li>• They both have delta in same position but of different sizes</li> </ul>
	Sample 1 Right Thumb	Sample 1's sibling Right Thumb	
Sample 1 (Sibling Comparison)			<ul style="list-style-type: none"> <li>• Sample 1 and their sibling do not share the same fingerprint pattern; Sample 1 has a right loop and the sibling has a whorl</li> <li>• They both have forks but with different counts and positions</li> <li>• Sample 1 has a delta but their sibling doesn't</li> </ul>
	Sample 1 Right Thumb	Sample 1's cousin Right Thumb	
Sample 1 (Cousin Comparison)			<ul style="list-style-type: none"> <li>• Sample 1 and their cousin do not share the same fingerprint pattern; Sample 1 has a right loop and the cousin has a whorl</li> <li>• They both have forks but with different counts and positions</li> <li>• Sample 1 has a delta but their cousin doesn't</li> </ul>

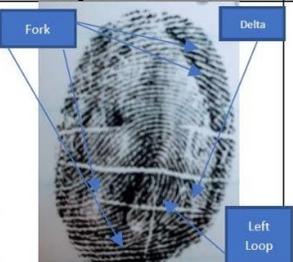
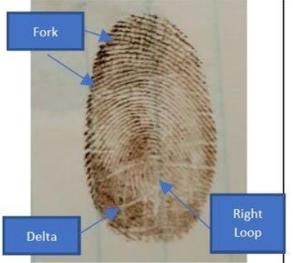
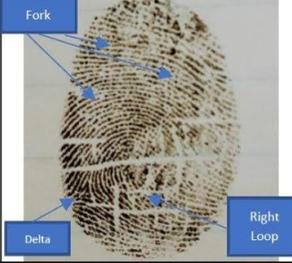
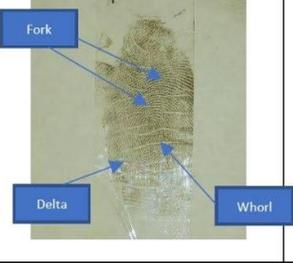
Feb 13, 2021

I continued my observation section of my project. I did the analysis for Sample 2 and their family.

Sample 2 Fingerprint Comparison Analysis			
	Sample 2 Right Thumb	Sample 2 Left Thumb	Observations
Sample 2 (Self Comparison)			<ul style="list-style-type: none"> <li>Sample 2's right and left thumbs do not share the same pattern; their right thumb has a right loop but the left thumb has a whorl</li> <li>The fork position and counts are also different</li> <li>Both left and right thumb do not have delta</li> </ul>
Sample 2 (Parent Child Comparison)			<ul style="list-style-type: none"> <li>Sample 2 and their child share the same fingerprint pattern which is right loop, however, the loop position for Sample 2 is upright and the one for the child is tilted</li> <li>They both have forks but with different counts and positions</li> <li>Sample 2 doesn't have delta, however, their child has one</li> </ul>
Sample 2 (Sibling Comparison)			<ul style="list-style-type: none"> <li>Sample 2 and their sibling share the same fingerprint pattern which is right loop, however, the loop position for Sample 2 is upright and the one for the sibling is tilted</li> <li>They both have forks but with different counts and positions</li> <li>Sample 2 doesn't have a delta, however, the sibling has one</li> </ul>
Sample 2 (Cousin Comparison)			<ul style="list-style-type: none"> <li>Sample 2 and their cousin share the same fingerprint pattern of right loop</li> <li>They both have forks but with different counts and positions</li> <li>Sample 2 does not have a delta but their cousin does</li> </ul>

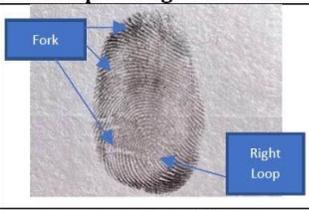
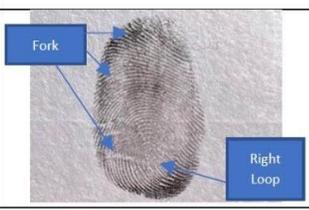
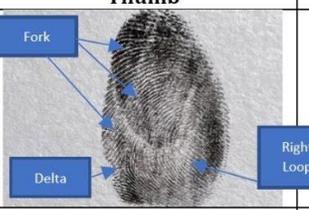
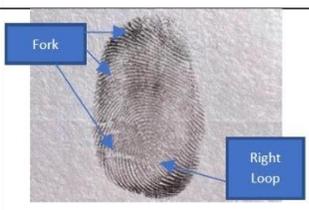
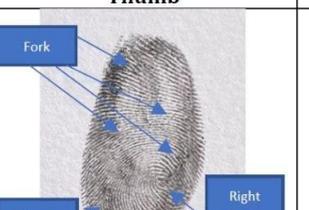
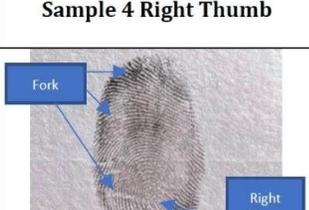
Feb 14, 2021

Today, I did the observation of the fingerprints of Sample 3 and their family.

