A study of the variability in footwear impression comparison conclusions

Kate Duffy[1], Lesley Hammer[2], Dr. Niamh Nic Daeid[1], James Fraser[1]
[1]University of Strathclyde, Centre for Forensic Science, Glasgow, Scotland,
[2]Hammer Forensics, Anchorage, Alaska.

ABSTRACT

There are many well-known forms of impression evidence that are continually encountered by forensic science laboratories; among these are firearm impressions, latent prints and tool marks. There are also numerous forms of physical impression evidence that are not as familiar and consequently, undervalued by many crime scene investigators and members of the judicial system. For example, footwear impressions are frequently left at crime scenes but not recovered due to a myriad of reasons such as a lack of necessary equipment or sufficient training and experience of crime scene personnel [1, 2].

The first use of footwear impression evidence in a criminal case dates back to Scotland in the 1700's. A great deal of literature currently exists detailing the abundance of information that can be revealed by this form of evidence; however, little has been researched concerning how footwear examiners express the conclusions of their findings and convey the strength of the footwear evidence to individuals involved in the criminal investigation. A study performed by Heikki Majamaa and Anja Ytti in 1995 [3] demonstrated that there are substantial differences in the conclusions expressed by footwear examiners for identical cases and based on this finding, our laboratory began exploring this topic further.

Six case studies were prepared and footwear examiners were asked to assess each comparison based solely on the observations that were clearly identified for each impression. By requesting that the examiners base their conclusions on the Scientific Working Group on Footwear and Tire Track Evidence (SWGTREAD) guidelines concerning this type of examination, it was discovered that the use of standardized terminology significantly decreased the variations seen within the results reported by certified examiners. Furthermore, it was determined that experienced examiners are able to interpret the findings of footwear comparisons more accurately than individuals with an education in forensic science, but limited knowledge, training or experience in this particular field.

PROJECT AIMS

1. **To establish the range in the conclusions drawn for specific cases by International Association of Identification (IAI) certified footwear examiners when a standardized list of conclusions was provided.**

2. **To determine if the variations observed in the conclusions drawn by certified examiners in our study were greater than, less than or equal to those observed in the 1995 study by Heikki Majamaa and Anja Ytti.**

3. **To compare the conclusions reached by experienced IAI certified footwear examiners to those reached by individuals with education in the field of forensic science, but limited knowledge, training or experience concerning the examination, evaluation and analysis of footwear impression evidence.**

EXPERIMENTAL

Six sets of photographs, representing six fabricated cases, were prepared. Each set consisted of photographs of the suspect shoe, a gelatin lift of an unknown impression and a scanned image of a test impression. Each shoeprint that was recovered varied in quality to represent those routinely discovered at crime scenes.

Four different pairs of shoes were used to create the six cases. All shoes were chosen based on their class characteristics and the presence or absence of individual characteristics visible on their outsoles. Footwear with different characteristics were chosen to increase the variety of features the examiners would have to observe.

All characteristics and observations that were to be considered by the examiners during the comparison were clearly identified and labeled for each impression. The examiners were to assume that all observations listed were correct. It was not expected that the examiners conduct their own comparison in order to limit the variables of this study to conclusions rendered given a set of features. As such, the examiners were asked to assess each comparison set as described and choose the SWGTREAD conclusion that best matched their opinion.

The survey was disseminated via e-mail to all American and Canadian footwear examiners that were IAI certified as of July 2008 and all students enrolled in the University of Strathclyde's 2008-2009 Master of Science – Forensic Science programme. American and Canadian certified examiners were utilized in this study in order to eliminate any potential language barriers and lessen international differences in the procedures used when examining footwear impression evidence. The student group was chosen to evaluate differences in conclusions reached for the example set between individuals who have been trained to competence in footwear examinations and those who have not. Each individual was to record all of their conclusions along with any additional comments regarding the survey that they wished to include and return their answer sheet to our laboratory. The responses submitted by the certified and student examiners were tallied and appropriate statistical analysis was performed and comparisons made.

References

1. Bodziak, W. *Footwear impression evidence: detection, recovery and examination* 2nd ed.; CRC Press: Florida **2000**. pp 1-178, 197- 374.
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3. Majamaa, H. and Ytti, A. A survey of the conclusions drawn of similar footwear cases in various crime laboratories. *Forensic Science International* **1996 82**: 109-120.
4. FBI Scientific Working Group on Footwear and Tire Track Evidence. Standard terminology for expressing conclusions of forensic footwear and tire impression examinations. www.theiai.org/guideline/swgtread/index.php. Accessed June 01, **2009**.

Contact: Kate Duffy
University of Strathclyde, Centre for Forensic Science
krlduffy@hotmail.com

Case Studies

Figure 1. Six sets of photographs, representing six fabricated crime scenes, were prepared and disseminated via e-mail to IAI certified footwear examiners and students enrolled in the University of Strathclyde's 2008-2009 Master of Science - Forensic Science programme. Each set consisted of a gelatin lift of an unknown impression, a scanned image of a test impression and photographs of the suspect shoe. The colour of the gelatin lifts was inverted and both the gelatin lifts and the outsole photographs were horizontally flipped in Adobe Photoshop. All characteristics and observations to be considered in the comparison were labeled for each impression. The examiners were to assume that all observations listed were correct. It was not expected that they conduct their own comparison, rather that they assess each comparison set as described and choose the SWGTREAD conclusion that best matched their opinion. We do recognize that there are several other ways in which to express conclusions when reporting footwear results; however, we chose the SWGTREAD guidelines as an example of standardized terminology. When reporting a final conclusion, the examiners were requested to only use the provided expressions, even if they do not typically use this terminology in their own reports.

