D20 Broken Windows: Evaluating the Reliability of a Crime Scene Reconstruction Technique

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Attendees can expect to learn about the reliability of the glass fracture examination technique used to determine from which side a window was broken. The attendee will also learn the history of this technique, and hear proposals for continuing research into the technique's reliability.

This presentation will impact the forensic community by contributing the first reliability data measured under blind, controlled conditions for a forensic technique that has been in use for more than 70 years.

Austrian criminalist Hans Gross published in the 1890's the first description of how a broken pane of glass may be analyzed to determine which side was struck by a penetrating bullet (Kendall 1934). In 1930, Ukrainian researcher S.N. Matwejeff expanded on the work of Gross and investigated glass fractures to determine from which side a window was broken by means of a fist, stick, or other object (Matwejeff 1931). According to Matwejeff, a pane of glass broken by a striking object often shows two types of fracture lines: 1) radial cracks, which originate at the point of impact and radiate outward in a starburst pattern, and 2) concentric cracks, which run from one radial crack to another, in a roughly circular pattern. The edge surfaces of these fractures often show distinctive curved lines, or arcs, running from one side of the glass pane to the other. At one end, each arc appears to intersect the face of the glass pane at an approximate right angle, while the other end of each arc will appear to intersect its respective face at a very oblique angle. The examiner determines if the fracture is radial or concentric, and then notes which face of the glass is intersected at a right angle by the arcs. Matwejeff's technique states that for radial fractures, the right angle is always on the reverse of the side of the pane that was struck. This has come to be known as the "3-R Rule" (Radial cracks have Right angles on the Reverse side of the force). Conversely, if the fracture being examined is a concentric fracture, then the right angle intersection will be on the same side as the face of the glass that was struck. Thus, if the examiner is able to determine which way the piece of glass was facing (such as by piecing together all the broken pieces to reconstruct the window, or by looking for dirt or paint on one side of the glass fragment, and comparing this to the glass remaining in the window) before the window was broken, the examiner can conclude whether the window was broken from the outside or from the inside.

Matwejeff's published results reveal little about the conditions under which his test windows were broken. Furthermore, the Matwejeff study does not state whether the windows were examined under a blind condition, that is, whether the examiner had information beforehand about which side was struck. The absence of a blind condition raises concerns about examiner bias. A search of the literature revealed no published studies addressing the reliability of this technique. A FBI Bulletin of 1936 refers to experiments done by the Bureau in which over two hundred panes of glass were examined, and reportedly in each instance Matwejeff's findings were confirmed (FBI 1936). However, this very brief description by the FBI reveals nothing about the conditions under which the research was done.

The present study sought to address two shortcomings of the existing research: lack of controlled conditions during experimental window breaks, and lack of a blind condition in evaluating the reliability of the technique. Ten identical wood-framed windows were constructed. Each was labeled with a number, and one side of each frame was marked A, and the other side was marked B. Each window was then randomly assigned to be broken by striking either side A or side B. Each window was mounted on an upright stand and broken using a measured amount of force, by means of a pendulum. All glass fragments from each window were collected and stored in labeled packaging, and each window frame was packaged without disturbing any fragments that remained within the frame.

Twenty-two volunteers were given a brief tutorial on the technique, and then they examined each broken window and its associated fragments in a blind condition. The volunteers were asked to determine from which side each window had been struck, and to record their responses on a form. Each volunteer also completed a questionnaire regarding his or her confidence in the accuracy of his or her examinations, and whether the volunteer had any prior experience with the technique (a volunteer reported previous training in the technique). The volunteers' average performance was 8.1 correct evaluations ($s=2.18$, median=9.0), a result that is significantly higher than what would be expected due to mere chance ($p<0.001$). Of the 22 volunteers, nine evaluated all ten windows correctly. The probability of a volunteer getting all ten evaluations correct by chance alone equals 0.001. Of the 220 evaluations performed by the volunteers, 178 (80.9%) produced a correct response. There was a moderate correlation ($r=0.69$) between volunteers' reported confidence in the accuracy of their evaluations and their performance.

These results suggest that the Matwejeff technique enabled the volunteers, on average, to determine the direction of force at a rate significantly better than chance. However, this is a preliminary study. Further research is warranted, and should include a control group of volunteers with no familiarity with the Matwejeff technique, in order to rule out the possibility that study volunteers gain information about the direction of impact from sources other than the fracture pattern.

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References:
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Glass Fracture, Error Rate, *Daubert*

