Issues of Bias and Statistics

Glenn Langenburg

General Outline

1. Bias exists
2. So what?
3. Risk of error from bias v. risk of lack of information

Existence of Bias in Forensic Science

- Bitemarks
- Trace, hairs
- DNA
- Fingerprints

Bias in Fingerprints

- Mayfield incident
- LAPD; Seminole County; Boston PD, etc.
- From Cole “More than Zero” (2004)
  - 9/22 cases had 3 or more examiners

Dror Research

- Dror, et. al., 2006 (*Appl. Cognit. Psychol*.)
  - Re-presented cases to 5 experts
  - 4 out of 5 changed initial conclusion

- Dror, I; Charlton, D., 2006 (*J. Forensic Ident*)
  - 6 experts, each re-presented with 8 cases
  - 6 out of 48 inconsistent results
  - 4 out of 48 under bias conditions

Dror, Charlton, Peron (2006)

	1	2	3	4	5	6	7	8
Past Decision	individualization	individualization	individualization	individualization	exclusion	exclusion	exclusion	exclusion
Level of Difficulty	difficult	difficult	not difficult	not difficult	difficult	difficult	not difficult	not difficult
Contextual Information	none	suggest exclusion	none	suggest exclusion	none	suggest individualization	none	suggest individualization
Expert A	consistent	consistent	consistent	consistent	consistent	consistent	consistent	consistent
Expert B	change to exclusion	consistent	consistent	consistent	consistent	consistent	consistent	consistent
Expert C	consistent	change to exclusion	consistent	consistent	consistent	consistent	consistent	consistent
Expert D	consistent	change to exclusion	consistent	change to exclusion	change to individualization	consistent	consistent	consistent
Expert E	consistent	change to cannot decide	consistent	consistent	consistent	consistent	consistent	consistent
Expert F	consistent	consistent	consistent	consistent	consistent	consistent	consistent	consistent

Langenburg Research

- Langenburg, Champod, Wertheim. “Testing for Potential Contextual Bias Effects During the Verification Stage of the ACE-V Process when Conducting Fingerprint Comparisons”, JFS 2009, 54 (3), 571- 582.
- Langenburg. “A Performance Study of the ACE-V Process...”, JFI 59 (2), 219-257.

Bias exists and the data show…

- … that bias has been a contributor to some decision outcomes, including erroneous decision outcomes
- … that it is mostly a concern in complex comparisons, with limited quantity and quality of information
- …that it appears analysts are more robust to bias in the direction of pushing an erroneous identification, but considerably less robust in the direction of erroneous exclusions or inconclusive decisions

So What?

- What impact on the results?
- Does it increase the number of errors?
  - Yes, certainly with respect to erroneous exclusions
  - A “Mayfield Effect” has not yet been shown in the research data.
- What is the cost of errors compared to the cost of overhauling the system for the “potential threat of bias”. Cost v. Risk

On Blind Testing

‘systematic blind testing is not necessary during most routine examinations; it is time consuming and unnecessarily consumes significant personnel resources. Rather, a verification structure *should cater to potentially problematic latent prints and cases*.’

Margot, P., Champod, C., Lennard, C., Stoilovic, M. Fingerprints and Other Ridge Skin Impressions. Boca Raton: CRC Press, 2004, 200.

The Benefit of Additional Information: Informing Judgments Experiment (2010)

