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Article

Pilot Study: The Application of ACE-V to Simultaneous (Cluster) Impressions[1]

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Abstract: In December 2005, the Supreme Judicial Court of Massachusetts ruled that applying the ACE-V methodology to simultaneous impressions did not satisfy the requirements set forth in Daubert. Specifically, the Court stated that there was insufficient research on the topic of simultaneous impressions. This paper explores the hypothesis that an examiner can, after a thorough analysis, successfully determine whether two or more latent impressions were deposited at the same time. The study consisted of a series of thirty (30) latent impressions that were sent to volunteer latent print examiners around the world. Their task was to examine each impression and apply ACE-V to determine whether the impressions were truly simultaneous in nature. The data indicate that when making a definitive determination of either true or false, the participants were correct nearly 88% of the time.

Introduction

Budowle et al. defined simultaneous impressions as "…two or more friction ridge impressions from the fingers or palm of one hand that are determined to have been deposited at the same time" [1]. They further call for protocols and guidelines to be written, as well as documentation in the examiner's report.

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Many examiners recognize the term "cluster" as simply referring to a grouping of impressions on a given substrate, regardless of whether they were deposited during a single touch. The author acknowledges this, but also realizes that there are some examiners who use the terms "cluster impressions" and "simultaneous impressions" interchangeably. Although in the strictest sense the terms are not synonymous, for the purposes of this paper they will at times be used as such. This should present no difficulty for the reader.

SWGFAST noted "the ability to recognize simultaneous or adjacent friction ridge impressions and their value for examination" as one of its required training objectives under friction ridge examination [2]. Speaking of two prints that are located on opposite sides of a piece of glass, Ashbaugh stated, "When the prints are found to be in sequence in the opinion of the forensic identification specialist, the weight of unique details in both prints are accumulative in the aggregate toward individualization of the donor." [3] He further referred to this type of analysis as an "advanced technique" and one that "… may not be as easy to defend in court without a clear rationale derived from a structured analysis".

Regarding cluster impressions, Cowger stated, "As a practical matter, such a group of prints may be considered a single print for comparison purposes." [4] He further stated that "… even if the individual prints are inadequate for a conclusive determination of identity, the donor can be identified based upon a comparison of the entire group". Finally, he noted, "… that two persons may touch an object in such a manner that their prints will appear to constitute a group; caution must therefore be exercised in determining groups of prints for the purpose of search and comparison". This last statement actually alluded to a counter-hypothesis put forth by critics and will be briefly addressed in a subsequent section.

Ostrowski stated, "… this is an advanced technique that should be utilized with the utmost scrutiny" [5]. He also said, "… a complete scientific analysis of the latent impressions is needed before coming to the conclusion that a grouping of latent impressions are indeed simultaneous". Also, and consistent with Ashbaugh and Cowger, he noted, "they will be compared using the accumulative weight of the friction ridge detail in sequence for all of the impressions".

What the reader should glean from the preceding information is that simultaneous impressions do play an important role in fingerprint identification, that they can be used, and that they will require a thorough analysis complete with documentation. Fingerprint examiners have known this for years, albeit intuitively, yet until now, no formal studies have been conducted to test the hypothesis that simultaneity can be reliably determined after a thorough analysis.

Background

The Supreme Judicial Court of Massachusetts heard, and rendered a decision in, the case of *Commonwealth v Patterson* in the fall of 2005 [6]. In its opinion, the court presented an excellent factual history of the case which will not be discussed in great detail here. The case involved the murder of a Boston Police Department detective. Crucial fingerprint evidence on the detective's vehicle subsequently placed the defendant at the scene. This evidence consisted of a cluster of latent impressions that were determined by the examiner of record to have been deposited simultaneously. Furthermore, the examiner determined that none of the impressions in the cluster were able to stand alone regarding a conclusion of individualization. However, on the basis of the analysis that revealed this to be a simultaneous impression, the examiner used the information present in the aggregate to effect the individualization of the defendant.

This study is not specifically addressing the situation where none of the impressions stand on their own, nor does it need to. This is because the issue of simultaneity is being examined. If that condition can be demonstrated to exist, regardless of the amount of information available, then an examiner should be able to use the information contained within the aggregate to effect an individualization. If simultaneity cannot be supported, then each impression must be evaluated independently of the others.

In its ruling, the court upheld the overall reliability of both the ACE-V methodology and fingerprint evidence [7]. Also, it recognized SWGFAST as the body that sets the guidelines and standards for the fingerprint community. It also stated that the error rate for single latent fingerprint individualizations is low, but recognized that no data exist regarding simultaneous

impressions. More importantly, it ruled that the application of ACE-V to simultaneous impressions does not satisfy a Daubert analysis. This is because the court found that the technique lacks widespread acceptance by the fingerprint community, that no testing has been documented, that no publications exist, that there is no error rate information, and that there is a lack of accepted universal standards controlling its use [6]. The reader is encouraged to review the Daubert decision for a complete explanation of the criteria set forth regarding scientific evidence [8].

Ashbaugh referred to the analysis of simultaneous impressions as a "structured analysis" that naturally follows from a holistic approach to fingerprint individualization as opposed to a numerical standard. His approach involves such considerations as substrate, matrix, development media, deposition pressure, pressure distortion, red flags, and anatomical aspects [9]. These factors must be considered during any analysis involving possible simultaneous impressions.

Triplett and Cooney associate ACE-V with hypothesis testing [10]: analysis (A) with data collection, comparison (C) with the testing phase, evaluation (E) with conclusion, and verification (V) with peer review. Regarding the verification portion of the methodology, they state that it should not be confused with confirmation, or simply upholding the initial conclusion. They further state that for peer review to be conducted properly, there should be an attempt to falsify the original examiner's conclusion or how it was drawn.

Hypothesis and Counter-Hypotheses

The question at hand is this: Can two or more impressions be reliably determined to have been deposited at the same time from a single donor? The resulting hypothesis is that an examiner can, in many instances, after a thorough analysis, correctly determine that two or more latent impressions were deposited at the same time by a single donor. The counter-hypotheses put forth by opponents of this technique are either that the alleged simultaneous impressions could involve more than one donor (and could thus be mistakenly considered to be truly simultaneous in nature) or that the impressions could have been left by a single donor during separate touches (and could likewise be mistaken for simultaneous impressions).

Materials and Methods

Numerous bona fide simultaneous impressions were deposited by the author and others on a flat glass substrate. This substrate was cleaned prior to each series of depositions. The matrix of each impression was a sebaceous and sweat mixture. Black powder was used as the development medium. Once developed, each impression was lifted and placed on a standard lift backing card. These impressions were then captured at 1000 dpi using a Hewlett Packard Scanjet 8290 and were stored as JPEG files.

