Fired Cartridge Case Error Rate Study

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Disclaimer

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- Forensic Research Committee of ASCLD (Jay Henry)
- AFTE provided the largest group of participants (Jay Stuart).
- Story County Iowa Sheriff’s office made the pilot study possible, particularly Sheriff Fitzgerald, Sergeant Backous, and Detective Rhoads.
- SWGGUN Chair Andy Smith provided valuable guidance in designing the study and aided in identifying the proper selection of ammunition.
- Firearms & Toolmarks Unit at the FBI Laboratory
- Ames Laboratory Shipping and Receiving Department for coordinating and handling shipment of all of the materials for the study, and in particular Vicki Sieve.
Goals of the Study

• Measure false positive and false negative error rates by practicing firearms examiners for comparisons of fired cartridge cases

• Determine uncertainties in the measured rates
Important Design Criteria

- Sets must incorporate multiple independent comparisons (no comparisons between sets)
- Multiple groups of examiners must be examining independent sets of samples (to obtain a measure of uncertainty)
- Measure examiner rates, not agency rates (no review)
- Use accepted standard range of conclusions
- Incorporate a measure of sample quality
- Simulate realistic sample presentation
- AFTE range of conclusions
Experimental Design

- Sets of 3 Knowns + 1 Questioned
  - Mimics a questioned case and a handgun in evidence with multiple test firings
- 15 Sets provided to each participant
  - No overlap or repeats between sets (avoid biasing effects of repeats)
  - No comparisons between sets (15 independent comparisons)
- Asked each participant to look at knowns first and identify how many were suitable for comparison
  - Internal measure of rate of good pattern production
- “Spoiler”: each kit contained 5 same-source and 10 different-source sets (not announced)
- With 25 guns we randomly assigned each examiner to 1 of 5 groups
- Groups A through E (see Table)
## Sample Set Design

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1-A1</td>
<td>B1-B1</td>
<td>C1-C1</td>
<td>D1-D1</td>
<td>E1-E1</td>
<td></td>
</tr>
<tr>
<td>A2-A2</td>
<td>B2-B2</td>
<td>C2-C2</td>
<td>D2-D2</td>
<td>E2-E2</td>
<td></td>
</tr>
<tr>
<td>A3-A3</td>
<td>B3-B3</td>
<td>C3-C3</td>
<td>D3-D3</td>
<td>E3-E3</td>
<td></td>
</tr>
<tr>
<td>A4-A4</td>
<td>B4-B4</td>
<td>C4-C4</td>
<td>D4-D4</td>
<td>E4-E4</td>
<td></td>
</tr>
<tr>
<td>A5-A5</td>
<td>B5-B5</td>
<td>C5-C5</td>
<td>D5-D5</td>
<td>E5-E5</td>
<td></td>
</tr>
</tbody>
</table>

- **B v D:** 1v2, 2v3, 3v4, 4v5, 5v1 and other skip permutations

<table>
<thead>
<tr>
<th></th>
<th>C v E</th>
<th>D v A</th>
<th>E v B</th>
<th>A v C</th>
<th>B v D</th>
</tr>
</thead>
<tbody>
<tr>
<td>C v E</td>
<td>D v A</td>
<td>E v B</td>
<td>A v C</td>
<td>B v D</td>
<td></td>
</tr>
</tbody>
</table>
Materials Used

- 25 new Ruger SR-9 semiautomatic 9-mm handguns
  - Moderate price, new model replacing P95
- 20,000 fired rounds of Remington L9MM3 FMJ
  - 2 lots
  - 3 days on the range
- Materials obtained and samples collected at WVU
- Each weapon fired 200 times before collection
- 800 rounds collected from each
- Order known to within 100 rounds (collected 100 from catcher at a time)
Ruger SR-9
Brass Catcher
Participants

• Use of Human Subjects in federally funded project required review of design by Institutional Review Boards at Iowa State University and DoD
• Mitigate risk to participants by making responses anonymous
• Informed Consent from Voluntary participants
• Solicited from AFTE membership and ASCLD participating agencies
• Active examiners only (low rates mean little confidence in rates for small numbers in any subgroups)
• Attempt to recruit 200 to 300
• 284 enrolled, 218 responses
Labelling

