Fired Cartridge Case Error Rate Study

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Disclaimer

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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

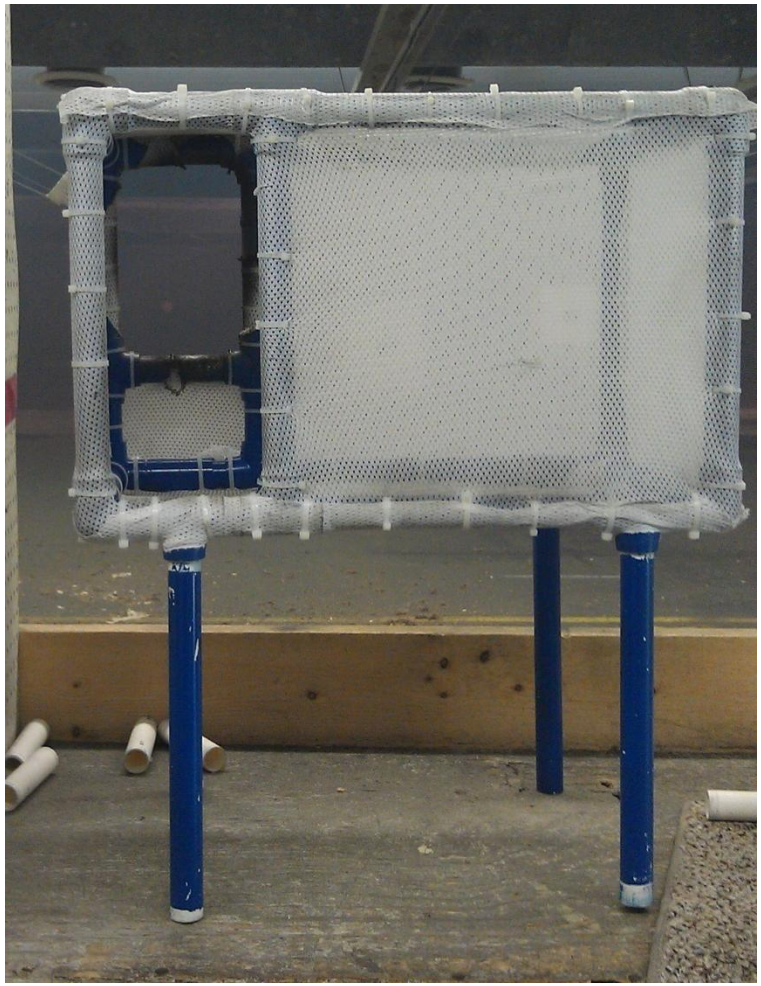
A	B	C	D	E
A1-A1	B1-B1	C1-C1	D1-D1	E1-E1
A2-A2	B2-B2	C2-C2	D2-D2	E2-E2
A3-A3	B3-B3	C3-C3	D3-D3	E3-E3
A4-A4	B4-B4	C4-C4	D4-D4	E4-E4
A5-A5	B5-B5	C5-C5	D5-D5	E5-E5
B v D: 1v2, 2v3, 3v4, 4v5, 5v1 and other skip permutations	C v E	D v A	E v B	A v C
C v E	D v A	E v B	A v C	B v D