A second set of impressions (Subset A) was then deposited on the same substrate. Both the matrix and development medium were the same as above. This time, two donors were used to create each cluster. Donor #1 deposited two or three prints simultaneously, using any degree of pressure or distortion he chose. (For purposes of simplicity and to ensure anonymity, male pronouns will be used throughout this article.) This information was unknown to Donor #2. The author directed Donor #2 to deposit a latent that would correspond numerically to the deposit from Donor #1. In other words, if Donor #1 deposited fingers 7 and 8, Donor #2 was instructed to deposit finger 9. Donor #2 could visualize the deposits from Donor #1 (using ambient lighting) and therefore tried to mimic the orientations of these deposits. However, Donor #2 had no knowledge of deposition pressure or distortion. All impressions in Subset A were false simultaneous impressions. These were developed, captured, and stored in the manner described above.

A final set of impressions (Subset B) was deposited in a manner similar to those in Subset A, with one major exception. After the latents were deposited by Donor #1, the author covered them with paper so that the top of the paper was placed at the upper limit of the impressions. This ensured that Donor #2 had no knowledge of the orientations prior to making the subsequent deposits. Additionally, Donor #2 had no knowledge of friction ridge area deposited. The unknowns of deposition pressure and distortion were preserved as well. All impressions in Subset B were false simultaneous impressions. Once again, they were developed, captured, and stored in the manner previously described.

Overall, thirty impressions were selected for this study. Eighteen were true simultaneous deposits and twelve were false. Six impressions each from both Subsets A and B were used. All images were stored on a compact disc, along with complete instructions and a worksheet (Figure 1). This worksheet was designed to be electronically populated for ease of use. The examiner was instructed to mark his conclusions on the top line. The choices were true, false, and inconclusive. True would mean that the prints were a simultaneous impression, false would mean that the prints were not deposited simultaneously, and inconclusive would mean that the participant was unable to make a determination.

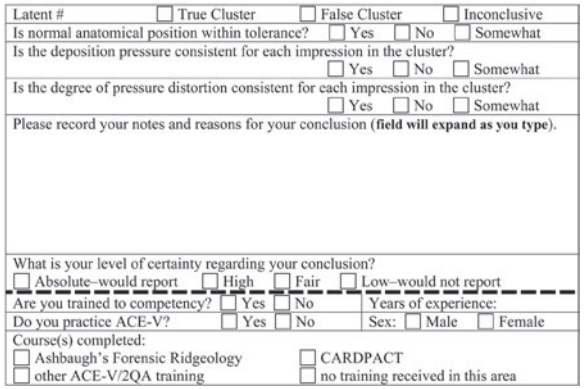
Latent # ☐ True Cluster ☐ False Cluster ☐ Inconclusive
Is normal anatomical position within tolerance? ☐ Yes ☐ No ☐ Somewhat
Is the deposition pressure consistent for each impression in the cluster? ☐ Yes ☐ No ☐ Somewhat
Is the degree of pressure distortion consistent for each impression in the cluster? ☐ Yes ☐ No ☐ Somewhat
Please record your notes and reasons for your conclusion **(field will expand as you type)**.
What is your level of certainty regarding your conclusion?
☐ Absolute–would report ☐ High ☐ Fair ☐ Low–would not report
Are you trained to competency? ☐ Yes ☐ No Years of experience:
Do you practice ACE-V? ☐ Yes ☐ No Sex: ☐ Male ☐ Female
Course(s) completed:
☐ Ashbaugh's Forensic Ridgeology ☐ CARDPACT
☐ other ACE-V/2QA training ☐ no training received in this area

Figure 1

Simultaneous impression worksheet.

Support for these conclusions would be given by responding to the first three questions and recording any bench notes in the next section. Examiners were then asked to designate their level of certainty, or confidence. The options were "Absolute – would report", "High", "Fair", and "Low – would not report", and were assigned values of 4, 3, 2, and 1, respectively, in a manner similar to that used by Wertheim, Langenburg, and Moenssens [11]. The confidence system also allows the researcher to determine which errors were associated with a high degree of confidence. Levels of confidence were defined in the instructions as follows:

> "The 'Absolute – would report' option means that you would record, in actual casework, the rationale for your conclusion in your bench notes. In other words, you would state definitively why the impression either is or is not simultaneous. Also, this option would be applicable if your departmental policy would permit you to record your conclusion of simultaneity in your formal report. All remaining options should be self-explanatory."

All participants were provided the information regarding substrate, matrix, and development medium because, in actual casework, if the participant collected this type of evidence at the crime scene, then he would know both the substrate and development medium and could certainly opine about the matrix based on education, training, and experience. Likewise, if the participant received this type of evidence in the laboratory, then he could conduct an analysis and determine whether the evidence was consistent or inconsistent with the information provided on the lift backing card.

Results and Discussion

Participant Demographics

Thirty-one examiners (16 male and 15 female) submitted results for the study. Their experience levels ranged from one to twenty-eight years, with a cumulative experience of 350 years. Fifteen states and three foreign countries were represented. All participants stated that they had been trained to competency, that they practice ACE-V, and that they have completed some formal training in quantitative-qualitative friction ridge analysis. This training was a prerequisite for participation.

Table 1 illustrates the collective results for each participant. The total number of true, false, and inconclusive responses are listed, along with the average confidence attributed to each response category. The "NR" in some of the confidence columns signifies the omission of this information by the participant. The total number of incorrect responses, or errors, is also listed along with the average confidence. Finally, the percentage of correct answers is listed. This is simply the total number of correct responses divided by the total number of conclusive (both true and false) responses. More will be said about the percentage of correct answers regarding specific participants later in this paper. Inconclusive responses were not counted as either correct or incorrect.

