2021

The Efficacy of Recovering Latent Fingerprints from Fired Cartridge Cases by way of Cyanoacrylate Fuming combined with Basic Yellow Dye Staining

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"The Efficacy of Recovering Latent Fingerprints from Fired Cartridge Cases by way of Cyanoacrylate Fuming combined with Basic Yellow Dye Staining"

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Forensic Science at Virginia Commonwealth University.

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May 2021

Abstract

This experiment attempted to tackle the long-standing struggle to consistently recover latent fingerprints from fired cartridges. With an emphasis on realistic handling of high volume of samples combined with Cyanoacrylate fuming followed by Basic Yellow dye staining, a total of 740 cartridges were examined. These included fired and unfired brass and nickel case 9mm Luger and 40 S&W cartridges. The cartridges were divided into five different groups; each were treated differently prior to cyanoacrylate fuming and dye staining, which was conducted in the same manner for the groups. The groups included the positive and negative controls, loaded, cycled, and fired. Once collected, the groups were placed into the cyanoacrylate fuming chamber, processed, and then dipped into Basic Yellow. All results were examined by an experienced forensic latent print examiner using a Crime-Lite 42S blue/green wavelength alternate light source. The purpose of the loaded, cycled, and fired groups was to isolate the firing process and demonstrate how each step affects the enhancement latent fingerprints. As expected, there were only two (2) cartridge cases from the 500 fired cartridges that had any friction ridge detail. One requires further advanced enhancement to determine if enough characteristics could be pulled to be of value, and the other contained some characteristics, but not enough to be of value. These were on a brass case and nickel case 9mm Luger cartridge casing, respectively. The loaded and cycled groups exhibited varying degrees of friction ridge detail, ranging from "not enough contrast to see characteristics" to "good to use for comparison." What sets this experiment apart from previous, similar studies is the prioritization of mimicking law enforcement's actual collection, packaging, and handling methods, as well as the large number of samples.

Keywords: fired, cartridges, cyanoacrylate fuming, basic yellow, unfired, latent fingerprints, alternate light source

Acknowledgements Page

I would like to start by thanking my committee members for their endless support and guidance. Stephanie, thank you for helping me design the experiment and keeping me grounded when unexpected issues arose. Sylvia, thank you for coming in-person to look over the results and offering clarification on latent fingerprint concepts. Dr. Miller, thank you for taking the time to thoughtfully review my proposal and written technical report, ensuring both were of the highest quality. I would like to thank Dr. Sarah Williams and her family for sharing her farm with me to fire all 250 40 S&W cartridges. I would like to thank the VCU Police Department for their help in shooting all 250 9mm Luger cartridges. I would like to thank Wendy Travis for providing me with a great foundation of knowledge on fingerprint development and analysis. I would like to thank my friends and family – especially my wife Dez – for their unquestionable support and encouragement during the past several months.

Introduction

Overview of fingerprints

It is commonly accepted that no two individuals have the same fingerprints, catapulting fingerprint identification of individuals to the forefront in the criminal justice system and forensic science community.[1] Despite the popularity of DNA analysis and it's "golden standard" status, fingerprint identification still plays a critical role in individual identification.[2]

Fingerprints are individualizing because of circumstances that start during embryonic and fetal development – volar pads and environmental factors in the womb.[1] Volar pads are tissue swellings that form and recede over a short period of time during gestation. The size and shape of the pad determines the pattern type and ridge count of each fingerprint, which are used for classification and identification comparison purposes.[1] There are several factors that affect the rate at which the fetus grows, which consequently affects the size of the volar pads. Some of the factors include the nutrients the fetus receives from the mother, the mother's medications during pregnancy, and the areas of the womb the fetus touches and the length of time those touches last.[1] Because there are so many different factors attributing to the volar pads, even identical twins could have different fingerprint patterns, but will always have a different ridge arrangement of characteristics.[3]

There are two types of fingerprint pattern evidence on surfaces: patent or latent. A patent print is readily visible and can be plastic or contaminated. A plastic patent print is impressed in a soft, malleable material such as clay. A contaminated patent print can be a result from blood, paint, or any other easily visible and transferable medium that can adhere to the finger(s) that is transferred to the contacted surface. A latent print is unseen to the naked eye and requires an additional enhancement technique so the latent print residue can be visualized.

