Fingerprint (Friction Ridge) Examination

Overview

In this activity participants will learn about;

1. Friction ridge skin and the difference between 'fingerprints' and 'fingermarks', and how each are recovered and analysed
2. The fingerprint comparison process which involves observing differences and similarities in detail between the impressions,
3. The importance of attention to detail and recording your observations in forensic analysis,
4. The difference between a human-based observational process (where features are viewed, recorded and compared between samples) and scientific analysis (which requires repetitive analysis to demonstrate precision (repeatability and(reproducibility) and accuracy as well as to understand error rates). Current fingerprint comparison requires human intervention and therefore does not follow a scientific analytical process but a subjective observational process. This means humas see things differently and will interpret their observation based on their training, study and experience, as opposed to having an objective analytical measure. The subjective nature of fingerprint interpretation has led to human error. This could open up topics for debate across the participants around the difference between objective measurements and subjective observations.

Timings

Task 1 should be relatively quick to undertake for all 10 fingers – approx. 30 mins once the materials are set up.

Task 2 can be expanded to include many different types of surfaces. It works best on glass. – approx. 30 mins to 1 hour.

Task 3 can be short or long depending on how many fingerprints you want to chart and how many people you want to chart the same fingerprint to look at inter observer differences.

Introduction

Friction ridge skin (FRS), commonly referred to as '*fingerprints*', is located on the underside of the fingers and palms of our hands and the soles of our feet. Friction ridge skin had ridges and sweat pores which help us grip objects and an abundance of nerve endings for touch. *Fingerprints* develop in utero (in pregnancy), are fully formed at birth, and will remain the same throughout life, unless changed through injury. The features observed in FRS develop at random and this allows for trained fingerprint examiners to compare and discriminate between two impressions. Identical twins have identical DNA, but very different friction ridge arrangements and fingerprint examiners can 'discriminate' between the two.

When you touch an item, there will be transfer of material between your fingers and the object. Recovery of an impression is dependent on several competing factors including and not limited to, the condition of the hands, the material being deposited (sweat or blood), the surface being handled (fabric, glass etc), the deposition pressure between hand and item, the environmental conditions, and the position of the deposition. The successful recovery is also dependant on the expertise of the crime scene examiner and their ability to search, visualise, develop, and record their observations.

This comparison follows an observational and feature comparison process rather than a scientific analysis and there is still very little understood about repeatability, reproducibility and the error rates in fingerprint comparison. **Repeatability** is the extent to which consistent results are obtained when

the analysis is repeated by the same person and **Reproducibility** is the extent to which consistent results are obtained when the analysis is repeated by different people. **Error rates** in this context are the proportion of identifications made by the examiner that are incorrect.

Terminology

- **Friction Ridge Skin (FRS):** corrugated skin located on the palmar (underside of palm), and plantar (underside of foot). Differs from the rest of the skin on the body and is anatomically used for grip and touch.
- **Friction ridge impression**: a fingerprint or fingermark – an impression left after contact with a surface
- **Fingerprint**: Friction ridge impressions obtained from a known person in a controlled environment (for example, upon arrest, or for a Visa application). Can be ink or digital. Also referred to as 'exemplars', or 'ten-prints', because the 10 digits, including palms, will be obtained from the known individual.
- **Fingermark:** A partial or incomplete friction ridge impression recovered from a crime related item or exhibit. Also referred to as an 'unknown' impression. The person that touched and deposited the fingermark is 'unknown;.

Fingerprint basics

- Friction ridge skin

The skin that covers our body is composed of 3 layers; the epidermis (outer layer), the dermis (inner layer) and hypodermis (a fat layer below the dermis). Friction ridge skin is only located on the palmar (hand) and plantar (feet) surfaces and differs from the skin on the rest of the body in the following ways.