Participant Identification Number	# of True Responses	Average Confidence Rating	# of False Responses	Average Confidence Rating	# of Inconclusive Responses	Average Confidence Rating	# of Incorrect Answers	Average Confidence Rating	% Correct
PSSI-1	10	4	1	1	19	2.6	2	4	81.8
PSSI-2	18	3.9	10	3.8	2	1	2	3.5	92.8
PSSI-3	16	2.9	5	3	9	1.5	3	2.7	85.7
PSSI-4	15	3.9	10	4	5	4	4	4	84
PSSI-5	15	3.1	8	3.3	7	2.3	0	NA	100
PSSI-6	12	3.8	12	3.7	6	4	4	3.5	83.3
PSSI-7	10	4	15	3.9	5	3	5	4	80
PSSI-8	14	3.5	13	3.8	3	3	3	3.3	88.9
PSSI-9	11	3.9	19	3.9	0	NA	7	3.7	76.7
PSSI-10	0	NR	19	NR	11	NR	7	NR	63.1
PSSI-11	17	3.6	9	3.4	4	2.8	0	NA	100
PSSI-12	0	NA	4	4	26	3.9	0	NA	100
PSSI-13	13	2.7	10	2.9	7	2.3	1	3	95.7
PSSI-14	11	3.9	8	3.8	11	2.6	0	NA	100
PSSI-15	14	3.1	4	2.8	12	2	2	3	88.9
PSSI-16	10	2.6	4	2.5	16	2	2	2.5	85.7
PSSI-17	13	3.6	9	3.4	8	1.9	0	NA	100
PSSI-18	7	3.3	11	2.5	12	2.2	1	2	94.4
PSSI-19	16	2.9	9	2.8	5	1	0	NA	100
PSSI-20	0	NA	2	1	28	1	0	NA	100
PSSI-21	10	3.2	10	3	10	1.8	1	2	95
PSSI-22	10	3.6	17	3.6	3	3	5	3	81.5
PSSI-23	16	2.8	9	2.7	5	3	4	2.5	84
PSSI-24	21	3.1	9	2.8	0	NA	7	2.3	76.7
PSSI-25	12	3	12	3	6	2	1	3	95.8
PSSI-26	6	3.7	23	3.2	1	NR	11	2.5	62
PSSI-27	19	3	7	3	4	3	4	3	84.6
PSSI-28	11	2.8	11	3.2	8	2.1	1	3	95.4
PSSI-29	11	2.6	12	2.6	7	1.4	1	3	95.6
PSSI-30	11	4	15	3.7	4	1.8	3	3	88.5
PSSI-31	9	3.2	13	3.5	8	2.1	2	3	90.9
Total	358		320		252		83		
Mean	11.5	3.3	10.3	3.1	8.1	2.3	2.7	3	
Median	11		10		7		2		
Standard deviation	5.12		5.03		6.64		2.66		

NR = Not reported

Table 1

Summary of collective responses and error rates.

As stated above, thirty-one examiners participated in the study, each conducting thirty examinations, for a total of 930 examinations. Table 2 illustrates the distribution of results from the participants in the study for each latent along with applicable subset designations. One can quickly observe that there were numerous impressions, both true and false, that presented little difficulty for the participants. Some of the true impressions will be discussed first.

True Clusters

Latent # L-1 (Figure 2) was determined to be true by 28 of 31 participants, with no errors. Therefore, one may expect the analysis of this impression to be fairly straightforward. This is indeed the case. Normal anatomical position is well within tolerance. The deposition pressure is consistent for all three latents, and a similar degree of pressure distortion (lateral pressure or smearing) is evident. The development medium has left a similar "signature" on each impression, to use Ashbaugh's term [12]. The ridges within the different ridge systems also appear consistent in width, as do the furrows. The conclusion is that sequence has indeed been maintained and that this impression is truly simultaneous. The bench notes from one participant read as follows:

> Three different latent impressions develop consistently with black powder and reveal deposition of anatomically oriented finger tips with matrix then diagonally distorted by movement of the fingers across the substrate toward a terminal deposit location, where fingerprints remain anatomically oriented as a middle finger and two flanking impressions (index, ring). The fingerprints each bear increased finger to surface attitude to the left of the central pattern area of the finger, and neither impression reveals any substantial ridge detail below the distal flexion crease. Each impression exhibits considerable pressure distortion within the central pattern area in that the ridges appear widened with some amount of matrix push (squeegee effect). Normal ridge/furrow width is found at the sides and platform ridges of each fingerprint. The "occasional" features of finger creases are evident in each print, which is supportive of the cluster having been caused by a single person.

Latent #	Participants' (n=31) answers # of True	# of False	# of Inconclusive	Actual Answer	Subset
L-1	28	0	3	True	
L-2	19	6	6	True	
L-3	16	5	10	True	
L-4	7	13	11	False	A
L-5	16	4	11	True	
L-6	0	29	2	False	B
L-7	6	4	21	True	
L-8	17	4	10	True	
L-9	2	16	13	False	A
L-10	13	7	11	True	
L-11	26	1	4	True	
L-12	0	31	0	False	B
L-13	3	20	8	False	A
L-14	22	1	8	True	
L-15	3	13	15	False	A
L-16	1	23	7	False	B
L-17	23	2	6	True	
L-18	18	4	9	True	
L-19	18	2	11	True	
L-20	0	22	9	False	B
L-21	2	23	6	False	A
L-22	27	0	4	True	
L-23	11	6	14	True	
L-24	2	19	10	False	A
L-25	24	0	7	True	
L-26	25	2	4	True	
L-27	2	23	6	False	B
L-28	1	28	2	False	B
L-29	12	0	19	True	
L-30	14	12	5	True	

Table 2

Distribution of participants' results.

Figure 2

Latent # L-1. A complete analysis demonstrates this is truly a simultaneous impression.

It should be evident that this examiner correctly applied ACE in this instance. Also, the bench notes are such that any subsequent competent examiner can see exactly how the conclusion was drawn (because each of the described components in the notes can be referenced back to the image). Recording in this manner maximizes the examiner's accountability for his findings and minimizes any potential for falsification.

Figure 3 depicts Latent # L-14. Twenty-two participants correctly concluded this to be true, one erroneously opted for false, and eight stated inconclusive. An analysis similar to that conducted for Latent # L-1 should again reveal this to be truly simultaneous. Note the presence of lateral pressure similar to that in Latent # L-1. This smearing was a common thread for many examiners to draw the conclusion of true in these and other impressions.

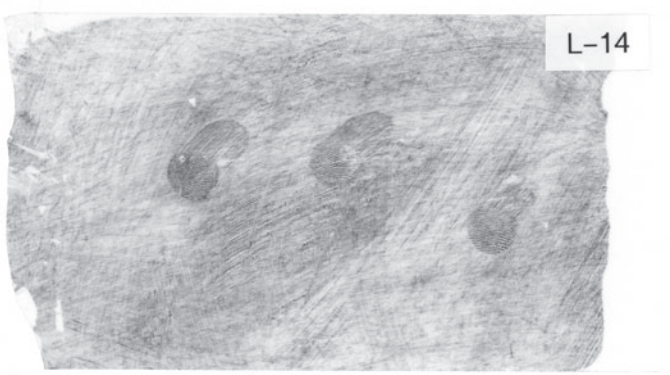

Figure 3

Latent # L-14. Note the lateral pressure (smearing) similar to that in Figure 2.