Latent fingerprint residue predominantly consists of sweat and oils – secreted by the eccrine, sebaceous, and apocrine glands. The residue also contains salts, amino acids, organic and inorganic compositions, and lipids.[1] It's important to note the residue consists of approximately 98% water, which will likely evaporate after contact. Because of this evaporation, certain development techniques will not be as effective.[1]

Cyanoacrylate fuming, commonly known as superglue fuming, was first used in the late 1970s and remains a useful and effective enhancement technique used today.[4] This enhancement process is used by many crime laboratories and law enforcement agencies. This enhancement technique is most effective on non-porous surfaces such as metal, glass, and plastic.[4] A superglue fuming chamber is enclosed so it can capture the fumes which are created by heating and vaporizing liquid superglue.[1] The vaporized glue, now self-polymerizing, adheres to the latent fingerprint residues and dries thereby, preserving the fingerprint. When superglue fuming a fired cartridge case, it is placed so the mouth or open end of the casing is facing down, maximizing the surface area that will come into contact with the glue vapors. After the glue has dried, a common laboratory practice involves the latent fingerprint being enhanced using a variety of fluorescent dye stains, making it easily visible with an alternate light source (ALS).[1] Some common dye stains used for this technique include Rhodamine 6-G, Basic Yellow, Ardrox, RAM, and MBD[5].

Overview of firearms

Modern day firearms have the similar internal basic mechanical components. This study examines semi-automatic handguns, which consist of a frame, barrel, chamber, trigger mechanism, firing mechanism (such as a hammer, firing pin, and/or striker), and a variety of safety features and accessories. The firearm's frame provides housing for the firing and trigger mechanisms.[6] The barrel looks like a tube and is what the bullet travels through before exiting the firearm via the muzzle.[7] In pistols, the chamber is integrated with the barrel. The trigger is the part of the firearm that is manually pulled, resulting in the firearm discharging.[7] The magazine is a container that holds the cartridges and is inserted into the firearm. Semi-automatic handguns can be hammer-fired or striker-fired. As defined by Chris Monturo, author of *Forensic Firearm Identification*, a hammer is "a component of the firing mechanism which strikes the firing pin or primer," and a striker is "a rod-like firing pin or a separate component which impinges on the firing pin." The firing pin is the component that comes into contact with the primer in a cartridge case.

Figure 1. Diagram of some features on a semiautomatic 9mm handgun.

The general cycle of fire is as follows: loading, chambering, locking, cocking, firing, unlocking, extracting, and ejecting.[7] In semi-automatic handguns, the firing process is used to complete part of the cycle of fire. The gas and pressure from the cartridge push the slide rearward. The cartridges are inserted into the magazine, which is placed into the firearm. The slide then closes. Manually pulling the slide back cocks the hammer. Pulling the trigger discharges the firearm. As the slide moves backwards along the track, the empty cartridge case is extracted and ejected from the chamber.

Latent fingerprints and firearms

After studying the cycle of fire and published research, three factors appear to have the greatest effect on the cartridge case as a result of the firing process and therefore, the potentially detrimental effects on any latent fingerprints thereon: extreme heat, high pressure in the chamber, and blowback gases.[8] When a person manually loads a firearm, their fingerprints can be deposited on the cartridges or ammunition. These latent prints are what examiners and researchers attempt to recover, after the gun has been fired. However, due to the aforementioned detrimental factors, these attempts are more often than not unsuccessful in producing quality identifiable fingerprints.[9,10,11,12] In North Carolina, there was one similar study from 2019 that examined 511 fired brass 9mm Luger cartridge cases for latent fingerprints. The technique used was superglue fuming followed by Rhodamine-6G dye staining. The 511 prints were naturally placed, meaning there was no deliberate deposition of fingerprints on the cartridges. None of the 511 cartridge cases yielded any friction ridge detail.[14]

The heat from the blowback gases can negatively affect the latent print in a variety of ways. Due to latent print residue consisting of mostly water, the extreme temperatures evaporate any moisture in the print. It is possible that the amino acids in the latent print residue likely denature because of the heat, consequently affecting enhancement techniques that target the amino acids, such as amido black and ninhydrin.[1]

The high pressure in the chamber results from the propellant and primer burning rapidly, which in turn causes the cartridge case to expand. This expansion, referred to as obturation, forces the cartridge case to physically contact the inside of the chamber wall as it is extracted and ejected. The friction introduces another reason for low recovery of latent prints; the residue can be literally smudged and obliterated by the chamber wall.[11]

The gaseous blowback when the gun is fired contains a mixture of combustion gases, “propellant by-products,” and gunpowder.[9,10] These gaseous particles can coat the cartridge case and have the potential to interfere with enhancement techniques, thus affecting the recovery of latent prints. These particles could physically damage the latent print residue as well.

