B95 The Development of Systematic Approaches for Physical Fit Comparisons of Trace Materials

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Learning Overview: After attending this presentation, attendees will be informed about newly developed systematic methods for evaluating performance metrics of physical fits of duct tapes and textiles and the inter- and intra-examiner variation in reported similarity scores.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating the value of physical fits in trace evidence and the need for standardized, material-specific protocols that describe relevant distinctive features and consensus-based criteria. This presentation will demonstrate the development of methods for comparing edges of trace materials and highlight quantitative and statistical results that can offer additional support to inform an examiner's expert opinion.

When separated items of evidence can be realigned with distinctive features, the result is known as a physical fit. In trace evidence, physical fits represent the highest degree of association. Many laboratories consider the presence of a physical fit to be conclusive support regarding the common origin of the items. If a fit is identified and documented, oftentimes no further analysis is required. However, there are currently no consensus-based criteria or methods that can be used to support the reliability or probative value of a physical fit. This work expands on the research presented at recent American Academy of Forensic Science conferences on the development and validation of systematic protocols for comparing edges of various trace materials. This study assessed the performance of comparison methods for duct tapes and textiles to provide objective, reproducible, and quantitative similarity scores that can be used to evaluate the suitability of a fractured-edge comparison and describe the quality of a given fit.

The duct tape dataset consisted of over 2,500 duct tape edges of varying grade, separation method, and degree of stretching. Edge Similarity Scores (ESS) were calculated as a relative ratio of observed matching sections per scrim area. The performance rates of the method were calculated, and the distributions of scores were assessed to interpret the quality of a fit between edges. Overall, the method produced accuracies of between 84.9%–99.8% for the different tapes sets, with no false positives reported. Scores above 80% were found to support the conclusion of a match, while scores below 20% were indicative of a non-match. Intra-examiner and inter-examiner variation demonstrated agreement in reported ESS within 15%.

The textile dataset was composed of 100 comparison pairs, originating from five different clothing items with varying composition and construction. Twenty pairs were generated per item with ten each of stabbed and hand-torn fractures. Two examiners blindly compared all the pairs in each set and documented any relevant distinctive features that informed their opinion. In addition, each pair was examined through ten units taken as equal divisions of the total fracture edge length to document and calculate the ESS. The method's accuracy ranged from 93%–95%, with false negative rates between 4%–8% and the false positive rate lower than 2%. Intra-examiner variability following a second, blind comparison of the original set was generally less than 15%, and true matching pairs were more likely to receive similar or higher scores, while true non-matching pairs typically received similar or lower scores. More misclassifications were noted in the clothing items with fiber types of higher elasticity and in the hand-torn set, indicating that fabric type must be considered in the assessment of the suitability for physical fit comparisons, particularly if large levels of distortion and stretching are observed during the separation.

Overall, these comparisons demonstrated the importance of developing material-specific features and criteria for a physical fit evaluation. The systematic method allows for direct, blind comparison between examiners and provides a quantitative score that can be used to support the examiner's opinion and facilitate the peer-review process.

Physical Fit, Similarity Scores, Systematic Comparison

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