Latent # L-22 and # L-25 also presented little trouble for the participants. Fifty-one out of 62 participants identified these as true, with no errors. These impressions are documented in the Appendix. Again, the reader is directed to Table 2 for the distribution of results. The overall performance of the participants for this category, as well as the two subsequent categories, will be addressed in the *Error Rate* section.

False Clusters – Subset A

When one recalls the experimental conditions for the acquisition of these clusters, one would expect them to closely resemble true clusters. After all, the second donor could visualize the first donor's deposits. An example is shown in Figure 4. Latent # L-9 contains three impressions that are within tolerance regarding normal anatomical position. However, the impression on the far right exhibits a marked difference in both deposition pressure and pressure distortion. Also, this impression bears a different signature of the development medium. The preponderance of the information available indicates this is indeed a false cluster. Bench notes from three examiners who correctly concluded this are listed below:

- Two impressions are consistent with simultaneous. Third impression has a different powder signature and has heavier deposition pressure. This impression also bears some pressure distortion not consistent with the other two.
- Anatomical aspects are a little off to be consistent with being consecutive fingers. The latent on the right is not at the right angle. Contrast is much darker in latent on right than in the two latents to the left. Deposition pressure different. The two latents on the left have thinner ridges and thicker furrows than the latent on the right. The two latents on the left are consistent with each other but not with the one on the right. Lateral pressure is not present in the two latents on the left. The latent on the right has pressure distortion present above and below core area.
- …Spatially they look to have a relationship. The pressure deposition shows inconsistency between the right mark and that of centre and left marks. The left and centre show little to no distortion. The right due to heavy pressure shows signs of distortion…

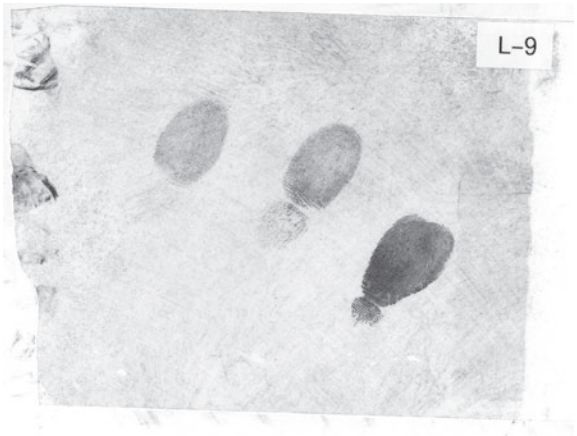

Figure 4

Latent #L-9. Note the differences in deposition pressure, pressure distortion, and development medium signature in the far right impression.

Without careful consideration of all this information, this impression could be mistaken for a true cluster. In fact, two examiners made errors on this latent, both apparently ignoring the issue of deposition pressure. The reader is directed to both Table 2 and the Appendix for the remainder of information regarding this subset.

False Clusters – Subset B

One can expect the appearance of this subset to vary dramatically from both Subset A and the true clusters. In this subset, the second donor had no knowledge of any dynamics from the first donor's deposits. This includes orientation, friction ridge area deposited, deposition pressure, and pressure distortion. Figures 5 and 6 illustrate two of the latents within this subset. It is immediately apparent that normal anatomical position is out of tolerance, as one would expect. The additional differences in area recorded, deposition pressure, and distortion are also evident. Collectively, 60 out of 62 examiners concluded these two clusters were false with no errors. It is interesting to note that the image in Figure 6 is the only one in the entire study for which the participants drew a unanimous conclusion. Three observations regarding this image are listed below:

- No reason to conclude the impressions simultaneously deposited…impressions not anatomically related, deposition pressure and pressure distortion inconsistent across the grouping.
- Far left finger has even deposition, little distortion in relation to other 2 fingers, also not aligned, with more detail (joint) recorded.
- Anatomical position is not consistent with a simultaneous cluster. The left impression is angled to the left, while the right two are angled to the right. Deposition and distortion are not consistent. The left one is a plain impression showing little if any movement during deposition. The right two show smears at the tips indicative of movement during deposition…This is a false cluster.

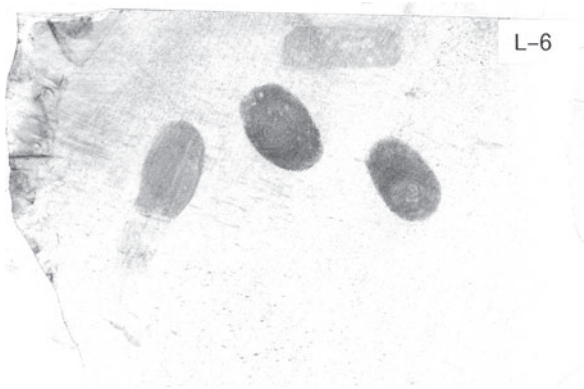

Figure 5

Latent # L-6. Normal anatomical position is out of tolerance for this cluster.

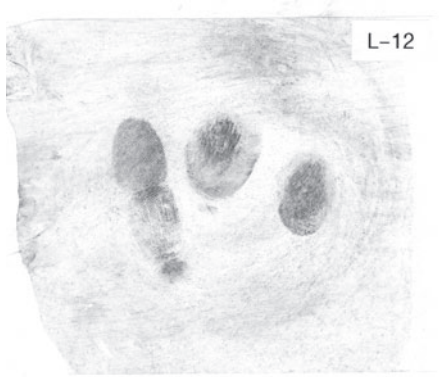

Figure 6

Latent #L-12. Ample information exists to conclude that this is a false cluster. This is the only image in the study for which all participants reached a unanimous conclusion.

The Difficult Ones

Having examined some of the more straightforward images, it is only proper to look at those that presented the most difficulty for the participants. Figure 7 depicts Latent #L-30, the image for which the most errors (twelve) were made. This cluster is truly simultaneous. The majority of examiners who were incorrect felt that the impression on the far left was out of tolerance with respect to normal anatomical position, an observation that appears, at first glance, to have merit. However, there is consistency in both deposition pressure and pressure distortion across the grouping. Both ridge and furrow widths are consistent as well. In addition, the development medium has left a similar signature. The majority of the information points toward this being a true cluster, the lone concern of anatomical position notwithstanding.

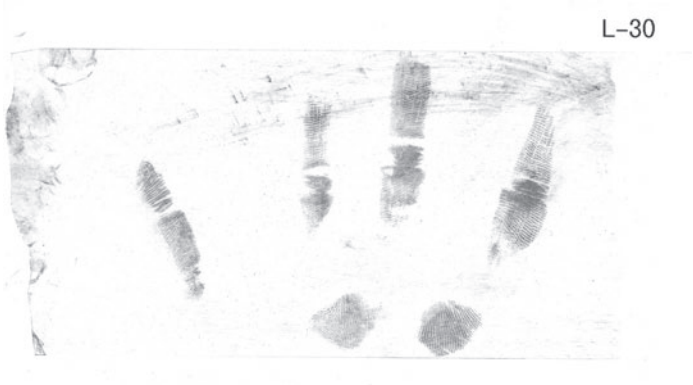

Figure 7

Latent #L-30. Examiners made the largest number of errors (twelve) on this image.

