

# The Impact of Various Substances on Fingerprint Clarity and Readability

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Edited by Lauren Wilson

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## **Abstract:**

This study investigates the impact of various substances on the clarity and readability of fingerprint impressions, a vital part of forensic science. The primary objective is to evaluate how substances such as lotion, hand sanitizer, foundation, and Clorox wipes influence the quality of fingerprints. It is hypothesized that lotion and foundation will cause the greatest degradation, while hand sanitizer and Clorox wipes will have minimal effect. This experiment involved preparing controlled fingerprint impressions using an ink pad and fingerprinting cards, followed by the application of each substance. Fingerprints were evaluated based on a predefined clarity scale of 1 to 5 using high-resolution images. Each substance was tested twice per finger to validate consistency. Findings revealed significant variations in fingerprint readability, with lotion and foundation and foundation showing the highest degradation levels corroborating the hypothesis. This research underscores the importance of controlling environmental and external factors in forensic investigations. This study shows the effect of common substances on fingerprint quality, the study provides insights for improved evidence collection.

*Keywords:* Fingerprinting, forensic science, degradation

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Fingerprint analysis is a cornerstone of forensic science, providing critical evidence for identification and criminal investigations. (Fingerprint Analysis) The reliability of fingerprint evidence depends significantly on the clarity and readability of the impressions collected. However, various substances present on the skin can affect the quality of fingerprint impressions, potentially complicating forensic analysis. It is seen that greasy substances can influence the clarity of the fingerprint. (Kumari) This research assignment explored the impact of different substances on fingerprint clarity and readability, aiming to deepen understanding of how these factors influence forensic

evidence collection (Recording legible fingerprints)

The objective of this study is to determine how substances such as lotion, hand sanitizer, foundation, and Clorox wipes affect the clarity and readability of fingerprints. By systematically applying these substances to fingerprint impressions, the experiment seeks to evaluate their effects under controlled conditions. This is done so that there is no appearance of false markings in the fingerprints. (Federal Bureau of Investigation) The hypothesis suggests that substances like lotion and foundation will cause the greatest degradation in fingerprint clarity, while substances such as hand

sanitizer and Clorox wipes will have a minimal impact (Seo)

The methodology involves using a fingerprinting kit, a high-resolution camera, and a predefined clarity rating scale to assess the quality of impressions. Safety precautions are implemented to ensure the careful handling of substances and the prevention of contamination during the experiment. A multi-step protocol, including preparation, substance application, clarity evaluation, and data analysis, is designed to produce robust and reproducible results.

This study's findings are expected to contribute valuable insights into the effects of common substances on fingerprint quality. These results will have practical implications for forensic science, particularly in developing best practices for evidence collection and improving the reliability of fingerprint-based identification. This is because fingerprint clarity through inking is often unreliable. (Ulery) By systematically. Examining the interaction between substances and fingerprint clarity, this research aims to enhance the scientific foundation of forensic fingerprint analysis.

## **Methods and Materials**

### **Preparing the Experiment**

The materials used in this study were a fingerprinting kit comprised of an ink pad, fingerprinting cards, and a digital camera, as well as lotion (Aveeno, Fredericksburg, IA), scented hand sanitizer (Bath and Body Works, New Albany, OH), foundation (L'Oreal Paris, New York, NY), and Clorox wipes. A control was made using unscented hand soap (soft-soap, Chaska, MN) and paper

towels. The study was conducted in my dorm room, at my cleaned off desk that was wiped down with Clorox wipes prior to beginning the experiment. The fingerprints all came from one person to act as a control during the experiment.

### **Control and Variables of the Experiment**

The Control in this study was the fingerprint taken when the subject washed their hand with unscented hand soap and dried off their hands using paper towels. The fingerprints were recorded in sets of two for every interval and every substance. The variables include each of the four substances that were applied to the hands. The readability was recorded after one minute and again after five minutes to test the clarity once it has been set on the hands for a period. The readability was ranked on a scale of 1-5 by three people to determine the average score for each substance.