- Corrugated skin (ridges and furrows) for grip, gives the appearance of ridges.
- Eccrine sweat pores only
- No hair
- No pigment (melatonin)
- Abundance of nerve endings (for touch)

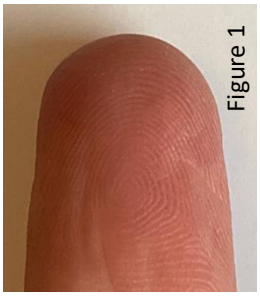


Figure 1

- 'Biological Principles of FRS' and why they can be used in the forensic context

Friction ridge skin display distinct patterns on the fingers, palms and soles of the feet. Friction ridges and creases on our hands (figure 1) allow us to grip items. (Primates and koalas are the only other species in the animal kingdom known to have friction ridge skin). These patterns and features are formed in during pregnancy) and do not change across a person's lifetime unless damaged at the dermal layer of the skin, and permanently scarred. A permanent scar will change the appearance of friction ridge skin.

The abundance of eccrine pores located in FRS, creates moisture and ultimately a deposit of the ridge pattern when they come into contact with a surface. This contact results in the transfer of material, either natural secretions from glands associated with the our skin, or by other surface contaminants such as grease, or paint, or blood. Latent (invisible to the eye) impressions require some form of development to be visualised which can be in the form of light, powders or chemicals, or a combination of each.

- Three levels of details

Fingerprints and their features are classified with respect to ridge flow, shape, and direction. There are 3 levels details called simply, Level 1, Level 2 and Level 3, or first, second and third detail. Before computers, all fingerprint sets were manually classified based on distinct fingerprint pattern types.

First level detail refers to the overall pattern type and ridge flow . Details observed at level 1 include observing the type of core and delta (figure 2), and counting the ridges between the two points. This' core-delta distance' can be used to quickly exclude digits that may have the same pattern type, but do not have the same core-delta distance ridge count.

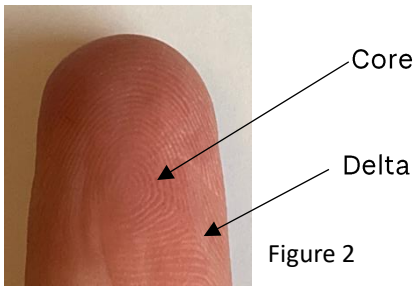
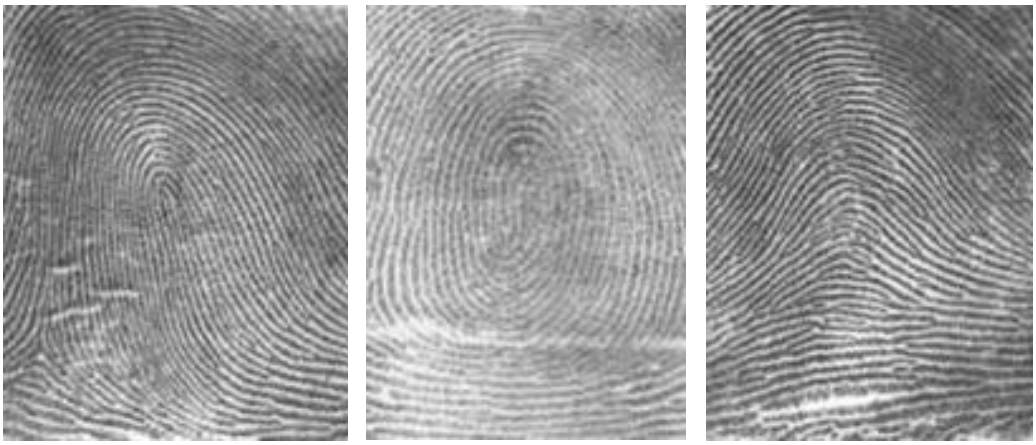


Figure 2

First level detail includes common patterns known as loops, arches and whorls (Figure3), and combinations of these. Palms also display specific ridge flows and pattern types depend on the area of the palm and if it's the right or left hand)



Loop Whorl Arch

Figure 3 (Image adapted from the U.S. Dept of Commerce, Public Domain)

Loops: Here the ridges of the print enter from one side, recurve around the core and exit the same side they entered on. There is only one delta. Population studies have shown that loops are the most common pattern type with 60-70% of individuals.

