

IMPROVING FORENSIC DECISION MAKING: A HUMAN-COGNITIVE PERSPECTIVE

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- A huge topic!
- Much to cover, today just scratching the surface
- Happy to answer questions
- Applies to all expert decision making
- Some of it is 'controversial' (especially in the adversarial legal systems)



Transferring academic knowledge
of the brain into the real world

IMPROVING FORENSIC DECISION MAKING: A HUMAN-COGNITIVE PERSPECTIVE

What is the *most consistent* finding in forensic science?

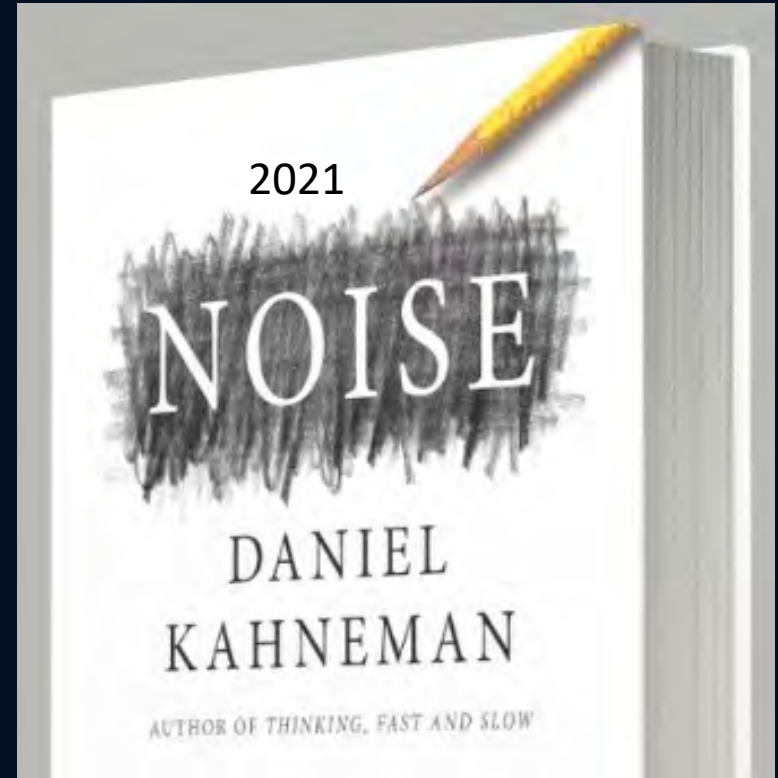
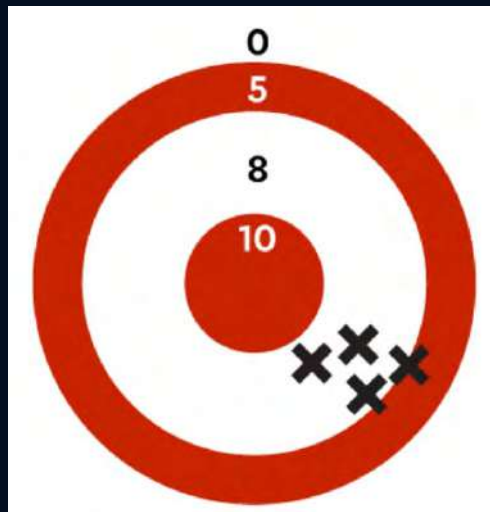
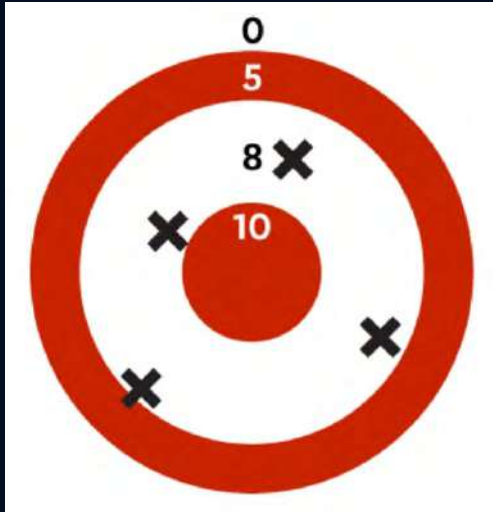
... the most consistent finding (in my view), is...: inconsistency!