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

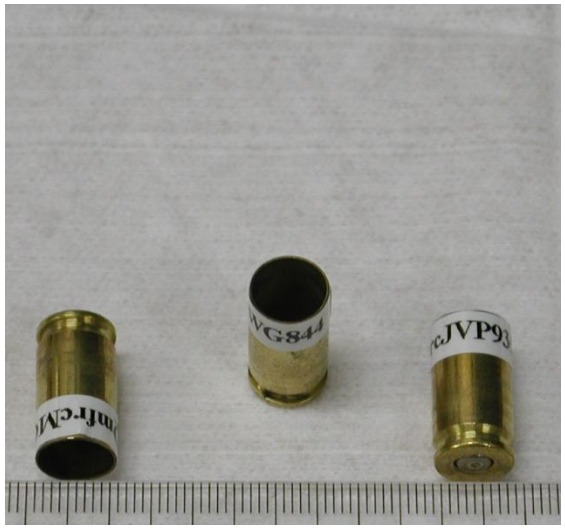


Participants

- 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

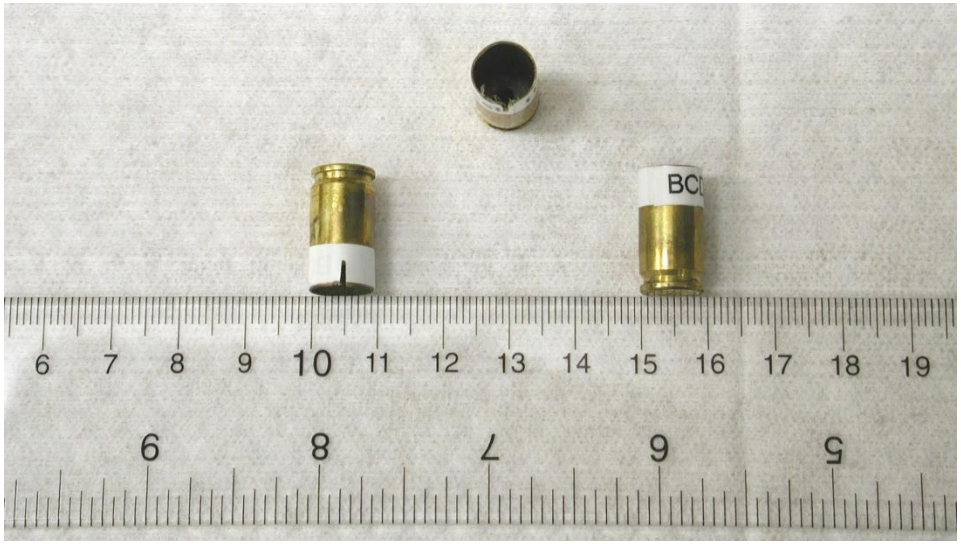
Labelling

- “Kmfrcxxxyyy” or “Qmfrcxxxyyy”
- Random alpha numeric coding
- Knowns and Questioned



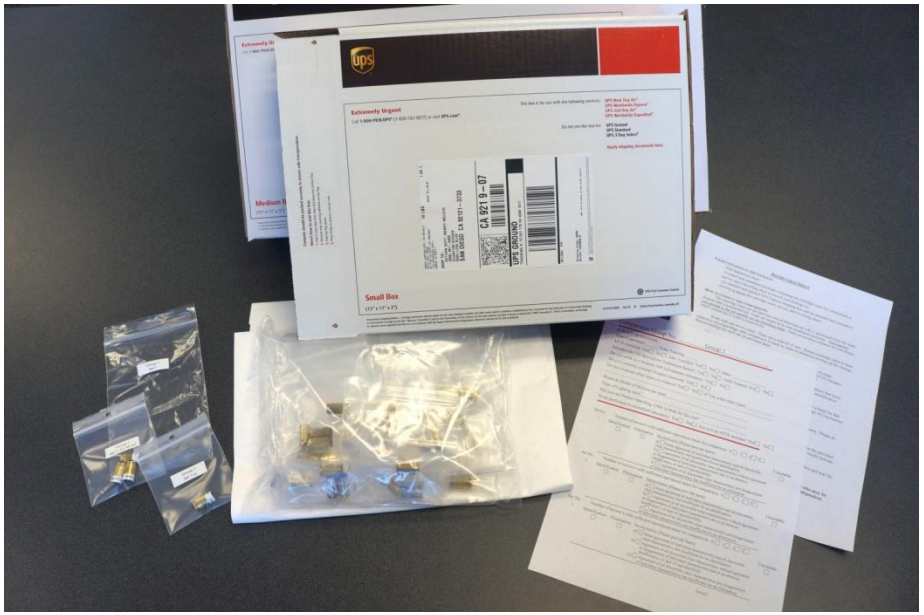
International Participants

- 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 3 k + 1 q.
- 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☐

1	Identification	Elimination	Inconclusive (Please provide basis)	Unsuitable
	☐	☐	a) ☐ Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification. b) ☐ Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility. c) ☐ Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.	☐

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