Whorls: Here the fingerprint contains some ridges that make at least one circuit around the centre core. There are two deltas. About 25-35% of the population has whorls.

Arches: Here there is an even flow of ridges from one side to the other. There is no recurve. There is no core and there are no deltas. About 5-10% of the population contains arches.

You can see other fingerprint patterns here (https://www.touchngoid.com/8-common-fingerprint-patterns/)

Second level detail refers to the more minute friction ridge characteristics or features of a fingerprint . These levels of detail are more discriminatory than Level 1 and are used to find an association between the fingermark (crime scene mark) and fingerprint.

There are 8 types of minutiae, the most common being a ridge ending and a bifurcation (divergence or separation of 2 ridges).

Minutiae are defined as any interruption in ridge flow. If you follow a ridge a long its path, at some point the ridge will end, diverge, or converge.

Third level detail refers to more minute features of friction ridge skin. Ridge shape, width, and the positioning of sweat pores. and details of the shapes of the edges of particular ridges as well as scars and other features. This level of detail is not always present in a fingermark recovered from an object or a surface.

Level 1 and 2 are used in combination with other. Level 3 detail is less discriminatory because it is less reproducible, making them unreliable and therefore should only ever be used in combination with level 2.

- Visualising fingermarks from objects and surfaces

Fingermarks can either be visible (patent) or invisible (latent). Visible fingermarks can be seen on surfaces whereas latent fingermarks are not visible to the eye unaided and require some form of development in order to be visible.

Latent fingermarks are enhanced using light, chemicals or powders depending on the surface or object that they are on. This is so that there is a contrast between the fingermark and the surface which enables the fingermark to be seen.

Once visible, the fingermarks are photographed so that a permanent record is made and the photograph is then directly compared with photographs or digital scans of fingerprints of known individuals on a database.

The development and visualisation of fingermarks are dependent on a variety of factors;

- The type of surface - Fingermarks on smooth surface such as paper or glass, will enable ridge detail of good quality to be observed. Rough surfaces such as wood or some plastics can interrupt the ridge detail. Surfaces can be non-porous, semi-porous or porous. The fingermark sits on top of non-porous surfaces such as glass. Semiporous surfaces such as wood can absorb the water-soluble part of the fingermark deposit over time. Porous surfaces, such as paper, absorb the water-soluble part of the fingermark deposit very quickly.
- The 'matrix' (composition) of the deposit and the amount deposited:
- The time between fingermark deposit and recovery
- The Pressure of contact.
- Diet and whether a person has washed their hands recently.

The crime scene fingerprint specialist is trained to recover fingermarks. They will also take careful notes of what they do and recovered impression are recorded digitally using a digital camera. These digital images are then uploaded to a database to be either manually compared against the fingerprints of a person of interest (suspect or person to be elimination), or searched against an called Automated Fingerprint Identification System (AFIS) or IDENT 1 in the UK

Examination of friction ridge impressions: unknown fingermark to known fingerprint

The examination of friction ridge impression involves a series of steps commonly referred to as 'ACE-V'