This research study sought to determine if it is beneficial to attempt to recover identifiable latent fingerprints from fired cartridge cases. Five experimental objectives were designed to aid in determining the final conclusion. The first objective examined a sample set of cartridges directly from the manufacturer’s packaging, followed by processing for latent fingerprints to confirm there are no fingerprints present prior to loading or firing. The second objective examined a sample set of cartridges directly from the manufacturer’s packaging and intentionally deposited fingerprints onto the surface of the cartridge case, then followed by processing for latent fingerprints. This analytical step was designed to confirm that not only were fingerprints present, but also that they can be successfully detected on unfired cartridge case surfaces. The third objective examined a sample set of cartridges directly from the manufacturer’s packaging, then loaded and unloaded the cartridges from the firearm magazine in a standard manner (without cycling or firing from a firearm), and followed by processing for latent fingerprints. This analytical step was designed to observe the loading process’ potential effect on detecting identifiable latent fingerprints. The fourth objective examined a sample set of cartridges directly from the manufacturer's packaging, then loaded the magazine and cycled through the firearm (without firing) in a standard manner, and followed by processing for latent fingerprints. This analytical step was designed to observe the cycling process' potential effects on detecting identifiable latent fingerprints. The final objective examined a sample set of cartridges removed directly from the manufacturer's packaging, then loaded the magazine, fired the firearm in a standard manner, and followed by processing for latent fingerprints to observe the firing process' effect on detecting identifiable latent fingerprints.

Methods and Materials

Preliminary Methods

Prior to beginning the examination of cartridges, information was gathered from the Henrico Police Department, Chesterfield Police Department, and Virginia Department of Forensic Science. This information included standard policies for collecting and packaging fired cartridge cases, processing cartridges for latent fingerprints, and any cleaning process that may be applied to the cartridge cases following latent processing and/or prior to the firearms analysis. The purpose was to simulate realistic and common methods used by current law enforcement crime scene units and forensic laboratories.

Three different dye stains were available for use after superglue fuming: MBD, Rhodamine 6-G, and Basic Yellow. However, only one was used to minimize the possible variables in the analysis. To determine which dye stain should be used, fingerprints were rolled onto previously fired cartridge cases to ensure the presence of latent prints and use the same evidence material. Then, these cartridge cases were processed using cyanoacrylate (superglue) fuming. Different sets of cartridge cases were be treated with the three different dye stains available. The dye stain that exhibited the best overall results in quantity and quality was used through the duration of the experiment. It was determined that Basic Yellow yielded the best results and prior research supported this result[9,13].

Reagents, Ammunition, and Firearms Used

For the present study, Basic Yellow premix (lot# 979654 or 313008 Evident) and superglue were used to develop latent fingerprints on fired and unfired cartridges. The cyanoacrylate fuming chamber used was a Misonix, model CA-3000 (SN# CA04430810).

Focusing on the most frequently observed calibers (9mm Luger and 40 Smith & Wesson) and cartridge case material types (brass and nickel-plated) observed in casework in most crime laboratories, a total of 740 cartridges were used for analysis. These calibers and cartridge case material types were determined after consulting with an experienced firearms examiner, Stephanie Walcott, who saw these most frequently over the years she worked on casework. One hundred and eighty-five (185) brass case 9mm Luger cartridges were used for analysis. Federal Champion Full Metal Jacket (FMJ) Brass case 9mm Luger 115 grain (lot# H17B410) ammunition was used. One hundred and eighty-five (185) nickel case 9mm Luger cartridges were used for analysis. Federal Premium Jacketed Hollow Point (JHP) Nickel case 9mm Luger 147 grain HST (lot# 6PL2A079A077 & S51P093) ammunition was used. One hundred and eighty-five (185) brass 40 S&W cartridges were used for analysis. Federal American Eagle FMJ Brass case 40 S&W 180 grain (lot#D258V42D259V61) ammunition was used. One hundred and eighty-five (185) nickel case 40 S&W cartridges were used for analysis. Federal Premium JHP Nickel case 40 S&W 155 grain Hydra-Shok (lot# Q50X570) ammunition was used. Table 1 summarizes the five groups that were examined.

Table 1. Ammunition that was examined.