It is appropriate at this point to share the notes of an examiner who chose "inconclusive" for this image. This examiner stated that normal anatomical position was somewhat within tolerance, and that both deposition pressure and pressure distortion were within tolerance. He then went on to make the following observation:

> Three of the fingers and the two areas of palm are consistent with simultaneous. The finger to the left seems too far away from the others, although it may be within the physical limits of the hand.

This is an excellent observation that should not be overlooked. It becomes significant because this impression was made by the author and presents itself in normal anatomical position, even though it may appear to be out of tolerance. Also, in this instance the examiner has provided accurate information without overstating his knowledge and abilities. Even though "inconclusive" does not match the ground truth for this impression, it was the correct *scientific* conclusion for him and he was able to provide sound justification for it.

Other impressions that proved difficult were Latent #L-4, #L-7, and #L-23. These are contained in the Appendix. Collectively, along with #L-30, the participants made 29 errors on these four impressions alone. This accounts for nearly 35% of the 83 total errors.

Error Rate

Table 3 summarizes the error rates. Overall, participants were incorrect 12.2% of the time. This is calculated simply by dividing the number of incorrect responses (83) by the total number of conclusive responses (678). In other words, nearly 88% of the time participants drew the correct conclusions when making conclusive determinations of either true or false. These numbers are very encouraging and support the hypothesis that an examiner can accurately determine simultaneity after a thorough analysis.

Latent Category	# True	# False	# Inconclusive	# Incorrect	Error rate (%)
True	335	60	163	60	15.2
False - Subset A	19	104	63	19	15.4
False - Subset B	4	156	26	4	2.5
Overall	358	320	252	83	*12.2*

Table 3

Summary of collective responses and error rates.

Upon closer inspection of the individual categories, one can see that for the true clusters, the error rate was 15.2%, which is nearly identical to the error rate for the impressions in Subset A (15.4%). This is likely due to the agreement in normal anatomical position exhibited by Subset A. What is of extreme significance for Subset A is that nearly 85% of the time examiners recognized these as false clusters, even though there was a deliberate attempt, or conspiracy, by the second donor to mimic the orientations of the first donor. Also, the donors were latent print examiners possessing much more knowledge than the lay person. Therefore, the author feels that this conspiratorial behavior, if exhibited at the crime scene, would be unlikely to mislead an examiner.

For Subset B, the error rate was 2.5%. This means that just over 97% of the time the participants correctly recognized these as false clusters. The true significance of this is realized when one recalls the experimental parameters for the acquisition of this subset. Donor #2 had absolutely no knowledge of the deposits from Donor #1, which includes friction ridge area recorded, orientation, deposition pressure, pressure distortion, and so forth. The author believes this is much more representative of what normally occurs during the dynamic environment of the crime scene.

When participants rendered a conclusive (true or false) opinion, they were correct 88% of the time. However, participants were only able to reach this conclusive response 73% of the time. Overall, participants were correct 595 out of a possible 930 examinations (64%). What is of note is that 35% of the inconclusive responses originated from 4 participants (#1, #12, #16, and #20). Figure 8 shows boxplots of the participants' responses by category. Extreme outliers (marked with an "o" and the participant number) are shown.

Percentage of Correct Answers (% Correct)

This area will now be addressed regarding specific participants in an attempt to prevent the dissemination of misleading information. The reader will notice in Appendix 1 that participants PSSI-11 and PSSI-19 were correct 100% of the time when making a definitive determination. This is remarkable when one considers that they did so on 26 and 25 occasions, respectively. Contrast this with the results from participants PSSI-12 and

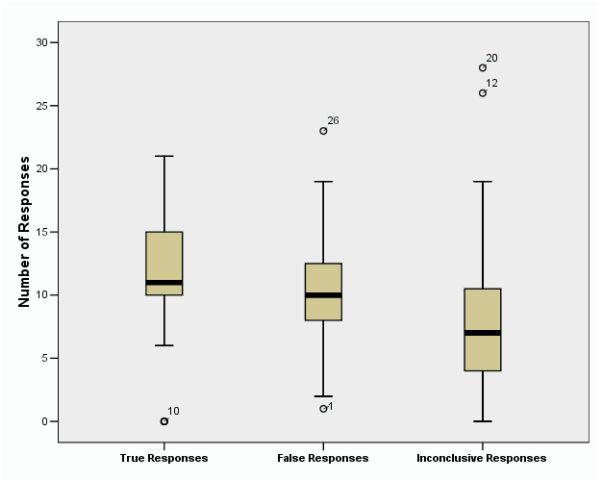

Figure 8

Boxplots of results.

PSSI-20. Although these also were correct 100% of the time when making definitive determinations, they only did so on four and two occasions, respectively. In other words, the vast majority of the time they were undecided.

This study has attempted to show that an examiner can support or reject simultaneity *without* making any comparisons. As a result, a large amount of potentially biasing information has been removed from the equation, thus preventing anyone from using the comparison results to justify the opinion of simultaneity. Comparison to a known standard is ultimately the confirmation of an examiner's hypothesis that a series of impressions was simultaneously deposited.

Confidence Levels

This was a measure of how sure the participants were of their conclusions and is summarized in the Appendix. As expected, participants were more confident when they made a definitive determination of either true (average confidence level = 3.3) or false (3.1) than when they made an inconclusive determination (2.3). This factor was not explored in great detail and is simply presented for the reader's edification.

The reader may also take an interest in the number of errors made at each confidence level. There were 21 errors made at the "Absolute" level, 38 at the "High" level, and 17 at the "Fair" level. This accounts for only 76 of the 83 errors. One examiner made seven errors but did not indicate the level of confidence for any of them. Efforts to reach this examiner were unsuccessful. No errors were reported at the "Low" level.

Conclusions

The data demonstrate that examiners can successfully determine simultaneity, or lack thereof, the majority (88%) of the time. This appears to have resulted from structured analyses that incorporate all the information available in each impression, such as substrate, matrix, development medium, deposition pressure, pressure distortion, appearance of ridges and ridge systems, as well as any red flags that are present. Examiners are capable of providing scientific rationale to support their conclusions as demonstrated by the accompanying bench notes in most cases. There were, however, some participants who did not provide any bench notes, but who merely answered the three questions at the top of the worksheet (Figure 1). The author feels that in some of these instances, perhaps the participants felt this was sufficient, because they would have recorded this information as part of their bench notes in actual casework. In other words, the three questions may have streamlined the note-taking process for them. Nevertheless, the author would have preferred (and actually requested) that bench notes be supplied.