Sample 3 Fingerprint Comparison Analysis			
	Sample 3 Right Thumb	Sample 3 Left Thumb	Observations
Sample 3 (Self Comparison)			<ul style="list-style-type: none"> <li>• Sample 3's right and left thumbs share the same pattern of loop but in opposite direction</li> <li>• The fork position and counts are also different</li> <li>• Both left and right thumb have delta but in different positions</li> </ul>
Sample 3 (Parent Child Comparison)			<ul style="list-style-type: none"> <li>• Sample 3 and their child share the same fingerprint pattern which is right loop</li> <li>• They both have forks but with different counts and positions</li> <li>• Sample 3 and their child both have delta but in different positions</li> </ul>
Sample 3 (Sibling Comparison)			<ul style="list-style-type: none"> <li>• Sample 3 and their sibling share the same fingerprint pattern which is right loop, however, the loop position for Sample 3's is tilted and the one for the sibling is upright</li> <li>• They both have forks but with different counts and positions</li> <li>• Sample 3 has a delta, however, the sibling does not have one</li> </ul>
Sample 3 (Cousin Comparison)			<ul style="list-style-type: none"> <li>• Sample 3 and their cousin do not share the same fingerprint pattern; sample 3 has right loop and their cousin has a whorl</li> <li>• They both have forks but with different positions</li> <li>• They both have delta but with different positions</li> </ul>

Feb 15, 2021

I did the observation of Sample 4 and their family today.

Sample 4 Fingerprint Comparison Analysis			Observations
Sample 4 (Self Comparison)			<ul style="list-style-type: none"> <li>Sample 4's right and left thumbs share the same pattern of loop but in opposite direction</li> <li>The fork positions are different</li> <li>Left thumb has a delta whereas the right thumb doesn't</li> </ul>
Sample 4 (Child Parent Comparison)			<ul style="list-style-type: none"> <li>Sample 4 and their parent have the same fingerprint pattern of right loop</li> <li>They both have forks but with different positions</li> <li>Sample 4 does not have a delta however their parent does</li> </ul>
Sample 4 (Sibling Comparison)			<ul style="list-style-type: none"> <li>Sample 4 and their sibling share the same fingerprint pattern which is right loop, however, the loop position is different</li> <li>They both have forks but with different counts and positions</li> <li>Sample 4 does not have delta, however, the sibling has one</li> </ul>
Sample 4 (Cousin Comparison)			<ul style="list-style-type: none"> <li>Sample 4 and their cousin share the same fingerprint pattern of right loop</li> <li>They both have forks but with different positions and counts</li> <li>Sample 4 does not have delta, however, their cousin does</li> </ul>

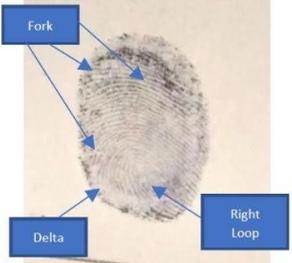
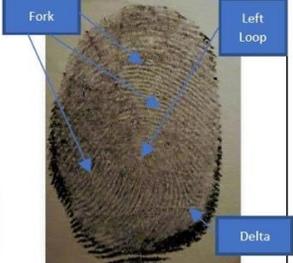
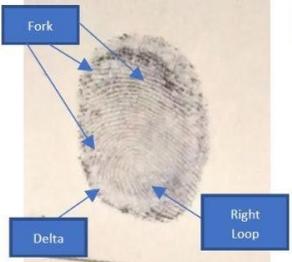
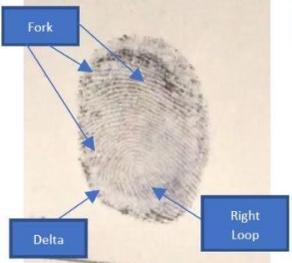
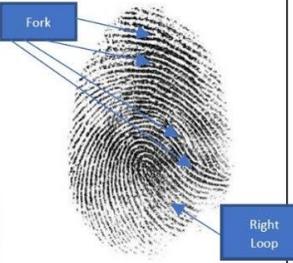
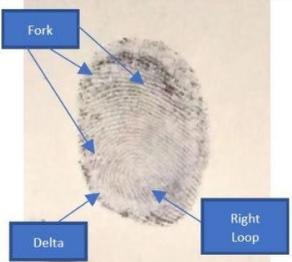
Feb 16, 2021

I did the observation of Sample 5 and their family today.

