

Junior Science and Humanities Symposium

Longevity of the Latent Fingerprints of Children vs. Adults

Raleigh Blasdell
Rochester High School

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INTRODUCTION

The purpose of this study was to determine if there was a difference in the longevity of the latent fingerprints of children vs. adults. In 1995, while investigating the abduction of a child, a criminologist in Tennessee was puzzled by the fact that he was unable to find any latent fingerprints of the child in the car which he was certain the child had been placed (Noble, 1995). Four days had passed since the abduction, and generally the lifting of latent fingerprints after this short time frame does not present any difficulties. It led him to question why the fingerprints of the child had disappeared.

It is a commonly held belief that there is no difference in the evaporation rates of the latent fingerprints of children and adults. The fingerprinting manual published by the Federal Bureau of Investigation does not indicate that there is any difference (Science, 1973). Most law enforcement personnel also are unaware that there may be a difference in how long the latent fingerprints of children vs. adults may last (Buchanan, 1997; Marass, 1997; Ryling, 1997; Stivers, 1997; and Wright, 1997.) The studies suggesting that a difference exists are extremely limited (Buchanan, Asano, and Bohanon, 1997; Noble, 1995).

In order to resolve this controversy, a controlled study was warranted. Although children are not usually involved in crimes, latent fingerprinting is a valuable tool in cases of missing children. It allows law enforcement personnel to identify the missing child and place the child at a location. If the latent fingerprints of children do disappear within forth-eight hours, as one author suggests (Noble, 1995), this has important implications for law enforcement personnel and the science of forensics.

Modern Fingerprinting

Fingerprinting is a method of identifying persons using the impressions that are made by the minute ridge formations or patterns of the fingers. Each person's fingerprints are unique. No two persons have exactly the same patterns or ridges, and these patterns do not change over the lifetime of the person (Fingerprinting, 1997).

Fingerprinting is a fundamental component in forensic science and modern law enforcement. Fingerprints have been used to identify missing persons, to place persons at the scene of a crime, and to convict persons in a court of law. Because no two persons' fingerprints are identical, they can positively identify an individual.

In 1924, the Federal Bureau of Investigation (FBI) established the Identification Division of the FBI, which maintains a library of fingerprints. Currently, there are over 250 million civil and criminal fingerprint cards on file there. These cards are now being computerized and placed in the new Integrated Automated Fingerprint Identification System (IAFIS) which will allow a quick and efficient computerized identification of fingerprints (Fingerprinting, 1997). These fingerprints can be electronically sent out to other law enforcement agencies as well.

The Fingerprinting Procedure

Fingerprints are impressions left by the friction ridges found on the inner surfaces of the fingers. These prints are the result of body sweat and body oils being transferred from the finger to a surface touched by the person. The surface must usually be fairly smooth, hard, and clean. Items such as glass, aluminum, polished metals, polished woods, plastic bags, porcelain, china, smooth painted surfaces and hard plastic are ideal surfaces for fingerprints. Rough or porous surfaces, such as raw wood, grained leather, and cloth tend not to yield as adequate fingerprints (Marriner, 1994; Science, 1973; Stivers, 1997).

Fingerprints are classified into three categories: 1) latent (invisible to the naked eye without some sort of development), 2) visible (can be seen by the naked eye such as an inked fingerprint on a piece of paper), and 3) molded (an indented print such as that left in thick blood or cement). Latent prints require some form of development, usually with a powder, to make them visible for photography and identification. (Science, 1973; Stivers, 1997; Wright, 1997).

In order to develop latent prints, powders can be brushed lightly over a latent-bearing surface. This causes the powder to cling to the grease or moisture in the ridges of a latent print, making it visible to the naked eye. There are several types of powders that can be used and they come in several colors. A powder that contrasts with the surface will yield the most visible print. Gray and black powders are used most often on light surfaces. Aluminum powder will give the same contrast as gray. Gold and red bronze powders photograph dark and should be used on light surfaces. Dragon's blood powder is neutral and can be used on dark or light surfaces (Science, 1973; Wright, 1997).

Following the careful dusting of a latent surface, the print must then be lifted onto a special tape. Lifting tape is transparent and is pressed against the surface and then carefully peeled off the surface. The lifting tape is then placed on a light or dark card for storage. The tape transfers the print and protects it as well. The print can then be photographed on the card or the card can be stored or sent on for identification (Science, 1973; Stivers, 1997; Wright, 1997).