### **Protocol and Experimental Procedure**

The protocol for this study is as follows:

#### **Preparation:**

The initial step in the protocol is to set up a clean and controlled environment with consistent lighting. This arrangement is used to minimize external variables that could affect the experiment. Additionally, all necessary materials are to be organized and positioned within the workspace to maintain a smooth workflow during each phase of the experiment. In the preparation phase, clear fingerprints are to be created on multiple fingerprint cards using an ink pad. The participant involved in the fingerprinting process should be instructed to wash their

hands thoroughly with unscented soap and dry their hands completely using a paper towel to get off any excess dirt and oils. Using unscented soap will cleanse the hand while maintaining the moisture that is needed to get a clear reading. (Tips for Improving Fingerprint Quality) To ensure the reliability of the results, the subject is to provide two sets of fingerprints for each substance. The subject should be instructed to wash and dry their hands completely using unscented soap between the collection of each set of prints throughout the entirety of the experiment.

### **Application of Substances:**

To minimize bias in the experiment, substances are to be tested on each finger twice. This process is crucial in ensuring that the application of various substances is not influenced by systematic patterns. The testing of each substance twice on each finger aims to enhance the validity of the results and ensure a fair assessment of the effects that each substance has on fingerprint clarity. Each fingerprint should be taken using the rolling of the finger through ink and then onto a fingerprinting card. Starting from the right to the left roll the finger to get a clear print. (Introduction to Fingerprinting)

For each fingerprint card, a small amount of the respective substance shall be applied to the palm of the hand and spread evenly for thirty seconds by rubbing the hands together, as if washing hands. This method ensures that each substance is distributed well over the fingerprint region. This is important to obtain accurate and consistent results. After application of the substances should be allowed to sit on the hands for one minute before taking the print. This time frame was

selected to maintain consistency among each of the substances and their clarity readings. These steps are to be repeated for each of the substances being tested. After taking the fingerprints of each substance, the fingerprint cards should be laid out to dry completely before taking photos of the prints. It is essential to let the prints dry completely to avoid smudging of the prints. (Team)

### **Clarity Evaluation:**

Following the application period, each fingerprint is to be documented using a high-resolution camera. This documentation process is to be done from a consistent angle and distance to ensure uniformity in the images. This is essential for accurate comparison and evaluation of the clarity of each fingerprint.

The clarity of each fingerprint impression is to be assessed using a predefined scale ranging from 1 to 5, where a score of 1 indicated an unreadable impression and a score of 5 us for a clear readable latent print. To enhance objectivity, multiple evaluators should independently rate each print. This is to provide data for an average score for each of the substances after one minute and after five minutes. When observing these prints evaluators are told to observe the overall clarity of the print using the basic ACE-V method and listing the basic observations seen on the prints. (Buscaglia)

### **Data Collection and Analysis:**

All clarity ratings are to be compiled into a table for easy analysis. Each entry is to include the substance applied, the time interval, the rating, and comments about the readability of the fingerprint. This is to track

to degradation of each individual fingerprint. An average of all the scores will be taken for each of the substances in the study.

A chart is to be made of the average score for each time period and substance with notes from each evaluator justifying the score given.

## Results

Lotion and foundation have the highest average level of degradation as observed by the three evaluators.

**Table 1: Average rating of clarity based on substances**

Finger	Average Rating of Hand
Control	3.62
Hand Sanitizer (1 minute)	4.02
Hand Sanitizer (5 minutes)	3.62
Clorox Wipes (1 minute)	3.72
Clorox Wipes (5 minutes)	3.36
Foundation (1 minute)	3.42
Foundation (5 minutes)	2.36
Lotion (1 minute)	1.74
Lotion (5 minutes)	2.3

The data collected showed that overall, the average clarity score was higher for that of hand sanitizer and Clorox wipes than that of foundation and lotion. All the substances had a lower average score after five minutes aside from lotion which scored higher after five minutes. Throughout the experiment the pinky finger was rated lower than all other

fingers therefore indicating an error in printing for the pinky throughout the experiment.