Group 1: Control

Group 2: Expert Consensus Minutiae map

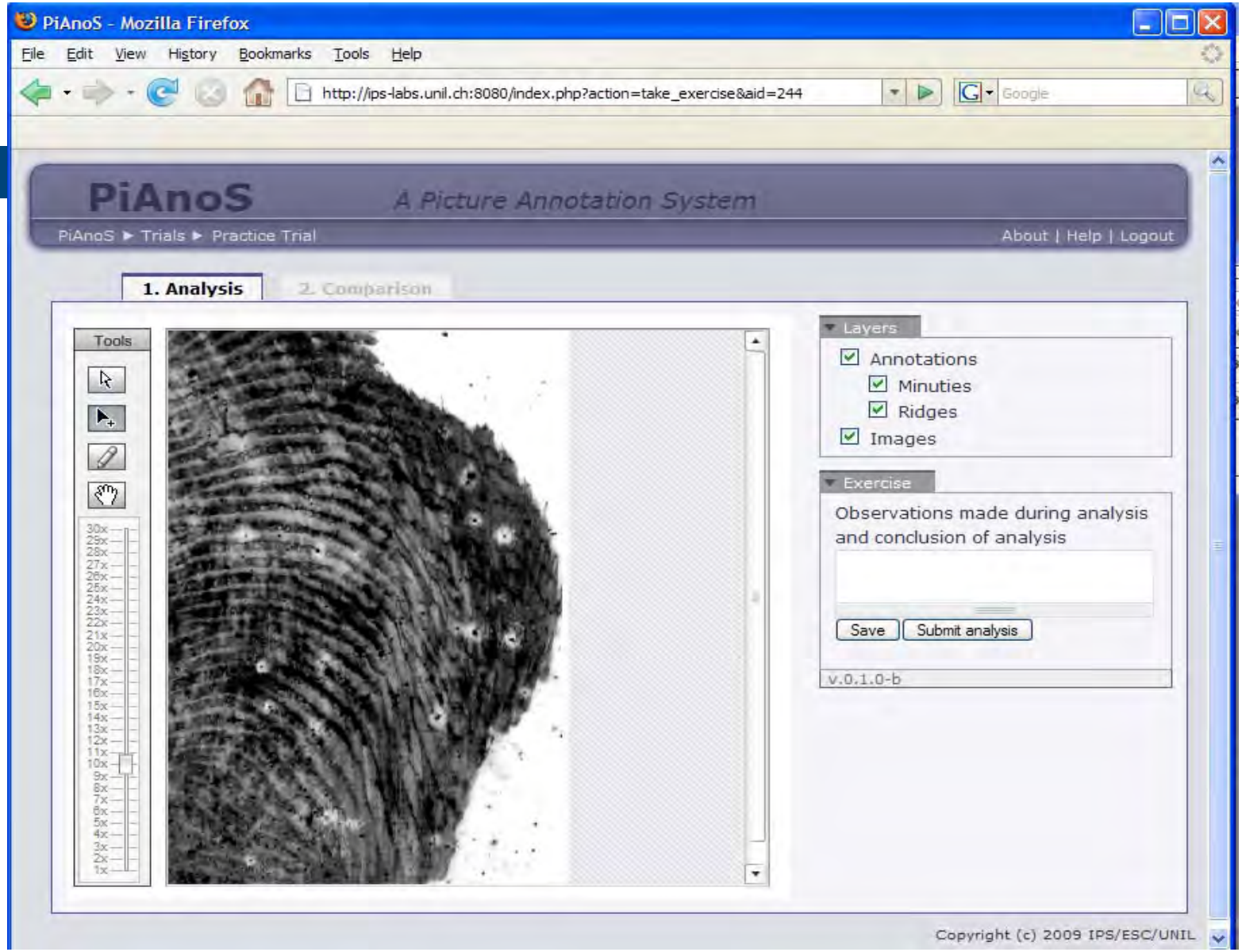
Group 3: LR Tool

Group 4: Quality map

Group 5: Expert Consensus Decision chart

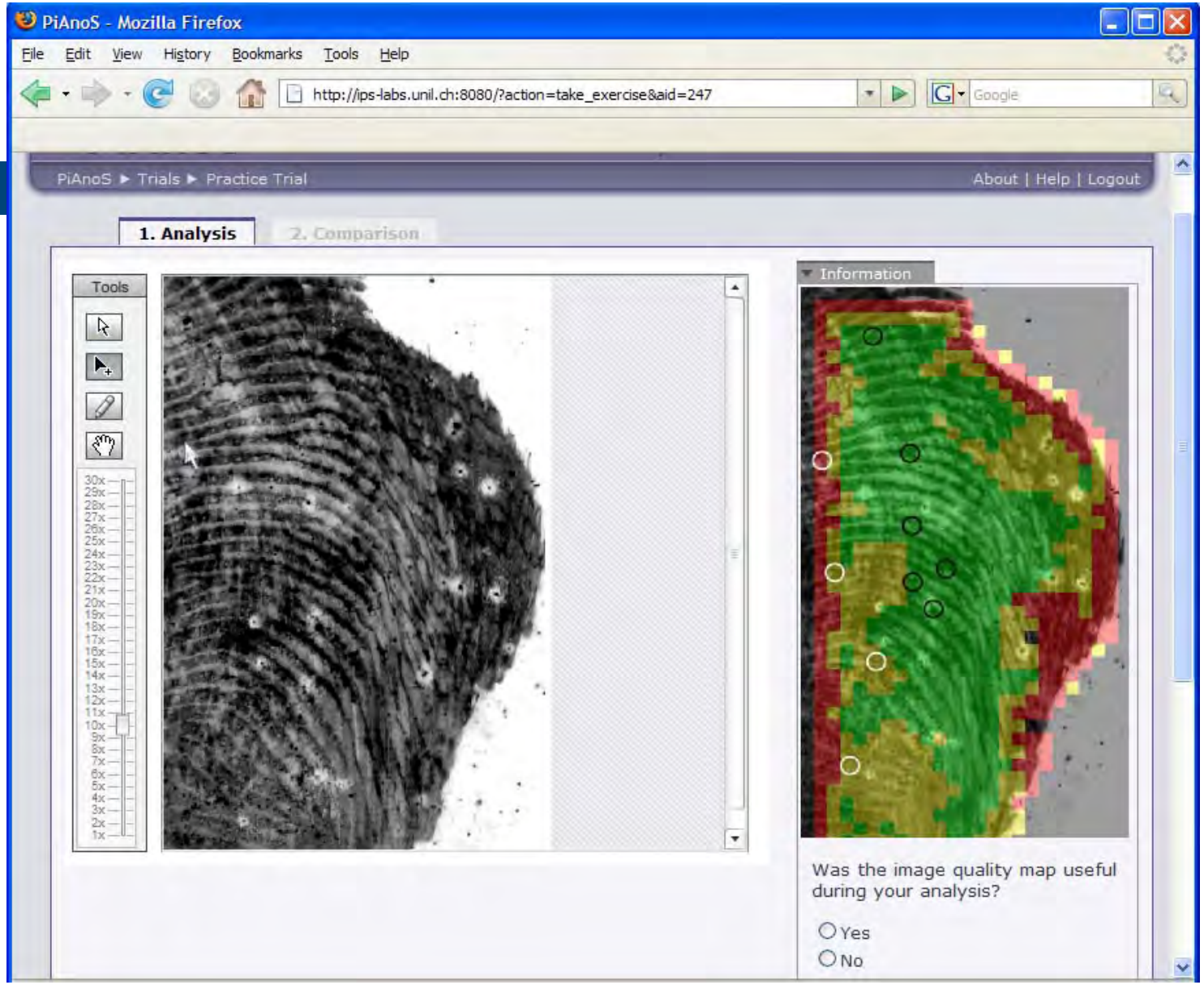
Group 6: Quality map & LR Tool

Group 1 – Control – No Tools

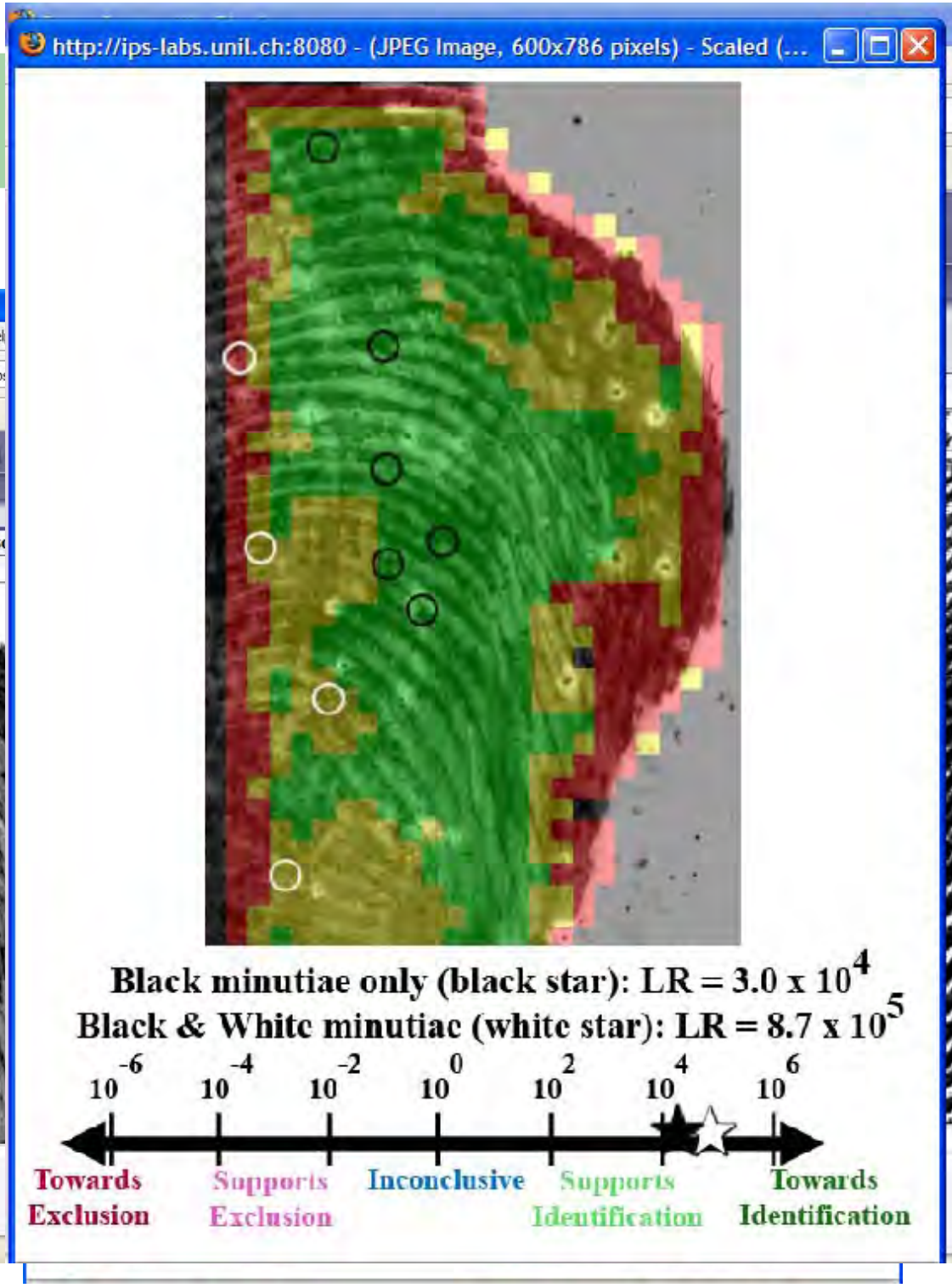


Group 2 – Consensus Map

Group 4 (and 6) – Quality Map




PiAnoS - Mozilla Firefox
File Edit View History Bookmarks Tools Hel
http://ips-labs
PiAnoS
PiAnoS ▶ Trials ▶ Practice Trial
1. Analysis
2. Comparis
Tools
Transferring data from ips-labs.unil.ch...

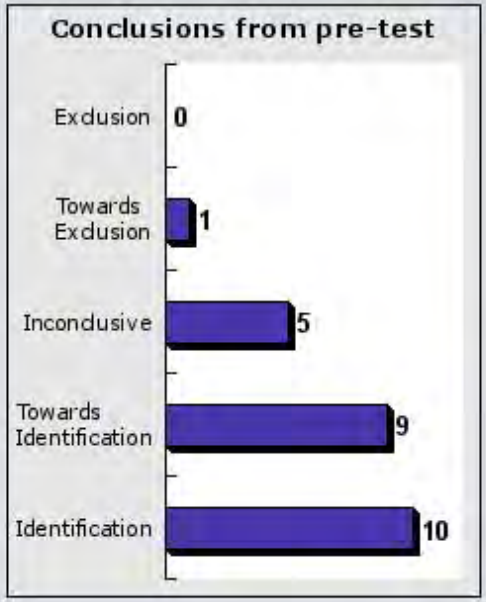

http://ips-labs.unil.ch:8080 - (JPEG Image, 600x786 pixels) - Scaled (...
Black minutiae only (black star): LR = 3.0 x 10^4
Black & White minutiae (white star): LR = 8.7 x 10^5
10^-6 10^-4 10^-2 10^0 10^2 10^4 10^6
Towards Exclusion
Supports Exclusion
Inconclusive
Supports Identification
Towards Identification

http://ips-labs.unil.ch:8080 - PiAnoS - Practice Trial - Conclusions from pre-tests - Mozilla Firefox