	Brass 9mm Luger	Nickel 9mm Luger	Brass 40 S&W	Nickel 40 S&W
Neg. Control	5	5	5	5
Pos. Control	5	5	5	5
Loaded	25	25	25	25
Cycled	25	25	25	25
Fired	125	125	125	125
Total used	185	185	185	185

For the 9mm Luger cartridges, a Sig Sauer model P229 (SN# 55B007376) firearm was used for loading, cycling, and firing, while a Glock model 23 Gen4 (SN# RYG485) firearm was used for the caliber 40 S&W ammunition.

Controls

For each group, approximately one gram of superglue was used to process the fired and unfired cartridges. The amount varied slightly due to the size of the drops from the dropper, but the amounts were well within the one to one-and-a-half-gram range suggested by the fuming chamber manual. Each group was fumed for about eight minutes. This was based on observation. The manual suggested placing a black plastic panel inside the chamber. A fingerprint was deposited onto the plastic, and when the print started to turn white, the fuming was completed. However halfway through processing the unfired cartridges, there was some concern about using a piece of plastic as the control for when fuming is done, since the cartridge case material was metal. Therefore, the cartridges were observed during fuming and any latent fingerprint residue began turning white after fuming for about 8 minutes (Table 2).

Table 2. The amount of superglue used and the fuming times for each group.

Group	Amount of superglue used	Fuming time
Negative Control	1.090g	7min 45s
Positive Control	1.090g	7min 45s
Loaded	1.018g	8min 58s
Cycled	1.000g	8min 1s
Fired	1.000g	7min 58s

For the negative controls, gloves were worn to take five cartridges directly from each box of ammunition and placed in the fuming chamber. They were processed with superglue, fumed, and dipped twice into a beaker filled with Basic Yellow dye. This process was done using forceps to grip the head of the bullet while ensuring the entirety of the cartridge casing was submerged. The purpose of this group was to verify there were no latent fingerprints already deposited on the cartridges from the manufacturing and packaging process.

For the positive controls, gloves were worn to take five cartridges directly from each box of ammunition and fingerprints were intentionally deposited or rolled onto the cartridge case walls, and then placed in the fuming chamber. The intentionally rolled fingerprints were made by collecting oils from the opposite palm and placing the thumb onto the cartridge case carefully. They were processed with superglue, fumed, and dipped twice into Basic Yellow dye. This process was done using forceps to grip the head of the bullet while ensuring the entirety of the cartridge casing was submerged. The purpose of this group was to verify that latent fingerprints could be detected on the cartridge case material.

Loaded group

Twenty-five (25) cartridges were taken from each box of ammunition and manually loaded into the magazine in a standard manner. Standard manner means the fingerprints were not carefully and purposefully placed onto the cartridges. This was to mimic how someone would realistically load their magazine. It is unlikely that someone would take measures to ensure their fingerprint is viable. Also, crime labs and law enforcement are likely to receive fingerprints that have not been deliberately placed. Therefore, it is more realistic to load the magazine without focusing on leaving a high-quality latent fingerprint. Gloves were not used when loading the cartridges, but gloves were worn when unloading them. The cartridges were not fired from the firearm. Immediately after being unloaded, the cartridges were placed in the fuming chamber. They were processed superglue, fumed for about nine minutes, and dipped twice into Basic Yellow dye. This process was done using forceps to grip the head of the bullet while ensuring the entirety of the cartridge casing was submerged. The purpose of this group was to show how the loading process may or may not affect the presence and/or detection of latent fingerprints, isolating the loading process from the firing process. This group was fumed for an additional minute than the others; this was due to unrelated circumstances.

Cycled group

Twenty-five (25) cartridges were taken from each box of ammunition and manually loaded into the magazine in a standard manner. The slide on the firearm was pulled back consecutively, forcibly ejecting the cartridges from the chamber. Two officers from the Virginia Commonwealth University (VCU) Police department conducted the cycling of the 9mm Luger cartridges inside their shooting range. The flooring was a rubber turf. An experienced firearms examiner conducted the cycling of the 40 S&W cartridges inside a building with laminate flooring. The cycling of the different calibers occurred at different times.

The cartridges were not fired from the firearm. Gloves were not used when loading the cartridges, but gloves were worn when collecting them. Immediately after being ejected from the chamber of the firearm, the cartridges were placed in labeled 2.5” x 4.25” Kraft coin envelopes (51120 ULINE S-6285). This collection method mimics common procedure for local law enforcement in Richmond, Virginia. They were processed with superglue, fumed, and dipped twice into Basic Yellow dye. This process was done using forceps to grip the head of the bullet while ensuring the entirety of the cartridge casing was submerged. The purpose of this group was to show how the cycling process may or may not affect the presence and/or detection of latent fingerprints, isolating the cycling process from the firing process.