The individual tables can be found below, each contain an average score for the substances and comments regarding observations of the prints:

**Table 2. Average Clarity of Control set**

Finger	Average Rating 1-5	Observation
Thumb	4.6	Clear
Pointer Finger	4.1	Clear
Middle Finger	4.3	Clear
Ring Finger	4.6	Some areas minimally unclear but overall still very easy to see minutiae
Pinky	4.2	Some areas as if there was too much ink on the finger making it hard to see minutiae



**Figure 1.** First set of controlled prints



**Figure 2.** Second set of controlled prints

**Table 3. Average Clarity of Hand Sanitizer after 1 minute**

Finger	Average Rating 1-5	Observation
Thumb	4.2	Very clear, potential crease areas appear bigger
Pointer Finger	4.2	Overall very clear, not clear in upper corners
Middle Finger	4.7	Smudged areas near the middle but overall very clear
Ring Finger	3.8	Lots of smudged areas, hard to see minutiae
Pinky	3.2	Lots of smudged areas



**Figure 3.** First set of prints after one minute with Hand Sanitizer



**Figure 4.** Second set of prints after one minute with Hand Sanitizer

**Table 4. Average Clarity of Hand Sanitizer after 5 minutes**

Finger	Average Rating 1-5	Observation
Thumb	4.3	Smaller minutiae harder to see, some smudged areas
Pointer Finger	4.2	Mostly clear, some smudged areas
Middle Finger	4.5	Mostly clear, one area super light in ink so harder to see, some smudging
Ring Finger	3.3	Hard to see detail in lower left corner, some smudging
Pinky	1.8	Very hard to see details



**Figure 5.** First set of prints after five minutes with Hand Sanitizer



**Figure 6.** Second set of prints after five minutes with Hand Sanitizer

**Table 5. Average Clarity of Clorox Wipes after 1 minute**

Finger	Average Rating 1-5	Observation
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Thumb	4.7	Some smudging
Pointer Finger	4.2	Some smudging
Middle Finger	3.5	Very light, making some areas hard to see
Ring Finger	3.7	Very light, some smudging
Pinky	2.5	Very hard to see any detail at all



**Figure 7.** First set of prints after one minute with Clorox Wipes



**Figure 8.** Second set of prints after one minute with Clorox Wipes

**Table 6. Average Clarity of Clorox Wipes after 5 minutes:**

Finger	Average Rating 1-5	Observation
Thumb	3.5	Moderate smudging and lighter areas
Pointer Finger	4	Some smudging
Middle Finger	3.8	Some smudging at top
Ring Finger	3.3	Some smudging
Pinky	2.2	Only about half the print is clear



**Figure 9.** First set of prints after five minutes with Clorox Wipes



**Figure 10.** Second set of prints after five minutes with Clorox Wipes

**Table 7. Average Clarity of Foundation after 1 minute**

Finger	Average Rating 1-5	Observation
Thumb	3	Moderately difficult to see detail overall
Pointer Finger	4	Overall very clear, smudging in top left corner
Middle Finger	4	Decently clear but light overall
Ring Finger	3.3	Overall difficult to see detail, bottom is easier to see than top
Pinky	2.8	Very difficult to see detail



**Figure 11.** First set of prints after one minute with Foundation



**Figure 12.** Second set of prints after one minute with Foundation

**Table 8. Average Clarity of Foundation after 5 minutes**

Finger	Average Rating 1-5	Observation
Thumb	3.3	Smaller details harder to see
Pointer Finger	3	Center very unclear
Middle Finger	2.2	Sparkles distorting print?
Ring Finger	1.5	Very unclear, sparkles distorting print
Pinky	1.8	Very light details are hard to see



**Figure 13.** First set of prints after five minutes with Foundation



**Figure 14.** Second set of prints after five minutes with Foundation

**Table 9. Average Clarity of Lotion after 1 minute**

Finger	Average Rating 1-5	Observation
Thumb	2.7	Some detail present, much of print missing
Pointer Finger	2.8	Some detail present, much of the print missing