Some of the most significant findings in this study resulted from the false simultaneous impressions contained within Subsets A and B. Subset A demonstrated that even when there is a conspiracy by a second donor to mimic the orientations of the first donor's deposits, examiners can recognize these as false nearly 85% of the time. The reader should note that this conspiracy was attempted by a latent print examiner, who obviously possesses more knowledge than the lay person. This makes it extremely unlikely that a true conspiracy in an actual case would be successful.

Data from Subset B actually more closely reflect what would happen in normal casework. When the second donor had no knowledge of the orientations, area recorded, deposition pressure, or pressure distortion of the first donor's deposits, examiners correctly recognized these false simultaneous impressions 97% of the time. This is much more representative of what would happen in the dynamic environment of the crime scene.

Regarding confidence, examiners did attach a higher level of confidence to the conclusive determinations of either true or false than to the inconclusive determinations. Confidence tended to increase when certain information was present, such as marked lateral pressure (smearing).

Overall, competent examiners should have little trouble when encountering possible simultaneous impressions. Additional training and personal experimentation are two avenues by which the error rate may be reduced. Using the information contained within the aggregate to effect the individualization of the donor is sound scientific practice. However, caution must still be exercised when using this technique.

Limitations and Future Considerations

This study was intended as a pilot project, and as with any good pilot project, several new aspects of this topic emerged. One potential weakness in the study involves using a single substrate. Glass was chosen for two reasons. First, it is a very simple surface with which to work. Second, it was the substrate bearing the simultaneous impression of interest in the Patterson case. Obviously, simultaneous impressions can and do occur on a variety of surfaces. Multiple surfaces need to be examined in future studies.

This study was limited to those trained in a quantitative-qualitative methodology. The author recognizes that there are numerous competent examiners who have not received formal training in this concept, and this was by no means intended as a slight to them. It was simply to establish a baseline for this technique. It is desirable for subsequent projects to compare the performance of both those who have been trained in nonnumerical comparison methodologies and those who have not. The testing of nonexperts could also provide additional data and understanding.

Some may feel that there was a potential design flaw in the acquisition of data in Subsets A and B. However, for the purposes of this study, the fact that the second donor knew where the initial deposits were should be of minimal concern, if any. Without this measure in place, it could have taken literally hundreds or thousands of attempts to produce viable clusters for examination.

Two participants made references to seeing repeat donors as they progressed through the study. Subsequently, they used the information from previous impressions to increase their confi-

dence levels. This was an excellent observation and is actually reflective of normal casework. It is quite common to receive a series of latent lifts in a case and find the same finger or fingers on several lifts. There is no reason this information cannot be used during the course of the examination.

Yet another aspect of this study that has raised some questions is the fact that the images were of good quality and contained large quantities of information. Is it possible that this contributed to the high success rate? Is it possible that accuracy would decrease if the amount of information would also decrease? Although it was not the intent here to deal with this issue, it can easily be evaluated in a future project.

Another study of potential interest would involve using a single donor to create false simultaneous impressions using multiple touches and comparing the results to those instances where two donors created the false clusters. Of course, a single donor would have knowledge of friction ridge area deposited, deposition pressure, pressure distortion, and anatomical aspects on subsequent deposits. The author conducted cursory experimentation in this area and found that it may perhaps be more difficult to reach the correct conclusion when this variable is introduced. This may warrant further research.

In spite of the concerns listed above, the results are nevertheless very compelling. It is the author's hope that this is simply the first pebble cast into the pond of research in this area that will generate a ripple effect throughout the latent print community. In fact, others have already commenced their own research projects. We, as practicing forensic scientists, should support these endeavors.

Afterthoughts

In closing, the author would like to share some remarks from one participant:

> "…I think your objective is to show that when presented with a 'true cluster,' a Friction Ridge Analyst trained to competency can recognize it as such, and when presented with a 'false cluster' that too can be determined with justification, and that there are some cases which somehow fall in the middle and that a prudent examiner will proceed in a cautious way with those."

The purpose of this study could not have been stated more accurately.

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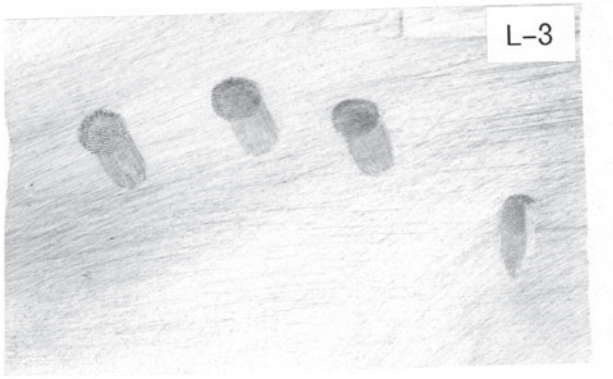
Appendix