Practice Trial - Conclusions from pre-tests

User No.	Conclusion	Class	Comments
1	Identification	1	
2	Identification	1	
3	Identification	1	
4	Inconclusive	2	Leaning towards ID, need better exemplars
5	Identification	1	
6	Inconclusive	2	Leaning towards ID, need better exemplars
7	Identification	1	
8	Identification	1	
9	Inconclusive	2	Very likely towards ID
10	Identification	1	
11	Inconclusive	2	Too few features to positively ID, need better exemplars
12	Identification	1	
13	Inconclusive	4	Leaning towards exclusion, need better exemplars
14	Identification	1	
15	Inconclusive	3	Need better known exemplars
16	Inconclusive	2	Leaning towards ID, need better exemplars
17	Inconclusive	2	Leaning towards ID
18	Inconclusive	2	Leaning towards ID, need better exemplars
19	Inconclusive	3	Need better known exemplars
20	Inconclusive	3	Need better known exemplars
21	Inconclusive	3	Need better known exemplars
22	Inconclusive	2	Leaning towards ID, need better exemplars
23	Inconclusive	2	Insufficient features to ID (but 8 points in agreement)
24	Inconclusive	3	
25	Identification	1	

Conclusion	Count
Exclusion	0
Towards Exclusion	1
Inconclusive	5
Towards Identification	9
Identification	10



[close the window]

Comments

- “Felt seeing other examiners markings yielded bias”
- “Although I formed a conclusion prior to looking at the LR, I wanted to check to see if I was on the right track. I almost feel as if I am biased by the LR's conclusion.”
- “The image quality map tends to create bias towards seeing a minutia where it may or may not be.”

Comments, cont.

- “The LR leans toward an identification when there is enough for an exclusion. So far, it seems the LR seems to make the examiner second guess themselves and spend extra time checking and rechecking their work to see if it is closer to the LR suggestion. I know this pushes toward "biasability“.

Comments, cont.

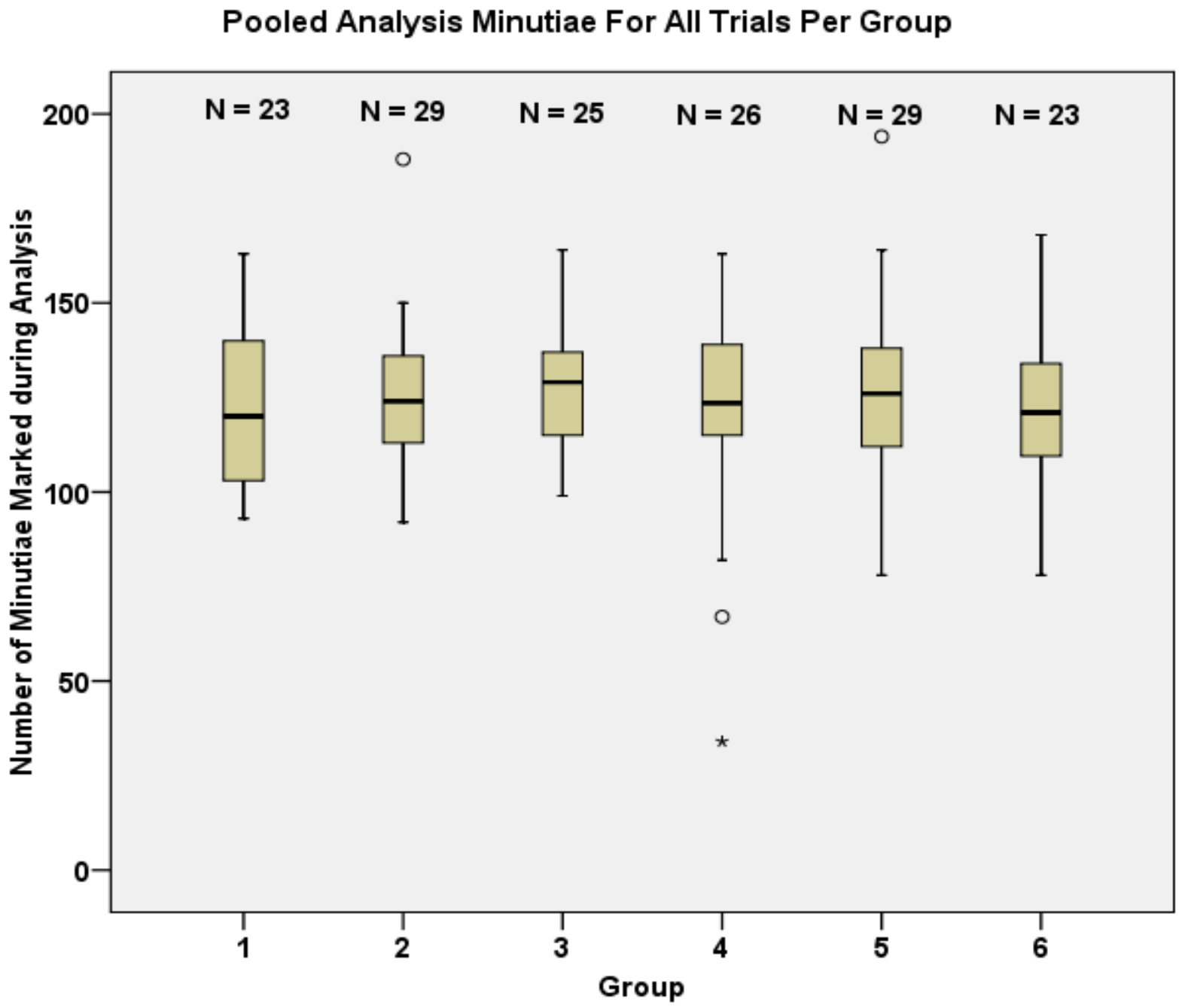
- “I do not let others influence my decisions unless they can show me why!”
- “The LR had no influence on my decision on this particular print.” (committed an error)
- “Actually, I tend toward calling it an [exclusion] but your LR likes it, so it has caused me to be uncertain.” (close non-match)
- “It appears that the LR ratio supports an identification, however, my opinion would be that this latent is not an ID.” (same trial)

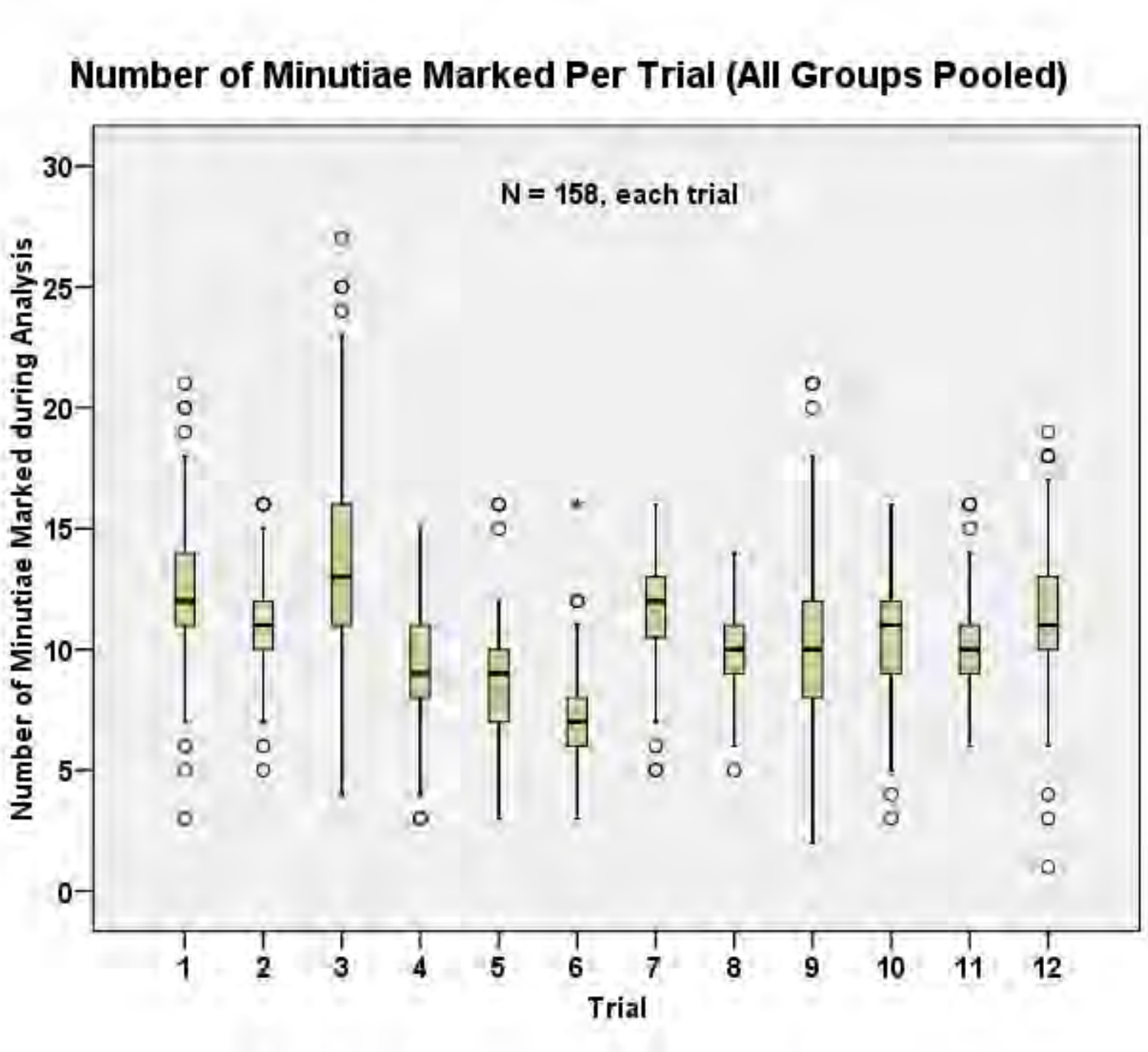
Comments, cont.