Fired group

One-hundred and twenty-five (125) cartridges were taken from each box of ammunition and manually loaded into the magazine in a standard manner. The cartridges were fired from the firearm and the ejected cartridge cases were collected while gloves were worn. The same two officers from the VCU police department conducted the firing of the 9mm Luger cartridges inside their shooting range. The flooring was a rubber turf. Members of the present study conducted the firing of the 40 S&W cartridges outside on a farm. To ensure all cartridge cases were collected, a blanket was laid on the ground for the casings to fall on, after being ejected from the firearm. The firing of the different calibers occurred at different times.

Immediately after being ejected, the cartridge cases were placed in labeled aforementioned ULINE coin envelopes. They were processed with 1.000 gram of superglue, fumed for 7 minutes and 58 seconds, and dipped twice into a beaker filled with Basic Yellow.

This was done using tongs to grip the bottom of the casing by the extractor groove while ensuring the entirety of the cartridge case was submerged. The purpose of this group was to show how the firing process may or may not affect the presence and/or detection of latent fingerprints on the cartridge case.

Latent fingerprint examination

All enhanced cartridges were screened for any friction ridge detail and set aside. An experienced latent print examiner, Sylvia Buffington-Lester, evaluated them for value and determined if they could be used for comparison. If a print is found to be of value, it can be used for identification or comparison purposes.

A 1 to 5 grading scale was created based off the latent print examiner's determinations (Table 3). The scale was approved by her to be sufficient for this study's purposes.

Table 3. The grading scale used for this research project, depicting the grade and description of the results examined by an experienced latent fingerprint examiner.

Grade	Description
1	No characteristics seen
2	Friction ridge detail is overlapping
3	Further enhancement required to visualize characteristics
4	With further advanced enhancement, there is potential for value
5	Of value, okay to use for comparison

Results and Discussion

After all the cartridges were processed, they were viewed with an alternate light source (ALS). The Basic Yellow dye stain is viewed best between wavelengths 365nm and 485nm. The available ALS was a Crime-Lite 42S. It emits blue/green light, and the wavelength range is

445nm to 510nm. Because of its range, it was suitable to view the cartridges. An orange filter was used when viewing the results.

Upon viewing the negative control group using the ALS and orange filter, there were no fingerprints present on any of the cartridges. This confirms no fingerprints existed on the cartridges after the manufacturing and packaging process.

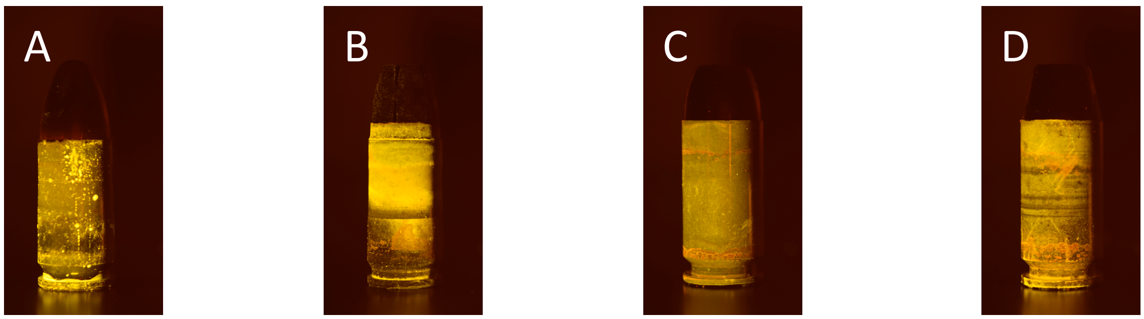

Figure 1. Photos of the negative controls on a: a) brass case 9mm Luger cartridge; b) nickel case 9mm Luger cartridge; c) brass case 40 S&W cartridge; d) nickel case 40 S&W cartridge. Taken with a Nikon DSLR camera model D3300 using a Nikon AF-P DX NIKKOR 18-55mm lens and a 52mm PROMASTER orange (YA2) filter.