Sample 5 Fingerprint Comparison Analysis			
	Sample 5 Right Thumb	Sample 5 Left Thumb	Observations
Sample 5 (Self Comparison)			<ul style="list-style-type: none"> <li>Sample 5's right and left thumbs share the same pattern of whorl but in opposite direction</li> <li>The fork position and counts are different</li> <li>Both the thumbs have delta but in different positions</li> </ul>
	Sample 5 Right Thumb	Sample 5's parent Right Thumb	
Sample 5 (Child Parent Comparison)			<ul style="list-style-type: none"> <li>Sample 5 and their parent have same fingerprint pattern of whorl</li> <li>They both have forks but with different counts and positions</li> <li>Sample 5 and their parent both have delta but at different positions</li> </ul>
	Sample 5 Right Thumb	Sample 5's sibling Right Thumb	
Sample 5 (Sibling Comparison)			<ul style="list-style-type: none"> <li>Sample 5 and their sibling share the same fingerprint pattern which is whorl, however, the whorl position is different</li> <li>They both have forks but with different counts and positions</li> <li>Both have delta but at different positions</li> </ul>
	Sample 5 Right Thumb	Sample 5's cousin Right Thumb	
Sample 5 (Cousin Comparison)			<ul style="list-style-type: none"> <li>Sample 5 and their cousin do not share the fingerprint pattern; sample 5 has pattern as whorl while their cousin has the pattern as right loop</li> <li>They both have forks but with different positions and counts</li> <li>Both have delta but at different positions</li> </ul>

**Feb 23, 2021**

I did the observation of Sample 6 and their family today.

Sample 6 Fingerprint Comparison Analysis			
	Sample 6 Right Thumb	Sample 6 Left Thumb	Observations
<b>Sample 6 (Self Comparison)</b>			<ul style="list-style-type: none"> <li>• Sample 6's right and left thumbs share the same pattern of loop but in opposite direction</li> <li>• The fork position and counts are different</li> <li>• Both the thumbs have delta but in different positions</li> </ul>
	<b>Sample 6 Right Thumb</b>	<b>Sample 6's child Right Thumb</b>	
<b>Sample 6 (Parent Child Comparison)</b>			<ul style="list-style-type: none"> <li>• Sample 6 and their child have same fingerprint pattern of right loop</li> <li>• They both have forks but with different positions</li> <li>• Sample 6 and their child both have delta but at different positions</li> </ul>
	<b>Sample 6 Right Thumb</b>	<b>Sample 5's sibling Right Thumb</b>	
<b>Sample 6 (Sibling Comparison)</b>			<ul style="list-style-type: none"> <li>• Sample 6 and their sibling share the same fingerprint pattern which is right loop</li> <li>• They both have forks but with different counts and positions</li> <li>• Sample 6 fingerprint has delta but their sibling does not</li> </ul>
	<b>Sample 6 Right Thumb</b>	<b>Sample 6's cousin Right Thumb</b>	
<b>Sample 6 (Cousin Comparison)</b>			<ul style="list-style-type: none"> <li>• Sample 6 and their cousin do not share the fingerprint pattern; sample 6 has pattern as right loop while their cousin has the pattern as whorl</li> <li>• They both have forks but with different positions</li> <li>• Both have delta but at different positions</li> </ul>

## **Feb 25, 2021**

Today I started noting down my analysis for different relationships.

- In 83.33% of the above cases, the left and right thumb of an individual shares the same fingerprint pattern (i.e., loop, whorl or arc) but in opposite direction with a different position and different counts of forks and deltas.
- In all the above cases, the fingerprint pattern of parent and the child is same but the count and position of forks and deltas are completely different.
- In 83.33% of the above cases, the fingerprint pattern of siblings is same but the count and position of forks and deltas are completely different.
- In 33.33% of cases, the fingerprint pattern of cousins is same however the count and position of forks and deltas are different.
- In all cases, even ones having similar pattern types, the count and position of forks and deltas are different, thereby making no two fingerprints alike.

## **Feb 27,2021**

Today based on the observations and analysis I completed my conclusion.

The background research conducted on the role of genetics on fingerprint patterns revealed that there is an inheritable quality to fingerprints. Pattern types are often genetically inherited, but the individual details that make a fingerprint unique such as count and position of forks and deltas are not.

The experimental results and associated findings concur with the hypothesis based on the study conducted as part of the background research”.

## **Feb 28,2021**

Today I completed my Application/uses section and they are:

- Providing biometric security
- Fingerprints are used to perform background check on an individual
- Fingerprints are used to identify individuals as part the process of issuing passports.
- Fingerprints are heavily used in the criminal justice system.

**March 02,2021**

Today I finished my Sources of error portion:

- Method of capturing the fingerprints can lead to error due to movement of finger, camera shake while taking the picture causing lack of clarity in the appearance of fingerprint patterns, forks and deltas
- Errors could also occur due to insufficient zoom capability while reading the fingerprints, since the images tend to get blurry as we zoom in to study the patterns
- Incorrectly captured fingerprints due to lack of ink covering all parts of the finger and leads to uncaptured fingerprint patterns, forks and deltas.

I also would like to thank Mr Joshua Downey, my science teacher for guiding me through this project.