- “Made identification decision with using LR”
- “I'm starting to understand how to really utilize the quality map, as long as I'm not doing false identifications.” (made an erroneous identification on that trial)

Error Rates by Groups

	N	False Discovery Rate		Sensitivity	Selectivity
		False +	False -		
Group 1	27	4.0%	10.1%	63.5%	79.3%
Group 2	33	0.6%	7.3%	66.7%	92.1%
Group 3	28	2.1%	7.6%	71.4%	86.4%
Group 4	31	4.6%	9.9%	66.8%	81.9%
Group 5	32	0.7%	7.8%	66.5%	95.6%
Group 6	25	4.3%	7.9%	75.4%	84.0%
All Groups	**176**	**2.7%**	**8.4%**	**68.2%**	**86.9%**


Pooled Analysis Minutiae For All Trials Per Group
N = 23
N = 29
N = 25
N = 26
N = 29
N = 23
200
150
100
50
0
Number of Minutiae Marked during Analysis
1
2
3
4
5
6
Group


Number of Minutiae Marked Per Trial (All Groups Pooled)
N = 158, each trial
Number of Minutiae Marked during Analysis
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
Trial

Informational Tools Results

- Tools:
  - “Slight impact” on error rates (Group 2 and 5)
  - Decisions in Group 2 and 5 “slightly more” consistent
  - No significance for mean number of minutiae and variance of minutiae selected

Two Analysts

- Both have marked 11 minutiae
- On paper, appear to be in agreement
- Need to look at actual minutiae marked

PiAnoS - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://ips-labs.unil.ch/?action=take_exercise&id=132#

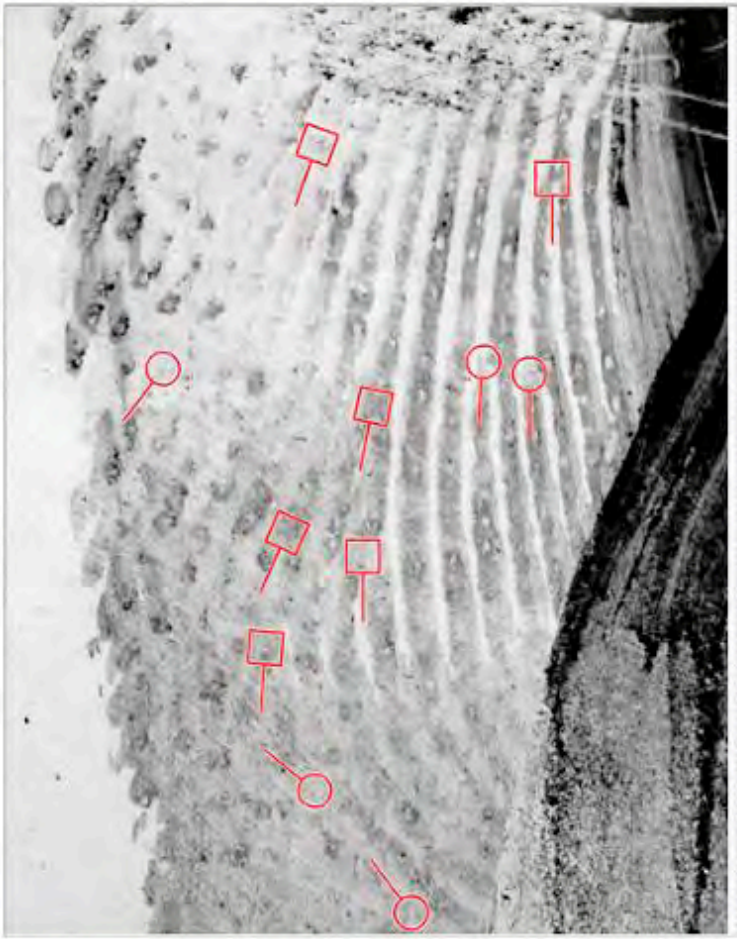
PiAnoS

A Picture Annotation System

PiAnoS ▶ Trials ▶ Trial 04

1. Analysis | 2. Comparison

Tools



Transferring data from ips-labs.unil.ch...

start | IAI_Spokane_2... | Distributions of ... | beta_error data... | 3 Microsoft Of... | Lab on 'BCA-File... | Inbox - Microso... | PiAnoS - Mozilla ... | Adobe Photoshop

PiAnoS - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://ips-labs.unil.ch/?action=take_exercise&id=132#