Upon viewing the positive control group using the ALS and orange filter, fingerprints were present on all the cartridges except the brass case 9mm Lugers. On the brass case 9mm Luger cartridges, the fingerprints were extremely faint. It appeared the dye stain didn't interact with the fingerprint residue or the superglue well, since the liquid is more easily seen than the friction ridge detail. This can be seen on cartridge A (Figure 2). This could be due to a lack of fingerprint residue or an excess of sweat when the fingerprints were placed. The other positive controls exhibited fingerprints that could be used for comparison purposes.

Figure 2. Photos of the positive controls on a: a) brass case 9mm Luger cartridge; b) nickel case 9mm Luger cartridge; c) brass case 40 S&W cartridge; d) nickel case 40 S&W cartridge. Taken with a Nikon DSLR camera model D3300 using a Nikon AF-P DX NIKKOR 18-55mm lens and a 52mm PROMASTER orange (YA2) filter.

Upon viewing the loaded group using the ALS and orange filter, some of the cartridges exhibited a distinct straight line through the friction ridge detail, which could be attributed to the point of contact the cartridges had with the magazine edge. This can be seen on cartridges A and B (Figure 3). Some of the fingerprints on the nickel case 9mm Luger cartridges exhibited a frosty appearance which resulted in not enough contrast to see any characteristics on the present ridge detail. These were given a grade of 1. This frosty appearance was attributed to over fuming. There is an ideal amount of superglue fumes that adhere or polymerize to the latent fingerprint residue and cartridge case. Over fuming means that the fumes coat both the residue and the background material too much. Frosty is a term that is used to describe this over saturation of fumes. The latent fingerprint is unable to be differentiated from the background or cartridge case material; it’s too opaque. This over fuming of the loaded group makes sense because the fuming time was about a minute longer than the others. This can be seen on cartridge A (Figure 3). Some of the fingerprints on the brass and nickel case 9mm Luger cartridges overlapped one another and require further study to see if a single print could be separated. These were given a grade of 2 and can be seen on cartridge B (Figure 3). Mideo LatentWorks software is used by the Virginia Department of Forensic Science to view and record the necessary documentation while examining latent fingerprints for casework.[15] This is a system that could be used for the required further studies and advanced enhancement of prints. It enlarges the print for better viewing and possibly clarifying if the suspected minutiae are there or not. It was not available to use, so the further studies and advanced enhancement could be considered for future research. One of the fingerprints on the brass case 9mm Luger cartridges showed a large amount of detail but requires further advanced enhancement to pick the characteristics out more clearly. This was given a grade of 3 and can be seen on cartridge C (Figure 3). This further advanced enhancement can be accomplished using the Mideo software. Two of the fingerprints on the nickel 40 S&W cartridges would be of value after further enhancement was conducted. These were given a grade of 4 and can be seen on cartridge D (Figure 3).

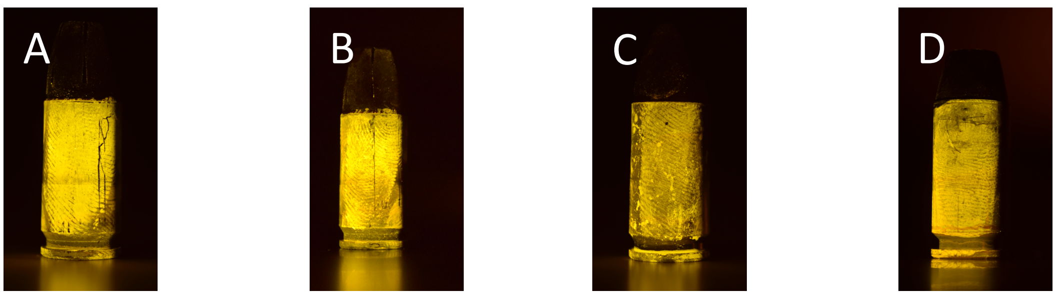

Figure 3. Photos of a: a) nickel case 9mm Luger cartridge; b) nickel case 9mm Luger cartridge; c) brass case 9mm Luger cartridge; d) nickel case 40 S&W cartridge. Taken with a Nikon DSLR camera model D3300 using a Nikon AF-P DX NIKKOR 18-55mm lens and a 52mm PROMASTER orange (YA2) filter.