Sometimes, latent prints may not be visible. There are newer techniques that can be used to chemically develop the latent impressions. These techniques are especially helpful on porous surfaces that typically do not yield a good latent print. Some of these substances include iodine,

ninhydrin, silver nitrate, and ultraviolet light (Forensics, 1997; Science, 1973; Stivers, 1997; Wright, 1997).

Factors affecting latent fingerprints

Sometimes, latent fingerprints are difficult to find, even when it is known that a subject touched a latent surface. The transfer of latent prints is dependent upon sweat and body secretions, especially oils, being transferred to the surface from the skin. There are several factors that have been suggested to affect latent fingerprints. The condition of a person's skin and the amount of oil and sweat normally secreted can affect the quality of the latent print. Another factor that can effect the print is the climate. The climate will affect the amount of body sweat. Warmer temperatures produce better prints. Emotional reflexes also affect sweat and can affect the transfer of body secretions. Fear and excitement will increase sweat and the amount of secretions present in the latent print. Finally, the amount of pressure applied when the hand touches the latent surface will affect the print. The more pressure applied when touching the surface, the greater the transfer of secretions and the better the print (Buchanan, 1997; Stivers, 1997).

Recently, another factor has been proposed that may affect the transfer of latent prints: age. In a study published in the Journal of Analytical Chemistry (Noble, 1995), a researcher suggested that the latent fingerprints of children may evaporate quicker than the latent fingerprints of adults. It was suggested that the prints of a child may completely disappear from the latent surface in as little as forty-eight hours. The latent prints of adults, in contrast, can last a week or longer. In a study that analyzed the chemicals present on the fingertips of adults and children (Buchanan et al., 1997), children were found to have greater amounts of long chain carboxylic acids which are volatile, low molecular weight, free fatty acids. These fatty acids

evaporate relatively fast. The adults, in contrast, had fewer of these volatile free fatty acids. The adults had greater amounts of long chain alkyl esters, which are higher molecular weight, less volatile lipids. These esters do not evaporate as quickly as do the fatty acids found on the fingers of the children.

It is interesting that the high molecular weight lipids are thought to come from sebaceous glands which have their highest density on the scalp and face and are relatively absent on the palms of the hands (Nicolaidis, 1974). Furthermore, sebaceous secretions increase following puberty (Nicolaidis, 1974), and most of the skin surface lipids are from sebaceous excretions (Rongone, 1983).

Both adults and children will have eccrine secretions from the sweat glands on the palms of the hands. These secretions also will bind to the powders used when dusting for prints, and it can be assumed that they will evaporate because of the high percentage of water contained in sweat (Buchanan et al., 1997).

The guidelines utilized by the FBI do not recognize any difference in the rate of evaporation of the latent prints of adults vs. children (Science, 1973). Further more, Ryling, regional director of the FBI fingerprinting division in Springfield, IL., stated that he does not believe there is a difference between the two (Ryling, 1997).

In conclusion, fingerprinting is an important component of forensic science and law enforcement. Fingerprints result from the deposit of body sweat and oil on a surface. The lifting of latent fingerprints involves the development of the print by dusting it with powder, making it visible, and transferring it to a transparent tape. Factors that affect latent prints include climate, emotion, the condition of the skin, and the amount of pressure applied. Most authorities do not believe that age of the subject affects the latent print, however, recent findings suggest that the

latent fingerprint of a child, which is higher in fatty acid content than that of an adult, evaporates much quicker than the print of an adult. This is an area that requires further research. A controlled study that investigates the difference in the disappearance rate of the prints of children vs. adults is needed. The results would have implications for law enforcement personnel and forensic scientists.

MATERIALS AND METHODS

A consent form was prepared following federal guidelines for the use of humans in experimentation (45CRF46) along with an introductory letter to be given to subjects and their parents/guardians. Following the approval of the Institutional Review Board, potential subjects were contacted using a non-probability sampling technique. Children under the age of 10 and adults over the age of 24 were invited to participate. Adolescents were excluded from the study because of the literature suggesting that a change in chemical secretion occurs during adolescence. Written informed consent was obtained from all adult subjects and from the parents/guardians of all child subjects.