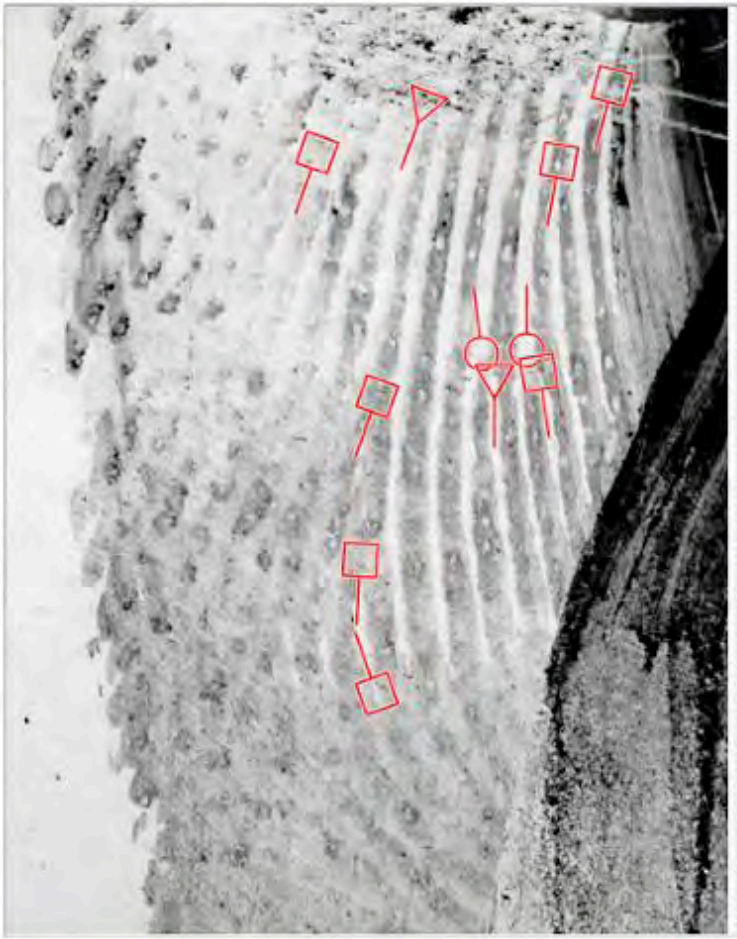
PiAnoS

A Picture Annotation System

PiAnoS ▶ Trials ▶ Trial 04

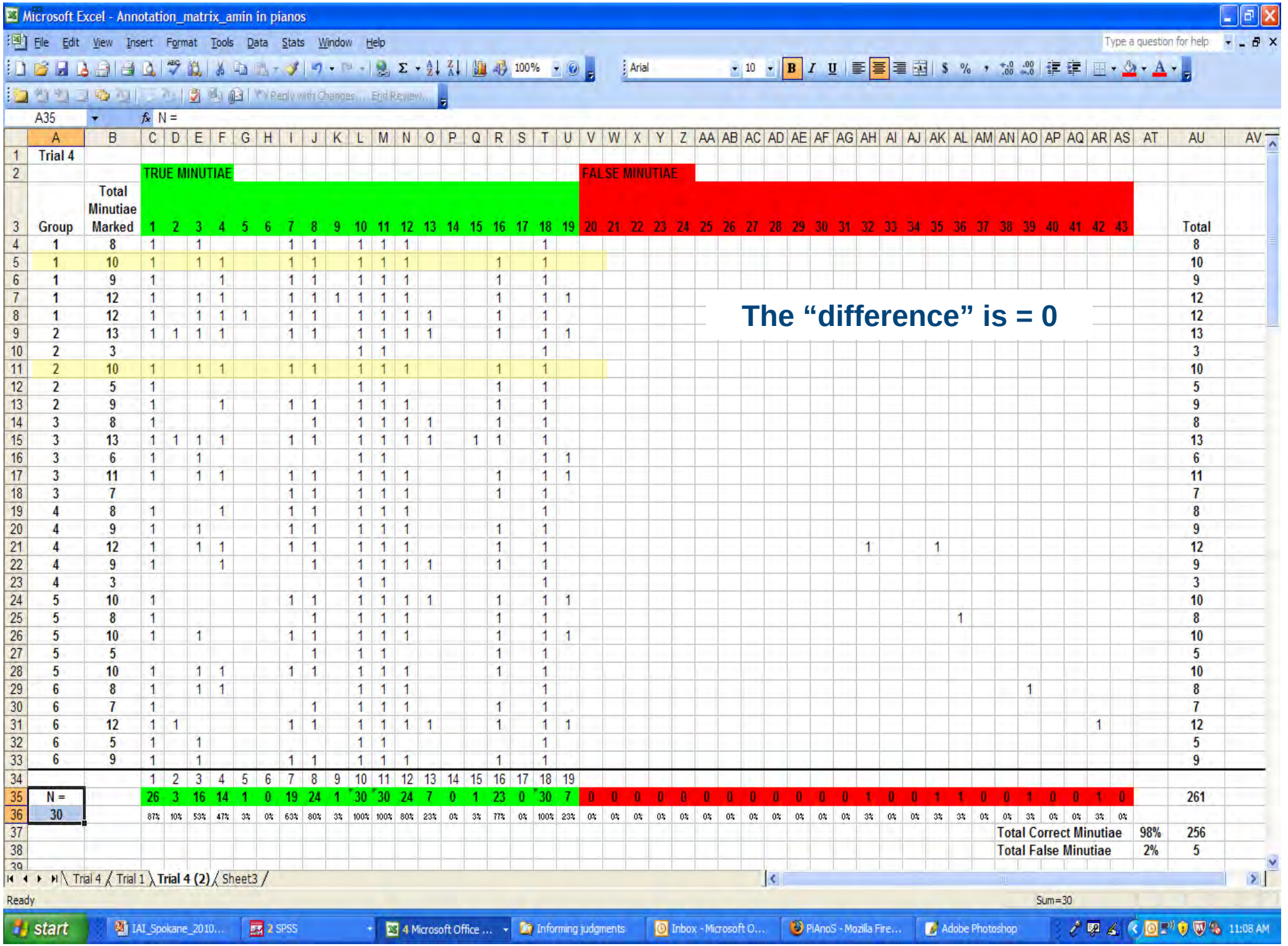
1. Analysis | 2. Comparison

Tools



Transferring data from ips-labs.unil.ch...

start | IAI_Spokane_2... | Distributions of ... | beta_error data... | 3 Microsoft Of... | Lab on 'BCA-File... | Inbox - Microso... | PiAnoS - Mozilla ... | Adobe Photoshop



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1	Trial 4																																															
2			TRUE MINUTIAE																			FALSE MINUTIAE																												
3	Group	Total Minutiae Marked	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43		Total	
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31	6	12	1	1					1	1		1	1	1	1			1		1	1																								1			12	
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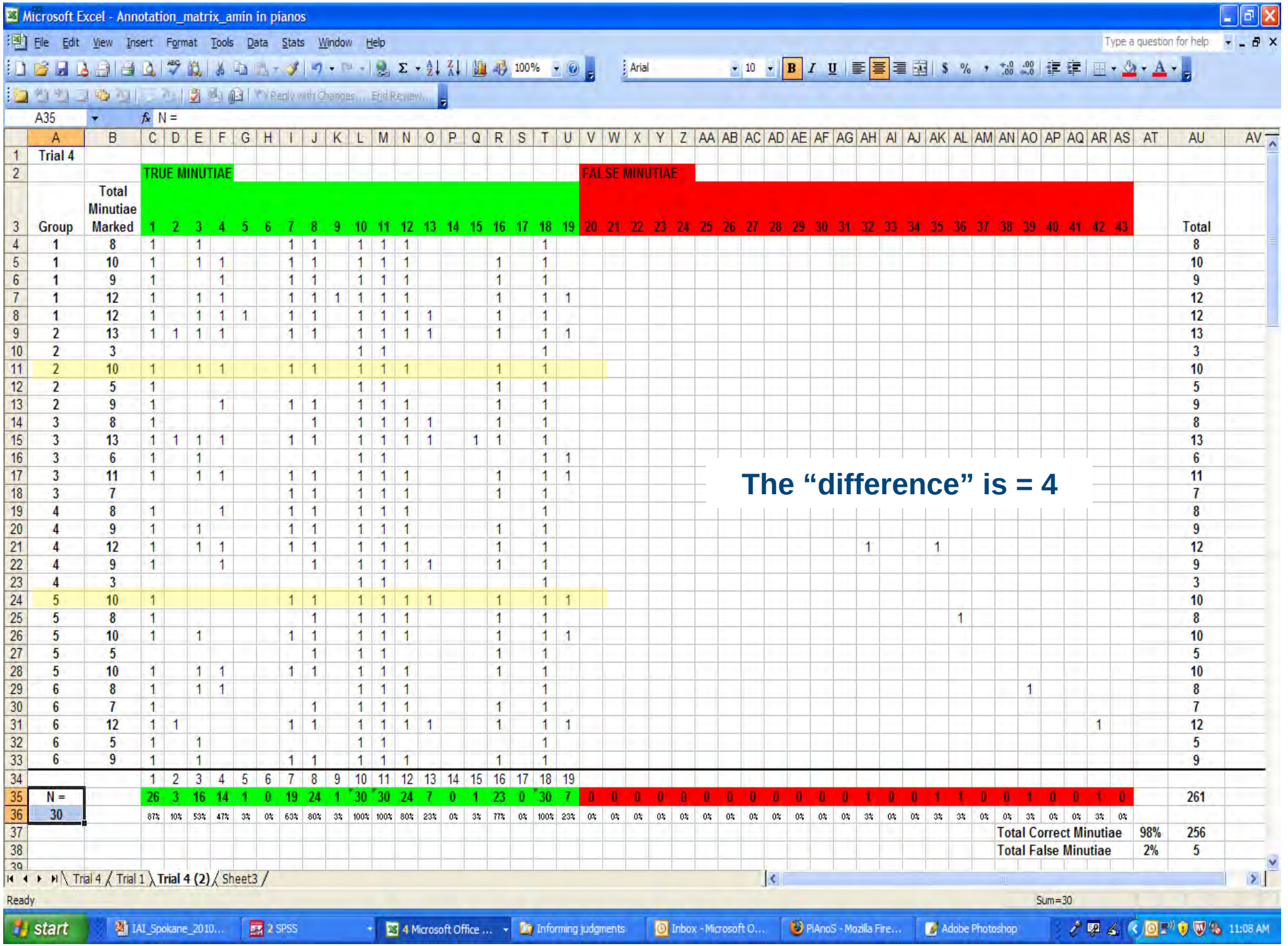
36	30		87%	10%	53%	47%	3%	0%	63%	80%	3%	100%	100%	80%	23%	0%	3%	77%	0%	100%	23%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	3%	3%	0%	0%	3%	0%	0%	3%	0%			
37																																														Total Correct Minutiae	98%	256	
38																																														Total False Minutiae	2%	5	
39																																																	