Upon viewing the cycled group using the ALS and orange filter, it was noted that none of the 9mm Luger cartridges exhibited any friction ridge detail, despite the firearm not being fired. On some of the cycled 40 S&W cartridges, the distinct straight lines from contact with the magazine edge can still be seen. Some of the fingerprints on the brass and nickel case 40 S&W cartridges exhibited ridge detail but it was unclear due to the prints overlapping. These were given a grade of 2 and can be seen on cartridge A (Figure 4). Two of the fingerprints on the brass and nickel case 40 S&W cartridges require further advanced enhancement using the Mideo software. These were given a grade of 3 and can be seen on cartridge B (Figure 4). One of the fingerprints on the brass case 40 S&W was found to be of value and could be used for comparison. This was given a grade of 5 and can be seen on cartridge C (Figure 4). There was no friction ridge detail on any of the 9mm Luger cartridges and this is likely because immediately prior to using the Sig Sauer P229 for the cycled group, the firearm was used to fire all the cartridges in the fired group. Therefore, the firearm's chamber was likely still hot – which past research has proven to negatively affect latent fingerprint residue.

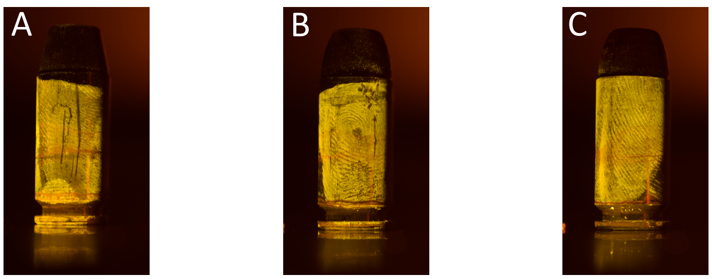

Figure 4. Photos of a: a) nickel case 40 S&W cartridge; b) brass case 40 S&W cartridge; c) brass case 40 S&W cartridge. Taken with a Nikon DSLR camera model D3300 using a Nikon AF-P DX NIKKOR 18-55mm lens and a 52mm PROMASTER orange (YA2) filter.

Upon viewing the fired group using the ALS and orange filter, one brass case 9mm Luger cartridge exhibited five characteristics. If further advanced enhancement determined it to be a single fingerprint using Mideo software, it would be possible to identify enough characteristics to be of value. This was given a grade of 4 and can be seen on cartridge A (Figure 5). One nickel case 9mm Luger cartridge showed some ridge detail, but not enough to be of value. This was given a grade of 3 and can be seen on cartridge B. Some nickel case 9mm Luger cartridges exhibited a very small amount of friction ridge detail by the extractor groove, but not enough minutiae were present to be of value or used for comparison. This is most likely attributed to obturation. However, because the metal is thicker at the extractor groove end of the case and is not as strongly affected by the expansion, some friction ridge detail may survive the firing process. Cartridge B is an example of the small amount of friction ridge detail by the extractor groove. There was no fingerprint ridge detail found on any of the brass case 40 S&W cartridges.

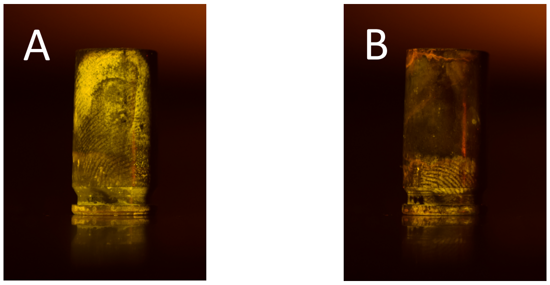

Figure 5. Photos of a: a) brass case 9mm Luger cartridge; b) nickel case 9mm Luger cartridge. Taken with a Nikon DSLR camera model D3300 using a Nikon AF-P DX NIKKOR 18-55mm lens and a 52mm PROMASTER orange (YA2) filter.

When looking at the loaded group and comparing the results of the brass case to nickel case cartridges, there is more overlap of fingerprints on the brass case cartridges. The nickel case cartridges have more variety, ranging from grades 1 to 4. When comparing the results of the 9mm Luger to 40 S&W cartridges, there is more overlap of fingerprints and not enough contrast to see the characters on the 9mm Luger cartridges. The 40 S&W cartridges have a few overlapping fingerprints, but most require further advanced enhancement by Mideo software to see the pattern or to be of value.

When looking at the cycled group and comparing the results of the brass case to nickel case cartridges, there is more variety on the brass case cartridges, ranging from grades 1 to 5. The nickel case cartridges have more overlapping fingerprints. When comparing the results of the 9mm Luger to 40 S&W cartridges, there are no 9mm Luger cartridges with friction ridge detail. Only the 40 S&W cartridges have friction ridge detail.