Following consultation with the local FBI forensic lab and the Rochester Police Department, the researcher learned the technique of lifting latent fingerprints at the Rochester Police Department. Fingerprints were then obtained using the following technique. Each subject wiped his hands on a dry paper towel. This procedure was instituted to control for possible contamination of food, dirt, occupational or work-related substances, etc. that could alter the prints of adults vs. children. In order to control the pressure exerted, the researcher then assisted each subject in pressing one of his fingers firmly onto a clean glass slide. Each subject pressed four different fingers on four different slides. The researcher wore vinyl gloves during the procedure to avoid leaving her own prints on the slides. The slides were labeled with the

subject's identification number. A written record was made assigning subjects an identification number with the subject's age and gender. No names or other identifying characteristics were collected on subjects. The subject's age and gender did not appear on the slide. All slides were stored together in a slide tray in an oven with an internal temperature of 100-120 degrees Fahrenheit (64.5-76 degrees Centigrade). Prints were lifted on days 1, 3, 5, & 7 (day 1 being the day the prints were made on the slides) using standard techniques for lifting latent prints. The researcher wore vinyl gloves during the procedure to prevent contaminating the slide. Because of the possible untoward health effects of accidentally inhaling the powder while dusting multiple prints in a short period of time, the researcher also wore a lab coat and mask for protection (as suggested by the regional FBI laboratory). Latent prints were taped to white index cards and each card was labeled with the subject's identification number and the day of the print. Because it is known that a small percentage of people do not leave much in the way of a latent print, prints were lifted on the evening of the first day for all subjects. This would also insure that adequate pressure had been exerted by both the children and adults. If a print could not be obtained on the first day, the subject was eliminated from the study.

In analyzing the prints, the four fingerprint cards of each individual subject were compared using a magnifying glass. If a minimum of 25 ridges of a print were no longer discernable, the print was considered smudged or inadequate and the day (day 3, 5, or 7) was recorded in the record book next to the subject's identification. By only the subject's identification number being present on the slide and index card, the researcher was unaware of the age of the subject while examining the print and making a decision regarding its presence, thus eliminating any researcher bias in the interpretation of the data. To confirm the researcher's judgment and eliminate any researcher bias, all cards were also reviewed by an independent retired police

detective who was unaware of the subject's age and the researcher's decisions regarding the clarity or disappearance (fewer than 25 ridges) of the print. The police detective's decisions were independent of the researchers. If there was any disagreement, the police detective's judgement regarding the presence or absence of a clear print prevailed.

RESULTS

Fifty adults participated in the study. The ages of the adults ranged from 24-54 years of age. Three were eliminated because a clear latent fingerprint was not present on any of the slides on the first day. The remaining forty-seven adults had clear prints on the first day. Of the 47 adult prints, all could still be lifted on days three and five; none were smudged or inadequate. On day seven, 4 (8.51%) of the adult prints were no longer clearly visible, but were smudged, no longer showing clear ridges and with portions of the print gone. (See figure 1.)

Fifty children participated in the study. Their ages ranged from 2-10 years of age. All 50 had clear latent prints on the first day of the study and remained in the study. On day three, 10 (20%) of the 50 subjects had prints that were no longer clear, but were smudged or inadequate. On day five, 27 (54%) of the 50 children's prints were smudged and no longer complete. Finally, on day seven, 38 (76%) of the 50 children's prints were smudged and no longer clear or complete. (See figure 2.)

The difference between the two groups of subjects was statistically significant on all days on which measurements were made. On day three, 20% of the children's prints were inadequate compared to 0% of the adults' prints ($\chi^2 = 10.49$, $df = 1$, $p < .01$). On day five, 54% of the children's prints were inadequate compared to 0% of the adults' prints ($\chi^2 = 35.20$, $df = 1$, $p < .001$). Finally, on day seven, 76% of the children's prints were inadequate compared to 8.51% of the adults' prints ($\chi^2 = 44.94$, $df = 1$, $p < .001$).

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DISCUSSION AND CONCLUSIONS

The purpose of this study was to determine if there was a difference in the longevity of the latent fingerprints of children vs. adults. Based upon the data analyzed in this study, the prints of children were found to disappear or become smudged much sooner than the prints of adults. All but 4 (8.51%) of the adult prints remained seven days. The prints of over half (54%) of the children became unclear by the fifth day with 76% of the children's prints becoming smudged and unclear by the seventh day. The latent fingerprints of children in this study did not remain as long as the prints of adults.