- **A**nalysis – The analysis involves gathering as much information about the fingermark as possible. This includes observations such as the item type (knife, door, glass), the surface of the item, the development technique used, any visible distortion. Distortion comes in many shapes and forms and can be the result of the surface texture, the development technique, or the pressure applied by the individual during the deposit. This is followed by a more in-depth analysis of specific friction ridge features at each of the three levels, starting with level 1. Each level of detail are analysed and recorded. The fingermark must always be examined first to avoid bias. All observations and features are marked on an image of the fingermark and recorded using computer software. Finally, an assessment of the quality and quantity of information observed in the fingermark is made to determine whether a comparison can be performed.
- **C**omparison – During a comparison the examiner will assess the level of association between the mark and known sample. This is performed by placing the fingermark and fingerprint side-by-side and searching for similar features (associations) between the two. Features must be in sequence, the same shape, type and direction between the two impressions. If a person of interest (suspect) is known, and a set of fingerprints have been collected from them, a comparison can begin. If no persons of interest are known, the examiner will search the fingermark against the database, and perform a comparison against the database.
- **E**valuation – The evaluation involves assessing the degree of support in the observed association. Here the examiner will 'evaluate' the level of association observed during the comparison and reach an opinion as to the source of the 'unknown' fingermark. These opinions can be categorical or probabilistic. The community is slowly moving toward a probabilistic approach because it allows examiners to express levels of uncertainty. Under the categorical system, the examiner will reach one of the following conclusions.
    - Individualisation: The fingermark belongs to the compared individual's fingerprint
    - Insufficient: The fingermark, and or fingerprint, do not have enough observable features to reach a conclusion of source
    - Exclusion: The fingermark does not belong to the compared individual – they have been excluded as the source of the fingermark
- **V**erification – The final step of the ACE-V process involves quality control. This is where a second qualified fingerprint examiner independently examines the impression/s and reaches their own opinion as to the source of the fingermark. If the two examiners reach the same conclusion, the fingermark is verified. If there is a difference of opinion, a third examiner will independently analyse, compare, and evaluate.

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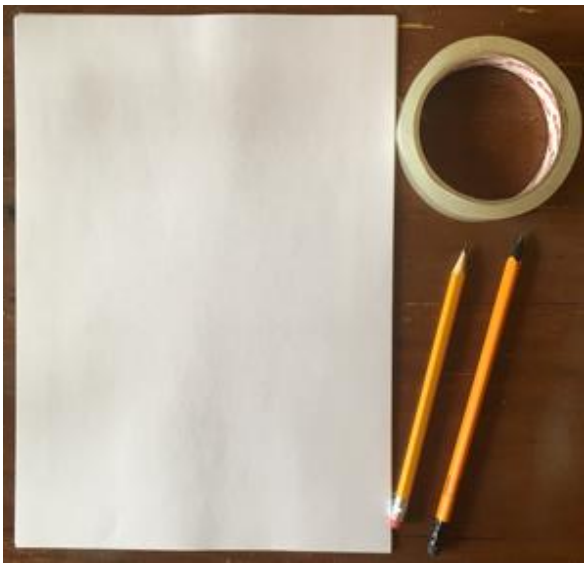
TASK 1 - Taking your own fingerprints in 5 easy steps

Equipment



You will need:

(1) A roll of Sellotape

(2) Some sheets of A4 paper

(3) HB pencils

(4) A magnifying glass if you have one

Step 1 – make a mark on the paper using the pencil.

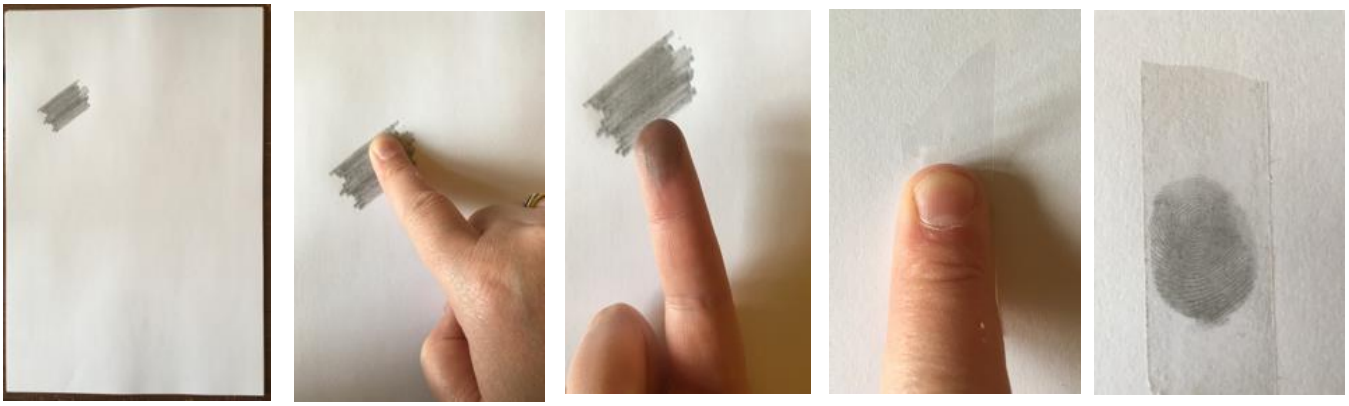
Step 2 – rub your fingertip across the pencil mark so that the graphite covers your finger