Latent impressions #L-1 through L-30.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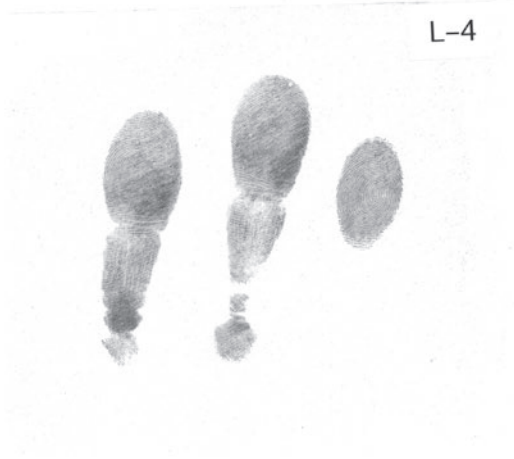
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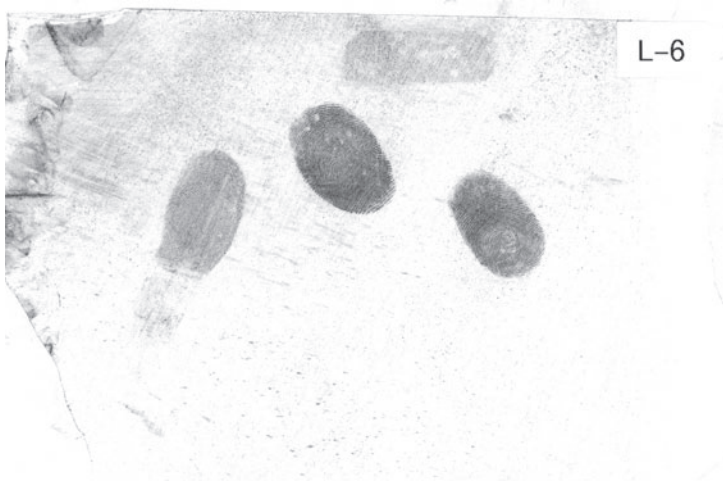
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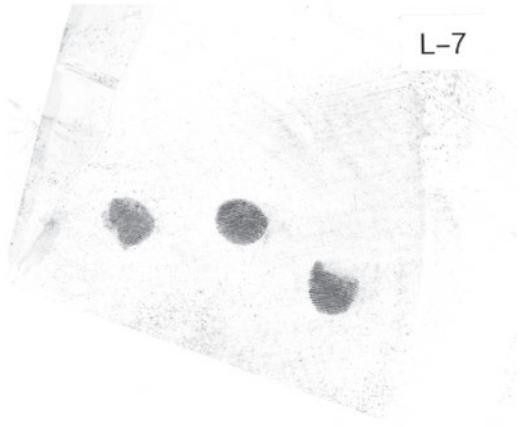
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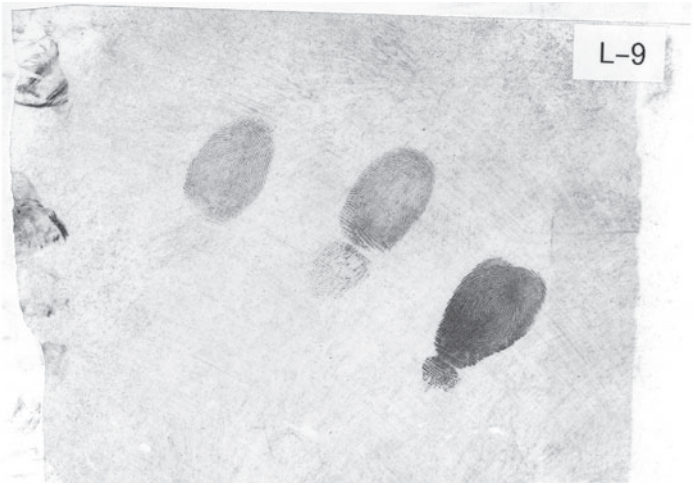
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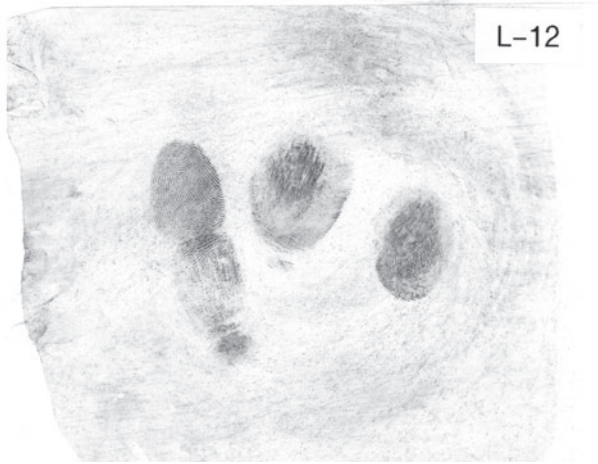
L–8