When looking at the fired group and comparing the results of the brass case to nickel case cartridges, there is little difference between them. The two results' grades were 3 and 4. When comparing the results of the 9mm Luger to 40 S&W cartridges, the 9mm Luger exhibited the most friction ridge detail that could potentially be further enhanced. There are no 40 S&W cartridges that exhibited any friction ridge detail. This could be because the cartridge case is larger than the 9mm Luger and thus potentially encountered more physical abrasion against the chamber of the firearm.

Of the non-fired cartridges – loaded and cycled groups – a majority of the friction ridge detail overlapped. This makes sense because when loading the cartridges into the magazine in a standard manner, there was no deliberate placement of a fingerprint to ensure it was of the highest quality and could easily be distinguished from another fingerprint placed on the cartridge. All 100 of the loaded cartridges exhibited some amount of friction ridge detail. All 50 of the cycled 40 S&W cartridges exhibited some amount of friction ridge detail. All 50 of the cycled 9mm Luger cartridges did not exhibit any friction ridge detail. Of the 500 cartridges fired, only two had any friction ridge detail. Of those two, only one had the potential to be of value, with further advanced enhancement.

Table 4. The grading scale and the results.

Grade	Description	Loaded	Cycled	Fired
1	No characteristics seen	20	2	0
2	Friction ridge detail is overlapping	56	38	0
3	Further enhancement required to visualize characteristics	19	9	1
4	With further advanced enhancement, there is potential for value	5	0	1
5	Of value, okay to use for comparison	0	1	0

Conclusion

This research project prioritized a realistic approach and high volume of samples when determining the efficacy of recovering latent fingerprints from fired cartridges. This priority was achieved by examining common cartridge materials and calibers of ammunition seen in forensic casework. Additional experimental control was shown by adhering to a common collection method of fired cartridge cases utilized by local law enforcement. Unlike previous research studies with smaller sample sizes, this project used over 700 cartridges; more than half of which were discharged. A high volume of samples provides more data and potential outliers. This project also attempted to isolate stages of the firing process by examining the loaded, cycled, and fired groups.

This work will impact the forensic field by serving as a guide for future research taking further steps, as well as suggesting possible success with fired brass and nickel case 9mm Luger and 40 S&W cartridges, for a requested examination which may be contributing to casework backlog.

While this experiment created a solid foundation for looking at the recovery rate between latent fingerprints and fired cartridge cases, there are several additional variables that should be considered in future studies. It is important to keep the same methodology of realistic handling and a high volume of samples. These will improve the value and applicability of the results to actual forensic casework. Further research studies should look into repeating similar, past studies with a higher volume of samples. Different calibers should also be considered, such as different handguns, rifles, and shotguns. Cartridge cases can be made of different materials such as aluminum or steel with olive, gray, or brass finishes. Thus, different cartridge case material should also be considered.

Taking all results into consideration, the firing process drastically affected the recovery of latent fingerprints in a negative way. It does not appear to be overly beneficial to attempt to recover latent fingerprints from fired brass and nickel case 9mm Luger and 40 S&W cartridges. The loaded and cycled groups did not appear to negatively affect the enhancement of latent fingerprints, with the exception of the 9mm Luger cartridges from the cycled group. If a firearm at a crime scene was found with unfired brass and nickel case 9mm Luger and 40 S&W cartridges in the magazine, it would be beneficial to attempt to recover the latent fingerprints. While it should be expected that fingerprints would be overlapping, there is the possibility of using Mideo software to separate them and further enhance for potential value.

This research project created a solid foundation for future research studies to expand upon. One consideration is to repeat similar past studies, with the new methodology. This means realistic collection and handling of cartridges, and high volume of samples. Additionally, different calibers such as handgun, rifle, and shotgun ammunition should be examined. This study only looked at 9mm Luger and 40 S&W cartridges. It is possible that other calibers could affect the efficacy of recovering latent fingerprints in a positive way, but only future research will be able to determine that. Also, different firearms such as revolvers, rifles, and shotguns should be used. Cartridge cases can be made using different materials, so future research should examine different cartridge case materials such as aluminum or steel with olive, gray, or brass finishes. Lastly, pairing superglue fuming with a dye stain is not the only way to enhance latent fingerprints. Black powder can be used after superglue fuming as well, another future research consideration. Some past studies often paired superglue fuming with a dye stain and gun bluing. Gun bluing is another enhancement method and could be added as an additional follow-up technique in future research.

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Vita

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