Step 3 – press your finger onto the sellotape sticky side up.

Step 4– stick the sellotape onto the clean recording sheet.

Step 5 – repeat this for all of your fingers and record your name, and the date you took the fingerprints.

Step 1 Step 2 Step 3 Step 4



(you could do this without graphite also to demonstrate that the sweats and oils in fingerprints are sufficient to produce latent fingermark – place your finger directly onto the tape and hold to the light)

Record the following:

What surface has the fingerprint been placed on?

What matrix? (i.e. sweat or graphite)

Can you observe the deposition pressure? (did you push too hard? What happens if you push lightly?)

Can you see the overall pattern type? (level 1); Can you see the minutiae? (Level 2); Do you have any scars?

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Fingerprint recording sheet

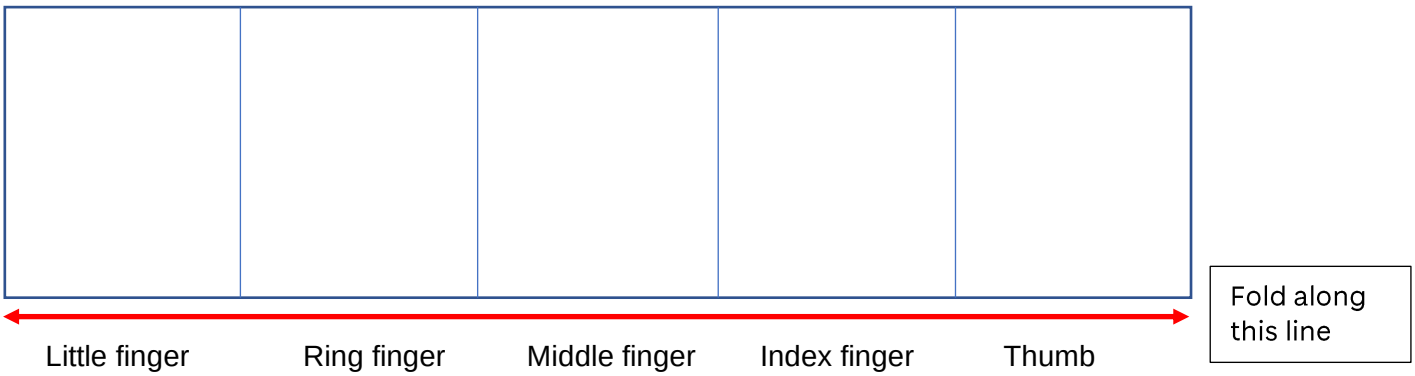
The primary objective when obtaining fingerprints is to get as much information as possible so if a comparison is required against a partial and incomplete impression, the set of fingerprints contains all the necessary information required to complete a comparison.

Important: Make sure you place you digits in the correct box. You'll be surprised at how many people get this wrong. On real fingerprint forms, the 4 finger digits are captured simultaneously to ensure the sequence of digits in each separate box is correct.