RESULTS

A

Case No	Identification	Probably made	Could have made	Inconclusive	Probably did not make	Elimination	Unsuitable	Mean	Medium
1	40	0	0	0	0	0	0	7	7
2	0	0	39	1	0	0	0	5	5
3	1	33	6	0	0	0	0	5.9	6
4	0	0	39	1	0	0	0	5	5
5	23	17	0	0	0	0	0	6.6	7
6	0	0	35	5	0	0	0	4.9	5

B

Case No	Identification	Probably made	Could have made	Inconclusive	Probably did not make	Elimination	Unsuitable	Mean	Medium
1	10	9	1	1	1	0	0	6.2	6
2	0	0	12	6	1	2	1	4.2	5
3	0	6	13	2	0	0	1	5	5
4	0	0	14	6	0	2	0	4.5	5
5	0	12	8	0	1	0	1	5.3	6
6	0	0	3	9	2	2	6	3	4

Table 1. Results of the survey for A) IAI certified examiners (*n = 40*) and B) Master of Science – Forensic Science students (*n = 22*). For the average and median, the scores of the responses were ranked by ordering them from lowest to highest and then assigning them the following numerical value: unsuitable 1, elimination 2, probably did not make 3, inconclusive 4, could have made 5, probably made 6 and identification 7. The $t_{calculated}$ was determined using the standard deviation of the differences and the mean difference of the averages. As $t_{calculated} > t_{table}$, the values reported by the two groups of examiners were statistically different.

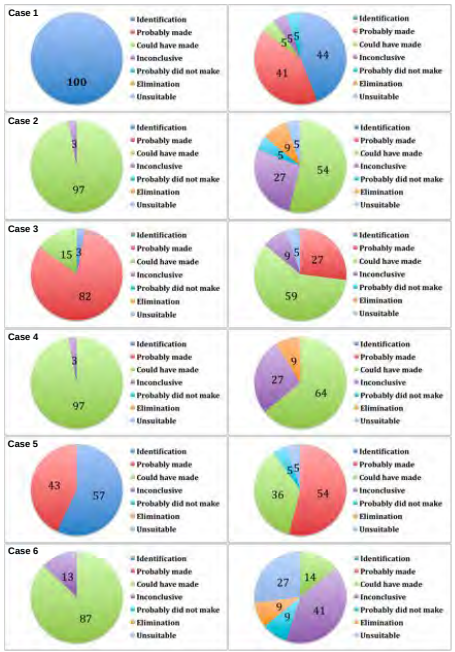

Figure 2. Results of certified and student examiners. Conclusions drawn by IAI certified footwear examiners (left column) and students (right column) for six case studies. Values represent percentage of total responses reported for each individual conclusion.

SWGTREAD'S Standard Terminology [4]

(For Expressing Conclusions of Forensic Footwear and Tire Impression Examinations)

A. *Identification* (definite conclusion of identity) – this is the highest degree of association expressed in footwear and tire impression examinations. This opinion means that the particular shoe or tire made the impression to the exclusion of all other shoes or tires.

B. *Probably made* (very high degree of association) – this opinion means that the evidence is very persuasive that the shoe or tire made the impression, yet some critical feature or quality is lacking and/or missing so that an identification is not in order.

C. *Could have made* (significant association of multiple class characteristics) – this opinion means that the design and physical size correspond, and there may also be some correspondence of the general condition of wear.

D. *Inconclusive* (limited association of some characteristics) – this opinion means some similarities are noted; however, there are significant limiting factors in the questioned impression that do not permit a specific association between the questioned impression and the known shoe or tire.

E. *Probably did not make* (very high degree of non-association) – this opinion means that the evidence is very persuasive that the shoe or tire did not make the impression, but the impression lacks sufficient quality or clarity for an elimination.

F. *Elimination* (definite exclusion) – this is the highest degree of non association expressed in footwear and tire impression examinations. This opinion means that the particular shoe or tire did not make the impression.

G. *Unsuitable* (lacks sufficient detail for a meaningful comparison) – this opinion means that insufficient detail was present in the questioned impression to enable any meaningful comparison with any known shoe or tire.

CONCLUSIONS

- **It is necessary for footwear examiners to interpret their findings by using a standardized conclusions scale, as by doing so, the variation between the conclusions drawn for identical cases fell within a justifiable range.**

- **The variations in the conclusions of trained, certified footwear examiners were statistically smaller than those of individuals with less training than certified footwear examiners. This finding confirms that examiners performing impression evidence comparisons must be knowledgeable and adequately educated in this field to accurately interpret footwear impression evidence.**

- **Even when a standardized scale of conclusions is used when interpreting the findings of a footwear impression comparison, some variability in the reported conclusions still exists. Reasons for this inconsistency may include the experience of the examiner with this type of comparison or the fact that the amount of corresponding individualizing characteristics that constitutes a positive identification is unknown.**