One can not say for certain why the latent fingerprints of children disappeared within a week while the prints of adults did not. Dr. Buchanan of the Oak Ridge National Laboratory (Buchanan et al., 1997) has determined that children have a higher amount of volatile esters on their fingertips than adults have. These esters evaporate at a faster rate than the less volatile lipids that adults have on their fingertips. This might explain why the latent prints of children evaporate quicker since the powders used to lift latent prints attach to the oils and sweat secretions that are left on a surface after touched by the subject. There may also be additional substances secreted by the skin that also change with age that could bind to the powders used. There is less material left in the fingerprints of children, and the compounds that do remain may not be very reactive with conventional cyanoacrylate, ninhydrin, or amido black dyes (Noble, 1995), such as the one used in this study.

There are several limitations in this study that the researcher has tried to address in the design of the study. If the reason that prints disappear or become smudged is because they evaporate, then the ambient temperature and humidity could be expected to affect the rate of disappearance. All fingerprint slides were kept in the same location with the same temperature

and humidity to control for this. As was discussed in the preceding review of literature, the warm environment of the oven was chosen because of the original difficulty the forensic specialist had in lifting prints from a car that had sat outside in the summer months (Noble, 1995). Still, in this study, the prints of children disappeared while those of the adults remained. A reasonable question might be to see if this same difference would exist in different ambient temperatures. This was a controlled study. Crime scenes obviously occur at many different ambient temperatures, and at cooler temperatures, the difference may not exist. This is an area for future investigation.

Another possible variable is the condition of the skin at the time the object is touched. Dry, clean skin may not leave as good a print as skin with more oil on it or any other sticky substance. It can be assumed that most persons, children and adults, probably touch their clothing throughout the day, and in essence, are wiping their hands in a manner similar to the dry paper towel used. However, adults may also come in contact with work-related chemicals or substances and children may retain food, dirt, etc. that one could argue would bias the print. Again, the author tried to control for this by having all subjects wipe their hands on dry paper towels before touching the slides. It is still possible, however, that one group had cleaner skin than the other. A tighter control would be to clean each subject's hands with rubbing alcohol before printing, however, there might be objections in terms of introducing rubbing alcohol onto the skin of children who may be sensitive to it. Another objection would be that such a procedure prior to printing would not likely occur in a real crime scene.

That same objection could be applied to the researcher trying to have a uniform amount of pressure applied for each fingerprint. This study could be strengthened if the actual amount of pressure was measured, however, one could also state that such an artificial scenario would not

be duplicating real conditions and technically difficult. In a real crime scene, the pressure would vary. In this study, the researcher, following the instructions of the evidence specialist of Rochester Police Department, tried to insure that all subjects pressed firmly onto the slides. As a check against possible bias on the researcher's part or inadequate pressure exerted, latent fingerprints were lifted for all subjects on the evening of day 1. Had inadequate pressure been present, a print would most likely be smudged or inadequate on that first day and the subject eliminated from the study. Three adults were eliminated on the first day because of inadequate prints, however, none of the children were eliminated because all had satisfactory prints on the first day.

Another possible variable or limitation in this study was the procedure to determine if the prints were still present or if they had become smudged or disappeared. In order to control any researcher bias, all prints were examined by an objective professional independently of the researcher. A gross inspection, using only a hand-held magnifying glass, was used to determine the presence of the latent fingerprint, and the procedures used were uniform for both the adult and child group. In difficult crime situations, however, modern forensic science has additional techniques that can be employed when a print does not appear visible. There are chemicals that can be used to help develop latent finger impressions on absorbent surfaces. While glass is considered a non-absorbent surface, it is possible that a forensic laboratory might be able to employ some of these processes. Also, with the advent of advanced computer classification of fingerprints, forensic computers may also be able to enhance the quality of the latent print. A reasonable follow-up to this study would be to have the glass slides examined in a forensic laboratory utilizing some of the newer chemical development techniques.

Finally, the sample size (47 adults and 50 children), while adequate for statistical purposes, should be enlarged. The researcher is currently continuing this research with the goal being a larger sample size and the possible use of other latent fingerprint development techniques.

Despite the limitations mentioned above, in this study there was a difference in how long the latent fingerprints of children vs. adults last. The prints of children disappeared or smudged much faster than the prints of adults. The findings of this study suggest that under certain conditions, the latent fingerprints of the majority of children may no longer be visible after five days or more. The latent fingerprints of adults may remain a week or more. Time may become a critical variable in criminal investigations requiring the lifting of latent fingerprints of children.

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