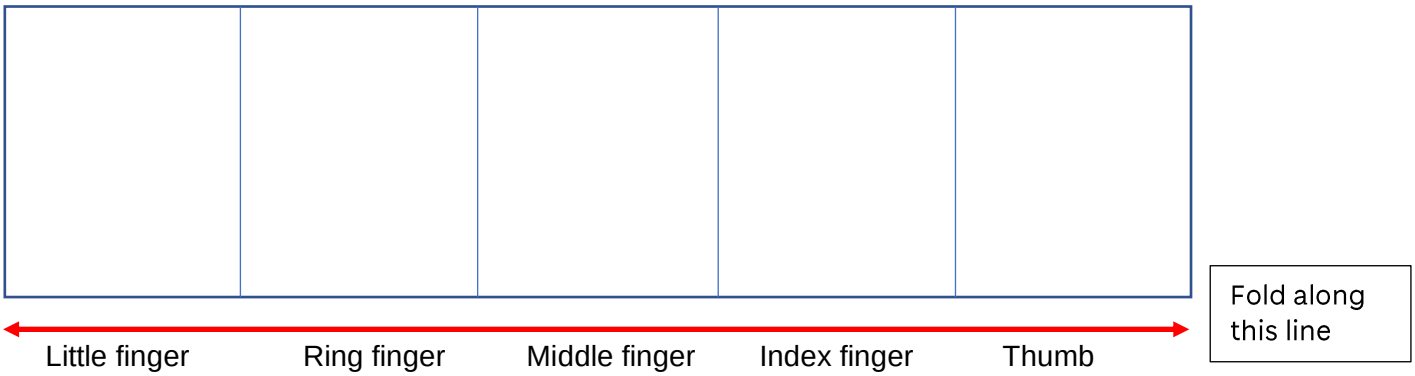
Tip: If you fold the bottom edge ("fold along this line") against the table edge, you will be able to place your fingerprints easier.

Your Name:

RIGHT HAND



LEFT HAND



TASK 2 - Recovering latent fingerprints:

Equipment

You will need;

(a) a HP pencil

(b) a metal nail file

(c) a small dish

(d) a small brush (small fine paint brush or fine makeup brush)

(e) some Sellotape, and

(f) white A4 Paper.

Step 1 – Pick up a clear glass jar - this will leave a fingerprint.

Step 2 – Using the nail file, grate the top of a HB pencil carefully into the dish to make a fine powdered graphite.

Step 3 - Using a small brush, carefully dust the fingerprint with the powdered graphite.

Step 4 – Once you see the fingerprint clearly, use a piece of sellotape to lift off the fingerprint and transfer it to the sheet of white paper. Record your name, where you recovered the fingerprint from and the date.

TASK 3 – Comparing fingerprints

1. Recover your own fingerprints and examine each one in turn to determine whether it contains loops, whorls or arches. You may wish to use a magnifying glass or you could also take a picture of your fingerprint using your phone and enlarge it to see the patterns more clearly.

2. Determine the 2nd level detail (ridge endings and bifurcations) if you can see them. Draw some diagrams of these to record the features.

3. Determine any 3rd level details (pores, scars) if you can see them. Draw some diagrams of these of these to record the features.

4. In Task 2 you recovered your fingerprints from an object. Examine these for 1st, 2nd and 3rd level detail. Draw some diagrams of these of these to record the features.

5. Compare the marked details of your fingerprints from Task 1 with the marked details of your recovered fingermarks from Task 2 looking for similarities and differences.

Questions to consider:

How different are the fingerprints from your different fingers and from the fingers of others in your family or others in your class?

Have other people examine your fingerprints and mark them up for 1st, 2 and 3rd level detail. Did they get the same results as you did? What do you think it means if they get different results?

Is there much difference between your fingermark recovered from the object in Task 2 and the set of fingerprints you made in Task 1?

Did other people see the differences and similarities that you did in comparing the fingerprints in Task 1 and the fingermarks recovered in Task 2? What does this mean if you want to use the results to suggest the identity of a person?

What do you think the error rates are in fingerprint examination? Do you think it is a scientific process or an observational process?

About

This activity was created by researchers and staff at the Leverhulme Research Centre for Forensic Science at the University of Dundee.

The Leverhulme Research Centre for Forensic Science is focused on research on forensic science and asks bold questions about the robustness of the science used in the investigation of crimes, laboratory analysis and the presentation of scientific evidence within the courts.

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