L–10


L–11


L–13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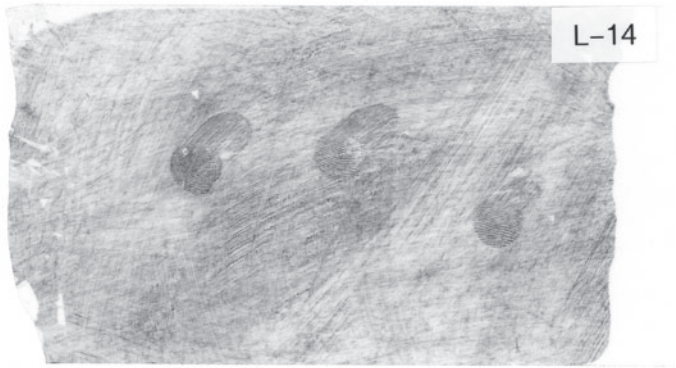
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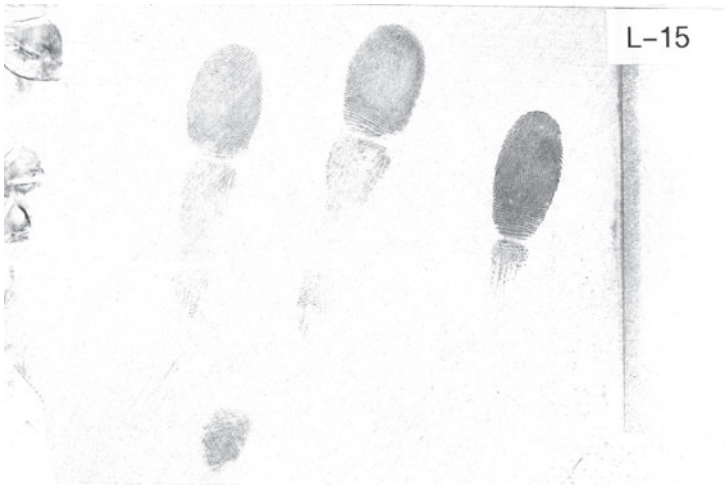
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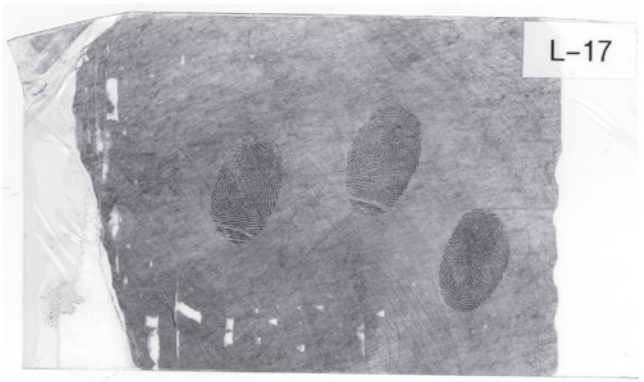
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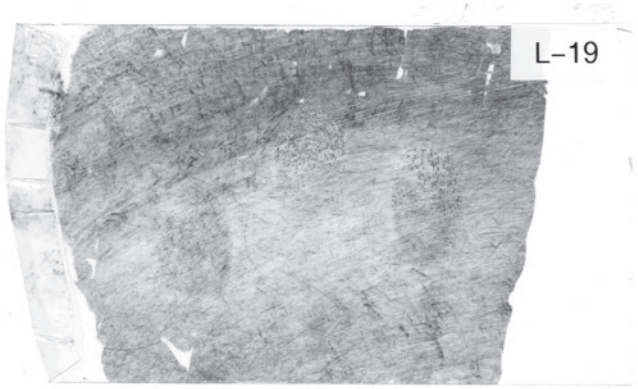
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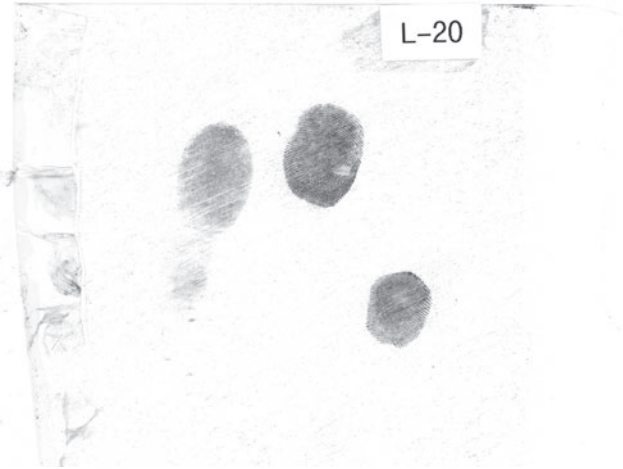
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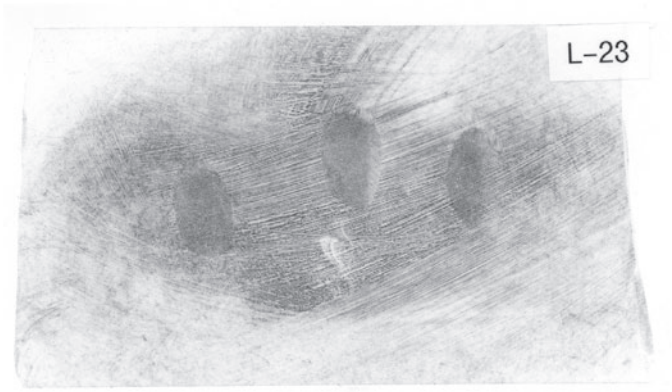
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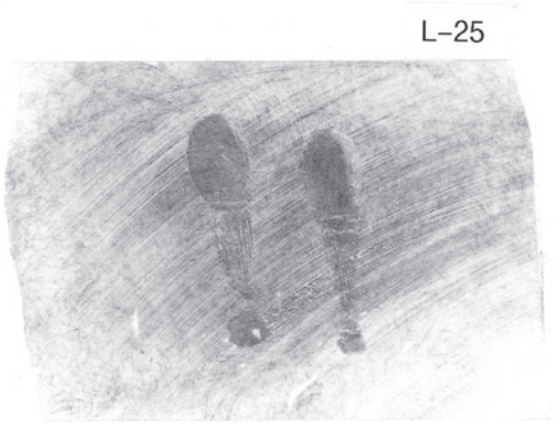
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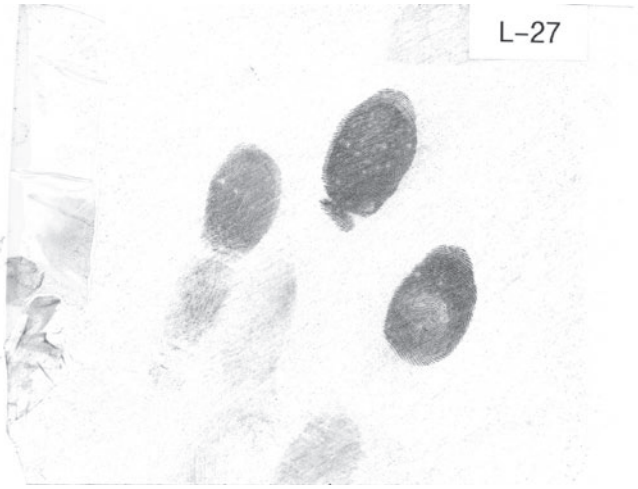
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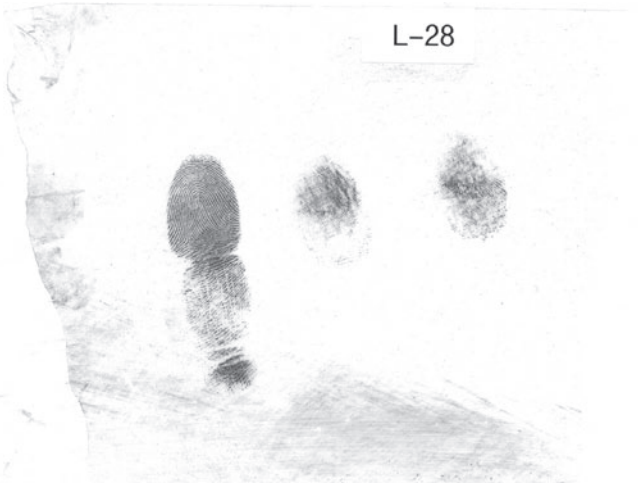
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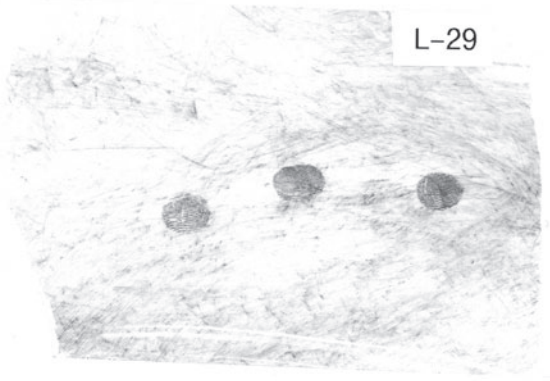
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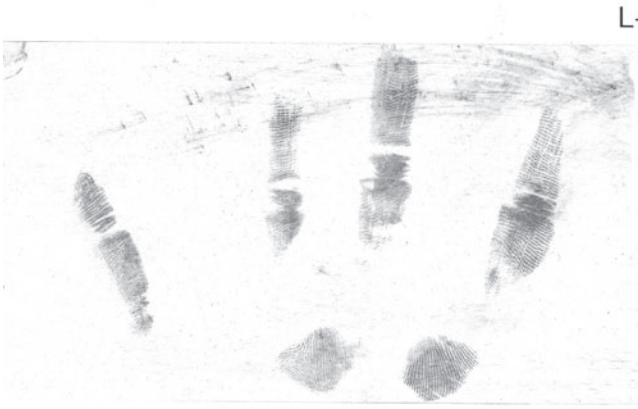
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