Trial 4 / Trial 1 / Trial 4 (2) / Sheet3

Ready

Sum=30

start | IAI_Spokane_2010... | 2 SPSS | 4 Microsoft Office ... | Informing judgments | Inbox - Microsoft O... | PiAnoS - Mozilla Fire... | Adobe Photoshop | 11:08 AM



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1	Trial 4																																															
2			TRUE MINUTIAE																			FALSE MINUTIAE																												
3	Group	Total Minutiae Marked	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43		Total	
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36	30		87%	10%	53%	47%	3%	0%	63%	80%	3%	100%	100%	80%	23%	0%	3%	77%	0%	100%	23%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	3%	3%	0%	0%	3%	0%	0%	3%	0%			
37																																													Total Correct Minutiae	98%	256	
38																																												Total False Minutiae	2%	5	
39																																																

Trial 4 / Trial 1 / Trial 4 (2) / Sheet3

Ready

Sum=30

Trial 1

A_{min}

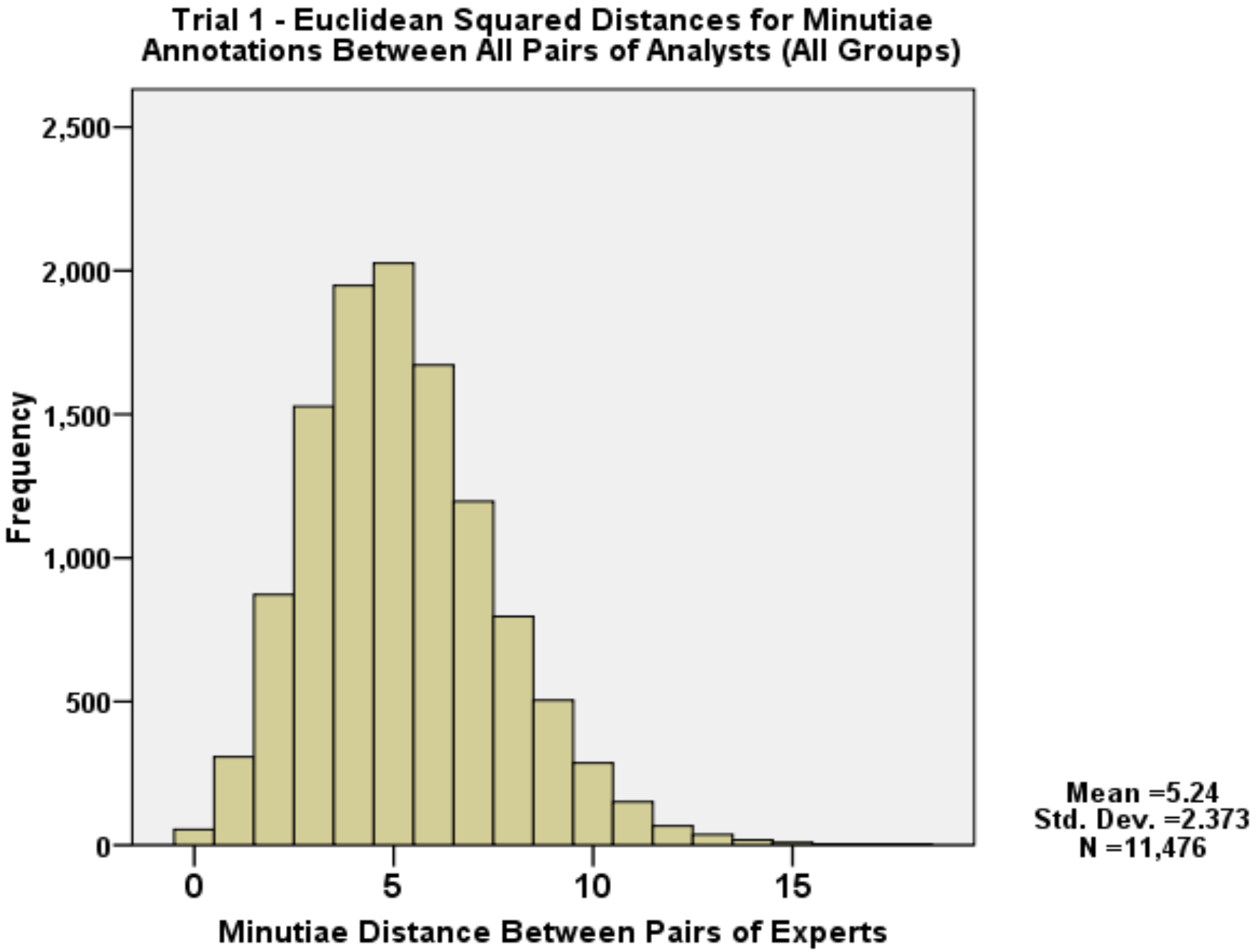
Mean = 12.2

Std Dev = 2.7

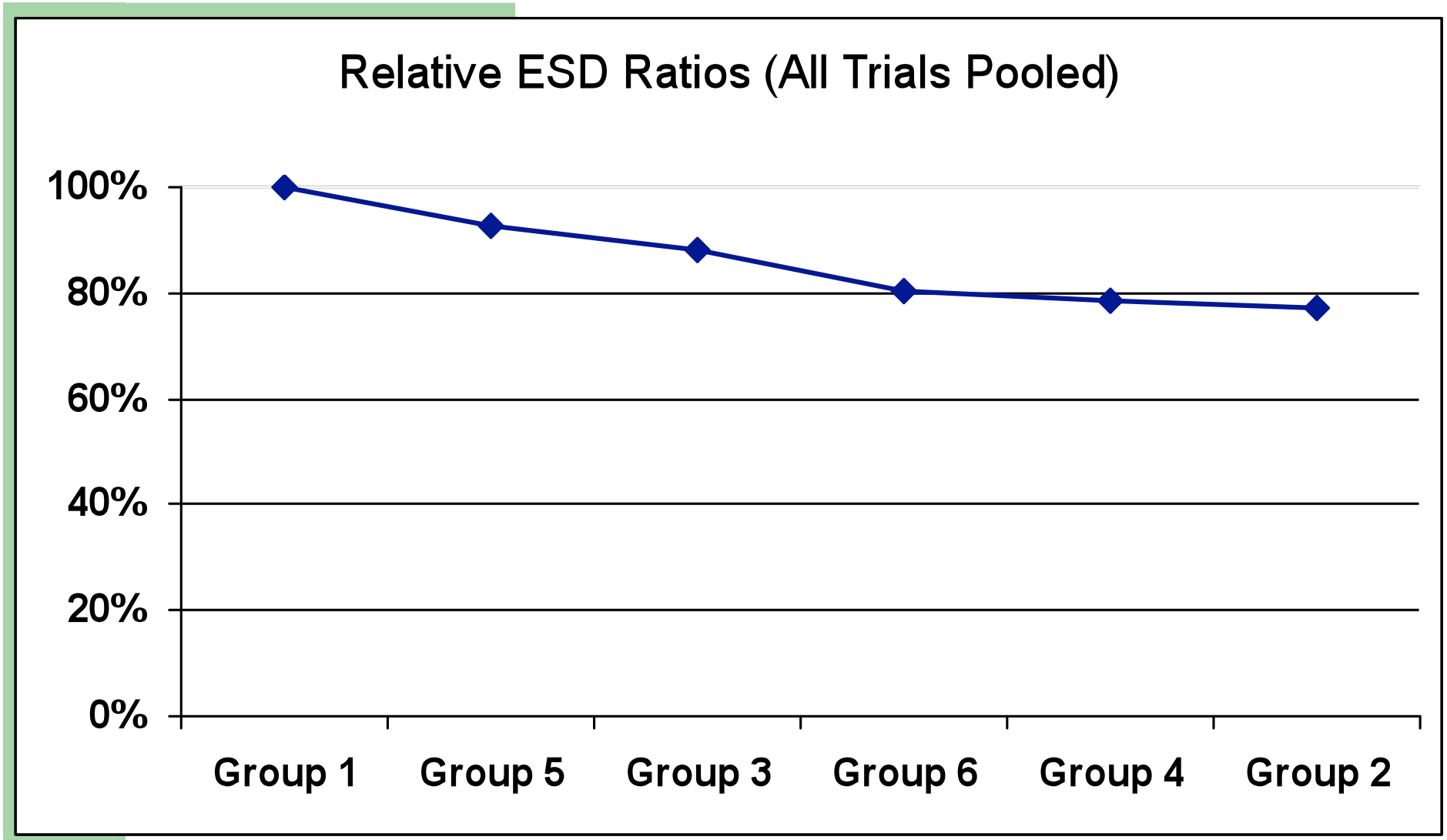
ESD (difference)