Middle Finger	1	Can barely see print
Ring Finger	1.2	Upper edges very clear, center of print missing
Pinky	1	Print very light and smudged



**Figure 15.** First set of prints after one minute with Lotion



**Figure 16.** Second set of prints after one minute with Lotion

**Table 10. Average Clarity of Lotion 5 minutes:**

Finger	Average Rating 1-5	Observation
Thumb	2.8	Some detail visible
Pointer Finger	2	Very smudged
Middle Finger	2.5	Some detail but slightly fuzzy
Ring Finger	2.2	Some detail but fuzzy
Pinky	2	Very hard to see any detail



**Figure 17.** First set of prints after five minutes with Lotion



**Figure 18.** Second set of prints after five minutes with Lotion

### **Discussion**

The findings from this study highlight the significant effects that various substances have on the clarity and readability of fingerprint impressions, underscoring their potential errors for forensic evidence collection and analysis. Each tested substance exhibited a distinct impact on fingerprint quality, which aligns with or diverges from the initial hypotheses.

Hand sanitizer and Clorox wipes showed minimal degradation of fingerprint clarity compared to the control group, particularly in the one-minute evaluations. The clarity scores for hand sanitizer averaged 4.02 at one minute and 3.63 at five minutes, while Clorox wipes scored 3.72 and 3.36, respectively. These results suggest that substances with components such as alcohol in hand sanitizer, evaporate quickly and have a lower long-term inference with fingerprint impressions. Similarly, Clorox wipes, which contain

cleaning agents that appear to minimally affect the visibility of ridge patterns within the short time frame studied. This supports the hypotheses that these substances would cause the least degradation making them less problematic for forensic fingerprint collection under controlled conditions.

As hypothesized, lotion and foundation caused the most significant degradation in fingerprint clarity. Lotion demonstrated the lowest level of clarity rating, averaging 1.74 after one minute and 2.3 after five minutes. The greasy and viscous nature of lotion obstructs ridge patterns by filling in the finer details of fingerprint, making them unreadable. Similarly, foundation, with its oil-based composition, contributed to a reduction in fingerprint readability, with scored dropping from 3.42 at one minute to 2.36 at five minutes. The foundation's texture and reissue transfer on the card would explain the lack of clarity.

An observation was the general trend of reduced fingerprint clarity over time across most substances. This was particularly evident in substances like hand sanitizer and Clorox wipes, where clarity scored declines from the one-minute to the five-minute mark. This suggests that a prolonged exposure to these substances may lead to partial smudging or residue transfer. On the other hand, lotion displayed a slight improvement in clarity over time, which can be attributed to its gradual absorption or redistribution onto the skin, allowing ridge patterns to become visible again.

The study revealed variability in fingerprint clarity among different fingers, with the pinky finger consistently scoring lower than others across all substances. This discrepancy could be the result of inconsistent pressure application or insufficient ink coverage during the fingerprinting process. Addressing these inconsistencies in future studies will help confirm validity of this experiment.

The findings point to the importance of controlling environmental and external factors during forensic investigations. Substances like lotion and foundation, both which are commonly found on hands, can severely compromise fingerprint clarity. This can play a role in the accuracy of forensic

identification. It should be made a priority to clean the hands before fingerprinting to avoid grease or other residues from inhibiting the clarity. The study suggested that using hand sanitizer or similar cleaning agents could be a viable step to prevent the degradation of fingerprints.

This study's scope was limited to a single subject and a controlled environment, which may not fully capture the variability encountered in real-world forensic scenarios. Future research should incorporate diverse participants, additional substances, and varying environmental conditions to broaden the applicability of the findings. Further exploration of the time-dependent effects and interactions between different types of residues could also provide a deeper insight into the way using ink to fingerprint affects degradation.

In summary, the experiment confirmed the hypothesis that lotion and foundation significantly degrade fingerprint clarity, while hand sanitizer and Clorox wipes have minimal effects. These results contribute to the knowledge of fingerprinting in forensic science and offer practical guidance for improving evidence collection methods and enhancing the reliability of fingerprint analysis.

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