- “Kmfrcxxxxyyy” or “Qmfrcxxxxyyy”
- Random alpha numeric coding
- Knowns and Questioned
International Participants

• U.S. arms control regulations required damaging cases to prevent reloading
• Cut with a handheld rotary tool with a cutoff wheel
Packaging

• Packaged in 15 sets of $3k + 1q$.
• Instructions
• Answer sheet
• Blank return envelope
• Prepaid return shipping package
Survey and Answers

Comparison Group No. ____________________________

SURVEY QUESTIONS:
Years Experience: _______ Years Training: _______
AFTE Certified: Yes □ No □ ABC Certified: Yes □ No □ Other: ________________
Attended the FBI Specialized Techniques School: Yes □ No □ CMS Trained: Yes □ No □
Do you work in a firearms ASCLD-member laboratory: Yes □ No □
Do you currently conduct firearms casework: Yes □ No □
Do you examine other types of evidence: Yes □ No □ If Yes, what other types __________

Brand & Model of Microscope used: ________________________________
Type of Lighting used: ________________________________
Did you use Pattern Matching, CMS or Both for this test? ________________
Work performed in accredited laboratory: Yes □ No □ Are you an AFTE member: Yes □ No □

Set No.   Number of known’s with sufficient reproduced detail for comparison: 0 □ 1 □ 2 □ 3 □

<table>
<thead>
<tr>
<th></th>
<th>Identification</th>
<th>Elimination</th>
<th>Inconclusive (Please provide basis)</th>
<th>Unsuitable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>□</td>
<td>□</td>
<td>a) □ Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification.</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) □ Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c) □ Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.</td>
<td></td>
</tr>
</tbody>
</table>
By the Numbers

• Not everyone answered every question or supplied a response for every comparison
  – Non responsive answers not included in totals
• 5 (known same-source) x 218 (examiners) = 1090
• 10 (known different source) x 218 (examiners) = 2180 (but only 2178 responses)
• Suitability of knowns: 3 (knowns) x 15 (sets) x 218 (examiners) = 9,810 (but only 9702 responses)
Results for Known Same-Source Comparisons

• False negatives: 4/1090 = 0.3670%
  – 95% CI (Clopper-Pearson): 0.1001% to 0.9369%
• Include 11 Inconclusives (not errors): 15/1090 = 1.376%
  – 95% CI: 0.7722%, 2.260%
• Rate of unsuitable mark production: 225/9702 = 2.319%
  – 95% CI: 2.174% to 2.827%
• Conclusion: the rate of poor mark production may be entirely producing or obscuring the rate of examiner error (false-neg.)
Results for Known Different Source Comparisons

- Identifications from known different-source cases: $22/2178 = 1.010\%$
- However, 20 of 22 errors by 5 participants
- Indicates a highly heterogeneous distribution of error rates
- Statistical analysis based on this type of distribution of rates in a beta-binomial model
- Maximum Likelihood Estimator 0.939\%
  - 95% CI: 0.360% to 2.261%
- Conclusion: error rates vary widely between different examiners
Use of Inconclusive

- 96 examiners (44%) did not use Inconclusive (used Elimination for samples without sufficient corresponding detail for an identification)
- 45 (21%) used only Inconclusive to denote insufficient corresponding detail
- 77 (35%) used a mixture of inconclusive and elimination
- Given same model of ammunition and firearms throughout, what does inconclusive mean to this third group?
- This variation in application of the standard language for conclusions makes the meaning somewhat ambiguous
Proposed Future Work

• Given the relative size of false negative and poor mark reproduction rates: Study the variation in poor reproduction rates
  – Firearm model, between multiple guns of same model, with different make and material of cartridges, between and within lots, with age of firearm, etc.
  – Are there true false negatives and should QA systems be designed to catch them?
• Study effectiveness of QA systems in catching the types and rate of false positives seen
  – Include evaluation of possible confirmation bias in study
Thank You

• For your attention
• For your participation and support