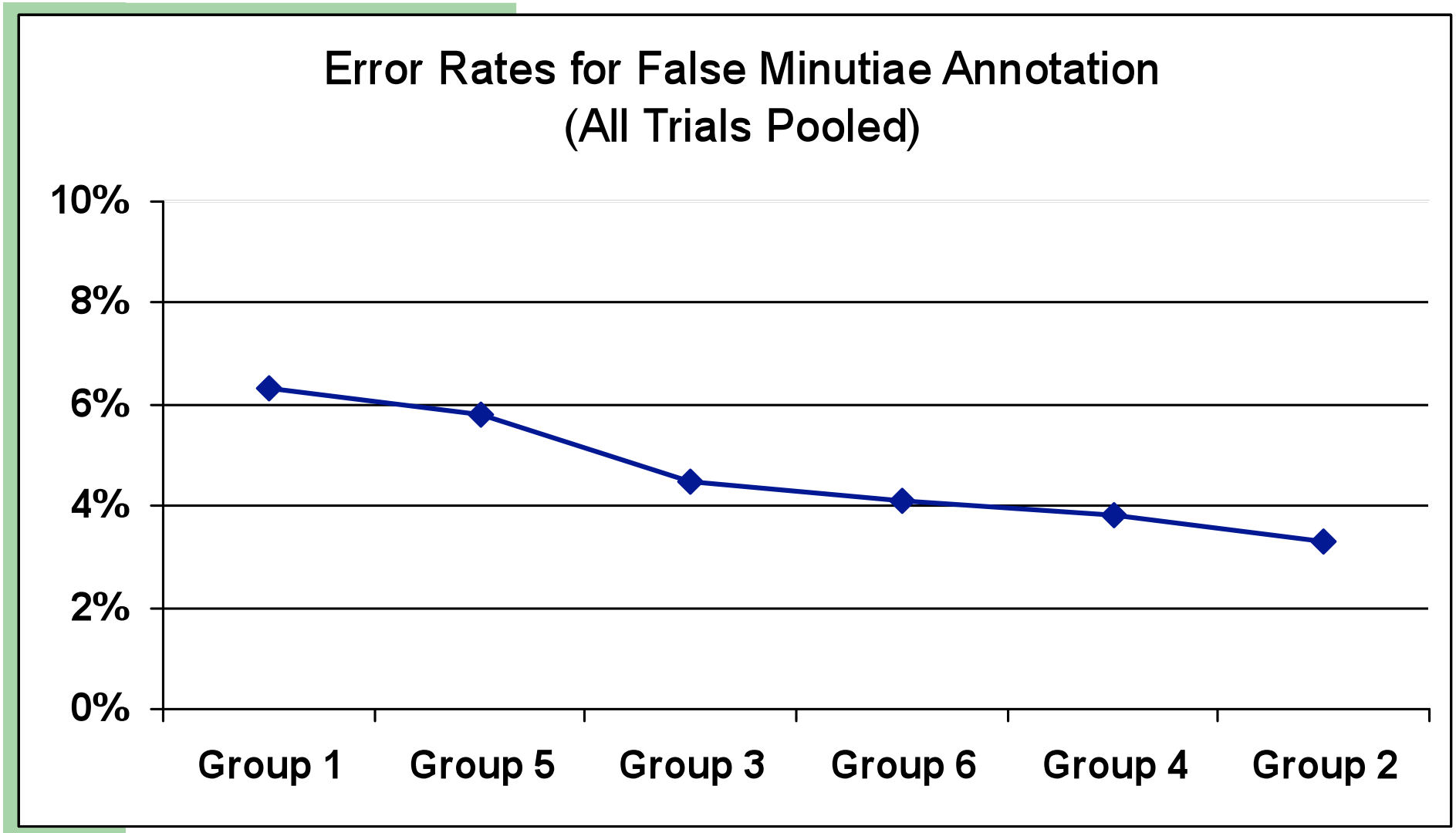
Mean = 5.2

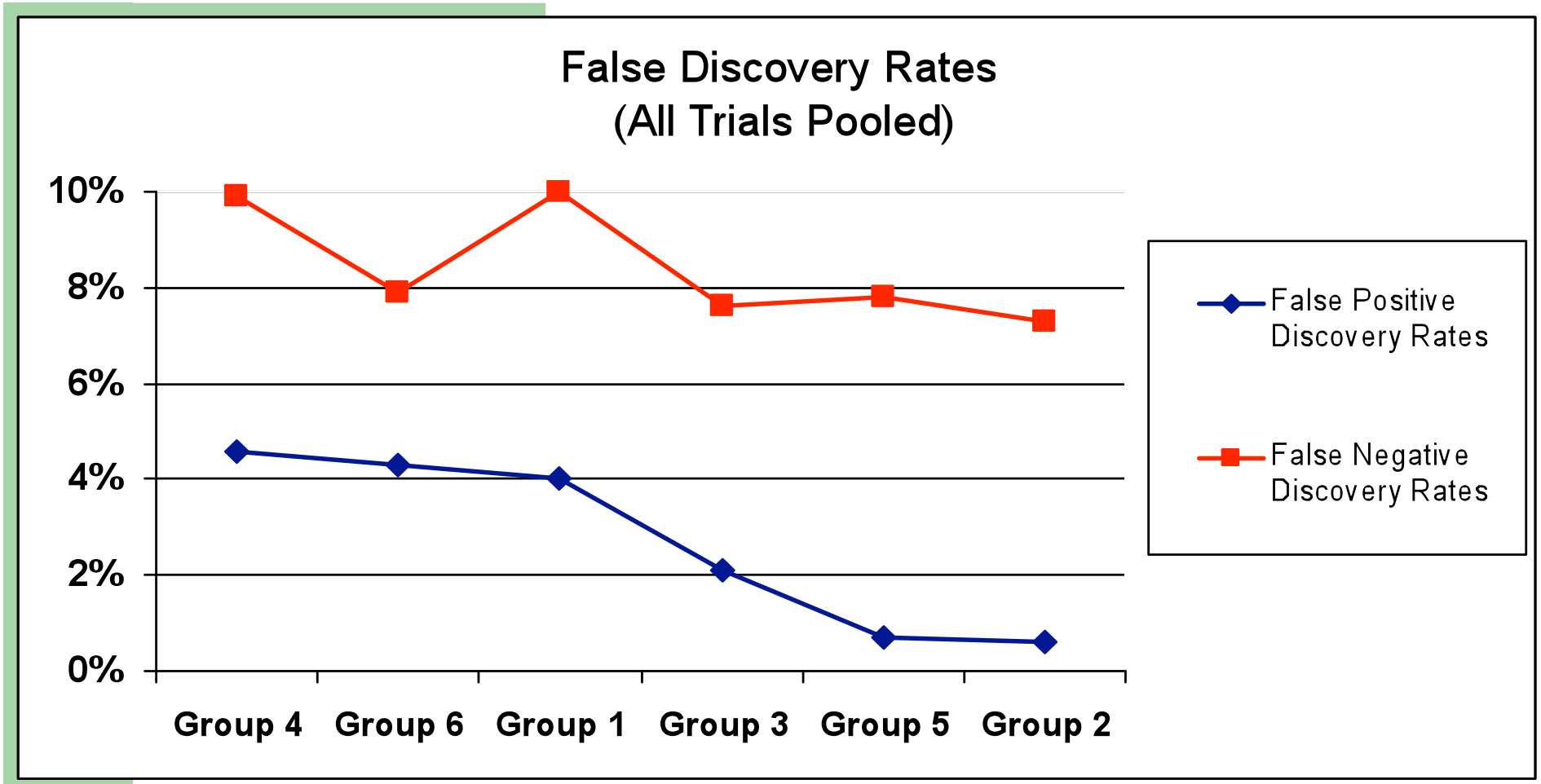
Std Dev = 2.4

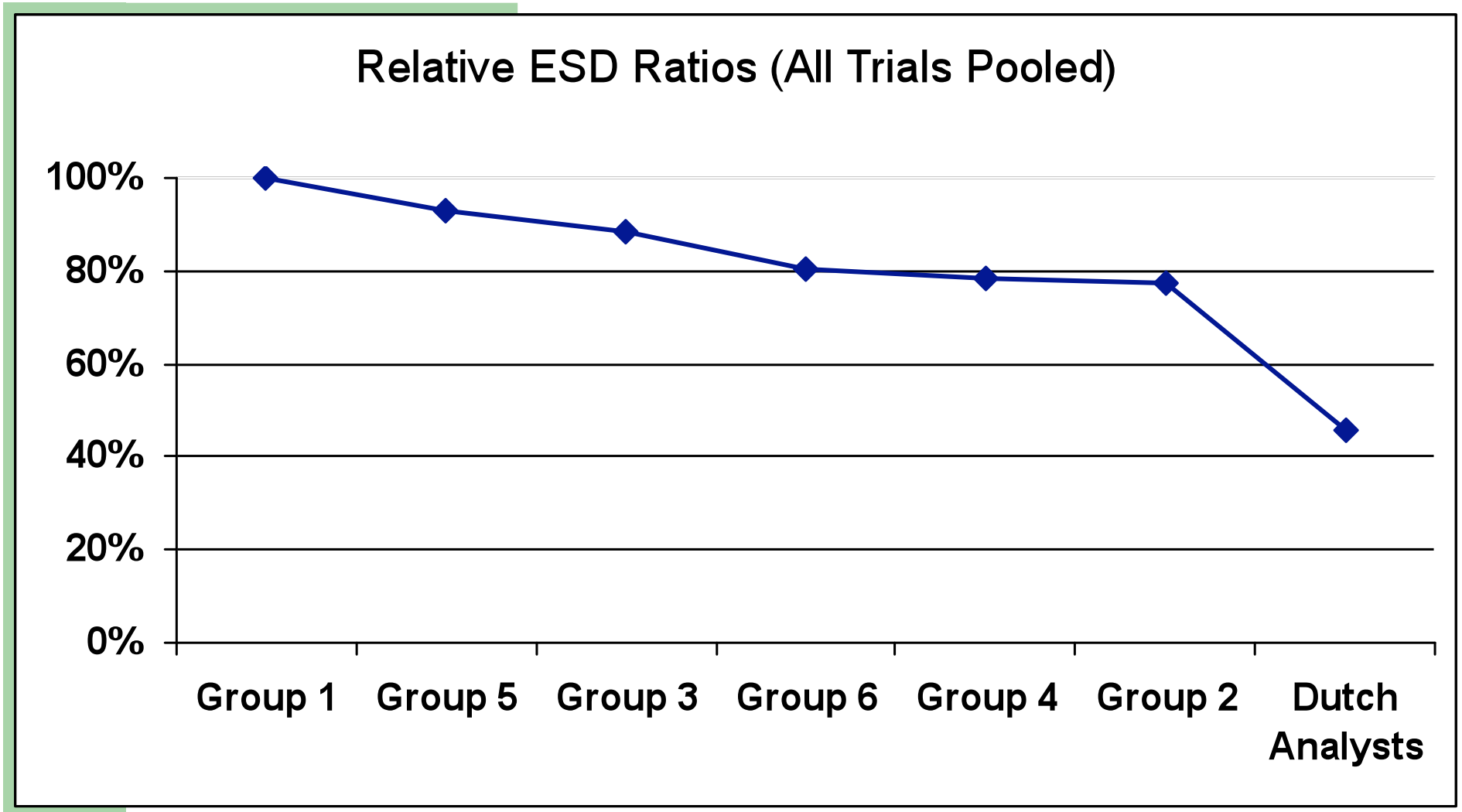

Trial 1 - Euclidean Squared Distances for Minutiae Annotations Between All Pairs of Analysts (All Groups)
Frequency
2,500
2,000
1,500
1,000
500
0
0
5
10
15
Minutiae Distance Between Pairs of Experts
Mean =5.24
Std. Dev. =2.373
N =11,476

	Amin			ESD Statistics						
	mean	SD	% False Marked	mean	SD	N	min	med	max	ESD ratio
Trial 01	12.2	2.7	3%	5.2	2.4	11,476	0	5	18	0.43
Trial 02	10.9	2.0	3%	3.6	1.8	11,628	0	3	11	0.33
Trial 03	14.1	3.8	3%	7.9	3.6	11,781	0	7	27	0.56
Trial 04	9.2	2.2	4%	3.9	2.1	11,476	0	4	12	0.43
Trial 05	8.6	2.1	2%	4.5	2.2	11,781	0	4	18	0.52
Trial 06	7.1	2.0	12%	3.8	2.1	11,935	0	4	15	0.53
Trial 07	11.6	2.1	5%	4.0	2.0	11,781	0	4	12	0.34
Trial 08	10.0	1.6	3%	3.3	2.0	11,781	0	3	17	0.33
Trial 09	10.3	3.3	7%	5.7	2.7	11,781	0	5	19	0.55
Trial 10	10.6	2.5	11%	5.3	2.3	11,935	0	5	17	0.50
Trial 11	10.4	1.8	4%	3.3	2.1	11,781	0	3	18	0.32
Trial 12	11.1	2.8	2%	4.6	2.7	11,935	0	4	18	0.42
									Mean	0.44
									SD	0.09


Relative ESD Ratios (All Trials Pooled)
100%
80%
60%
40%
20%
0%
Group 1
Group 5
Group 3
Group 6
Group 4
Group 2


Error Rates for False Minutiae Annotation
(All Trials Pooled)
10%
8%
6%
4%
2%
0%
Group 1
Group 5
Group 3
Group 6
Group 4
Group 2


False Discovery Rates
(All Trials Pooled)
10%
8%
6%
4%
2%
0%
Group 4
Group 6
Group 1
Group 3
Group 5
Group 2
False Positive Discovery Rates
False Negative Discovery Rates


Relative ESD Ratios (All Trials Pooled)
100%
80%
60%
40%
20%
0%
Group 1
Group 5
Group 3
Group 6
Group 4
Group 2
Dutch Analysts

Conclusion from Study

- While the impact on the decision and error was minimal from the tools, the greatest impact came from the consistency in the feature annotations. Analysts had fewer erroneous annotations and more consistency when using the Minutiae Mapping tools.
- This may have translated to some of the decisions, but the link is not clearly demonstrated in the data

The Benefit of Information

“After analysing 27 sets of forensic evidence, "Our research suggests that the superficially attractive objective of shielding the forensic scientist from information which might inappropriately influence her scientific judgment should be abandoned in favour of more productive efforts to improve the extent and quality of the information exchange between FSS scientists and instructing lawyers."

Roberts, P; Willmore, C. The role of forensic evidence in criminal proceedings. Royal Commission on Criminal Justice Research Study (No. 11), London, HMSO, 1993, p. 137.

The Necessity of Information

- In a Bayesian framework, priors are needed

- Prior x LR = Posterior

Corresponding features/characteristics

A + C

Decision

E

The Problem with Science and the American (Adversarial) CJ System

- Hypothesis testing (H_0, H_1, H_2, etc.)
- Presented with hypotheses, we perform a test.
- The evidence supports to varying degrees the hypotheses (LRs)
- When do hypotheses get generated?

The First Bias

The first great bias is the adversarial system itself. All other biases are insignificant to this first bias, inherent in the system.

(paraphrased from Pierre Margot)

- Sharpshooter's Fallacy
  - Paint the bullseye to fit the fired shots
  - You're a sharpshooter every time
  - Attorneys wait for the evidence results and then build a theory/story/defense around the evidence
  - This is the OPPOSITE of science

Proposed solutions

From Champod and Vuille (2010) "*Scientific Evidence in Europe—Admissibility, Appraisal, and Equality of Arms*"

- Earlier involvement of Defense
- Court appointed experts/tests
- Equal access to the tests
- Pre-trial conferences, joint expertise, hot tubbing
- Give precedence to written reports

Summary

- I don’t know the answer
- Let’s focus on the actual issues
- Let’s recognize some “superficially apparent biasing information” can be useful. What analysts THINK may be biasing, may actually be helpful in some ways.
- Let’s find a way to harmonize sequential unmasking, but recognize the advantages and special role of forensic science and evidence interpretation.