“Inconsistency is the most consistent finding in forensic science”

A problem...:

1. Science
2. Justice
3. Forensic

NOISE VS. BIAS



Journal of Applied Research in Memory and Cognition 5 (2016) 121–127

Contents lists available at [ScienceDirect](#)



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Journal of Applied Research in Memory and Cognition

journal homepage: www.elsevier.com/locate/jarmac



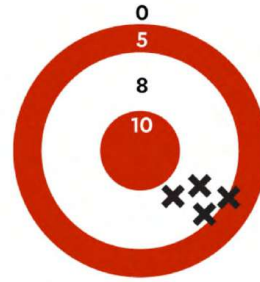
A Hierarchy of Expert Performance[☆]

Itiel E. Dror^{*}

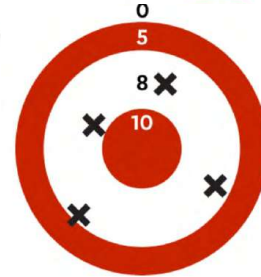


NOISE VS. BIAS

Biasability

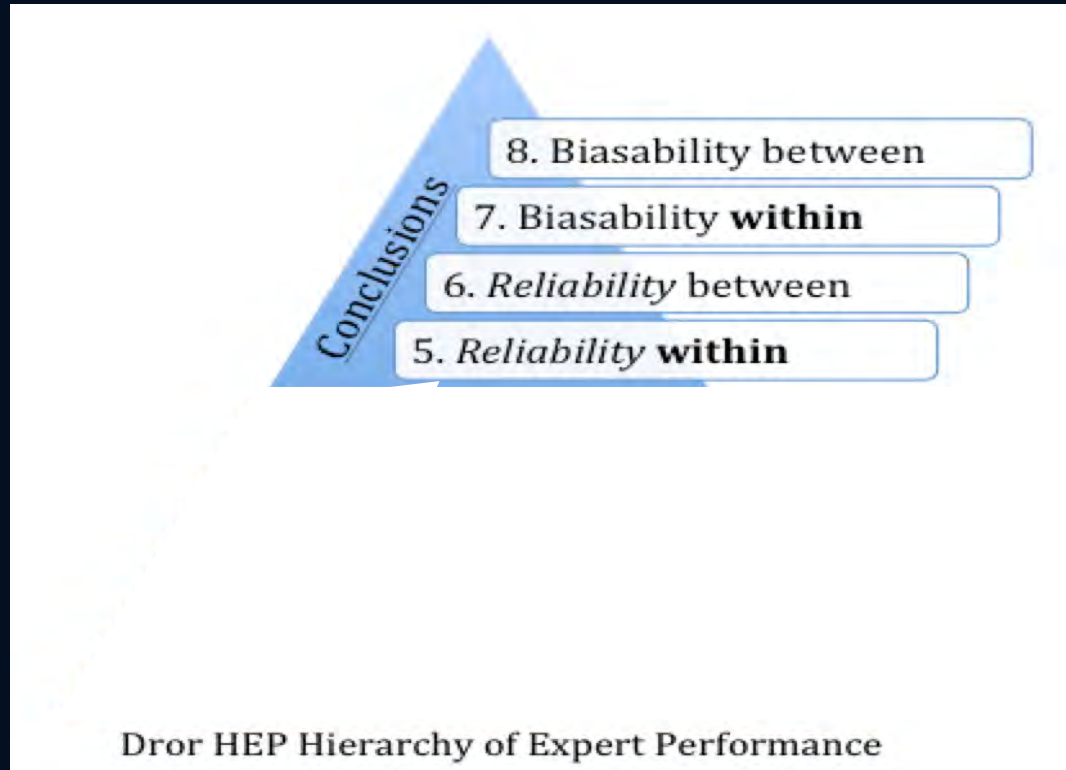


Reliability

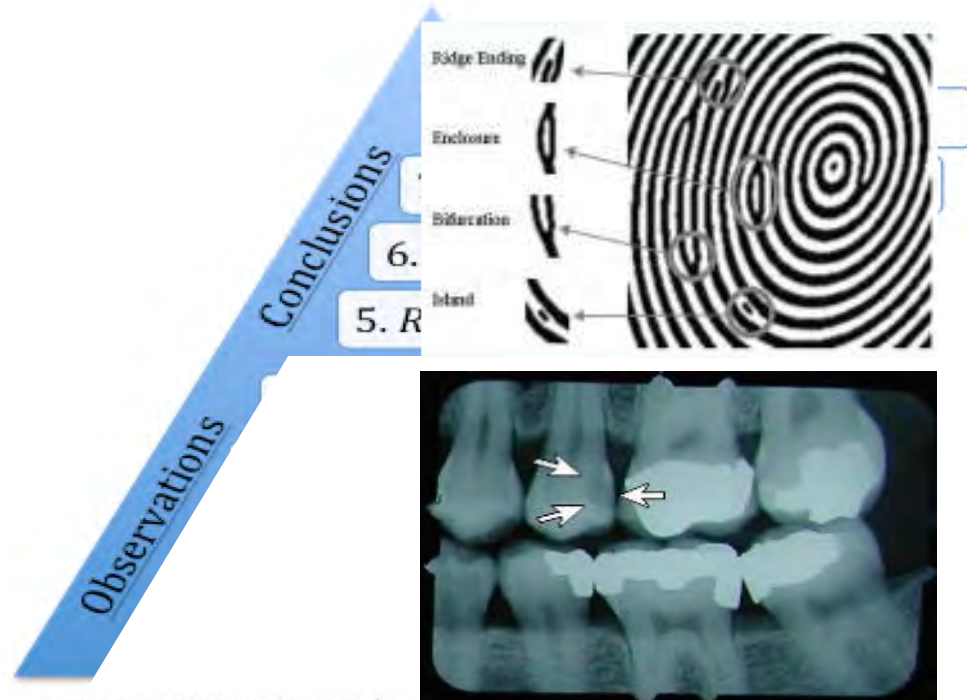


Dror HEP Hierarchy of Expert Performance

NOISE VS. BIAS



NOISE VS. BIAS

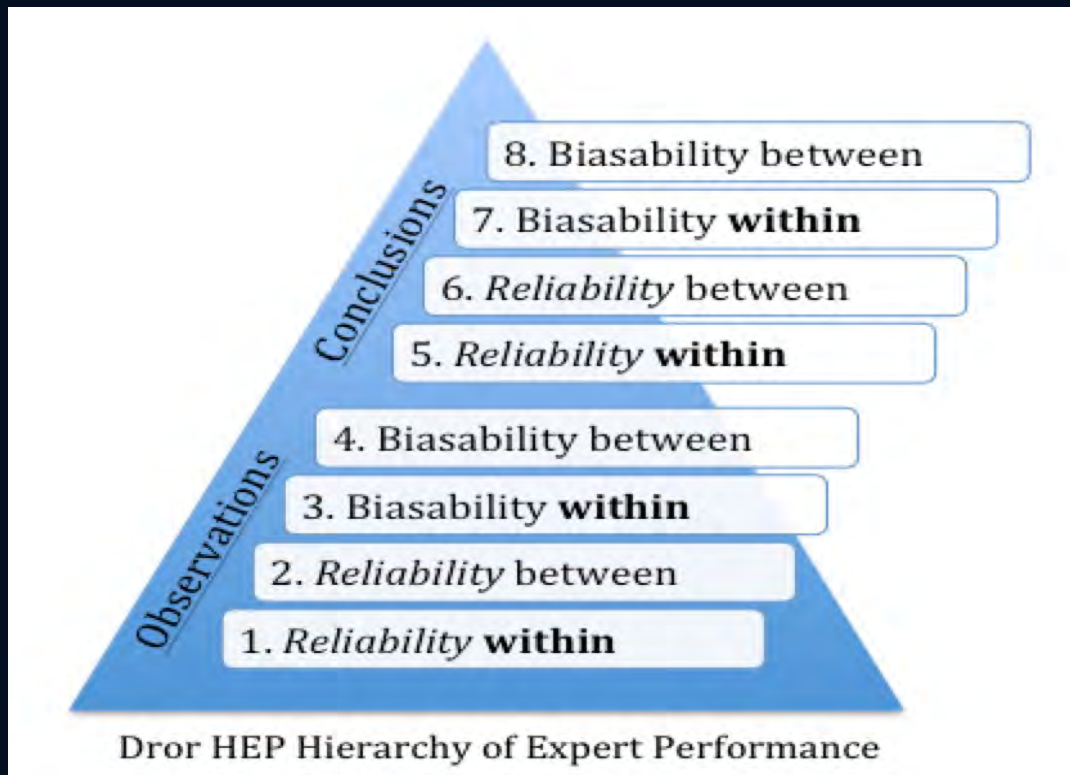


Dror HEP Hierarchy of Expert Performance

Let's see the data!

"Inconsistency is the most consistent finding in forensic science"

NOISE VS. BIAS



Let's see the data! From forensic science

"Inconsistency is the most consistent finding in forensic science"

NOISE VS. BIAS



*All forensic
domains!*



Dror HEP Hierarchy of Expert Performance

Fingerprinting

- Even in bias studies, i.e., irrelevant context X vs. Y:
- If we look only within one condition, (context X alone, or context Y alone), there are inconsistencies.
- And, in the control group too (when no irrelevant context is given)

SAME EXAMINERS – ‘WITHIN’

	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	<u>none</u>	suggest exclusion	none	suggest exclusion	<u>none</u>	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

NOISE VS. BIAS

6. *Reliability between*

5. *Reliability **within***

Dror HEP Hierarchy of Expert Performance

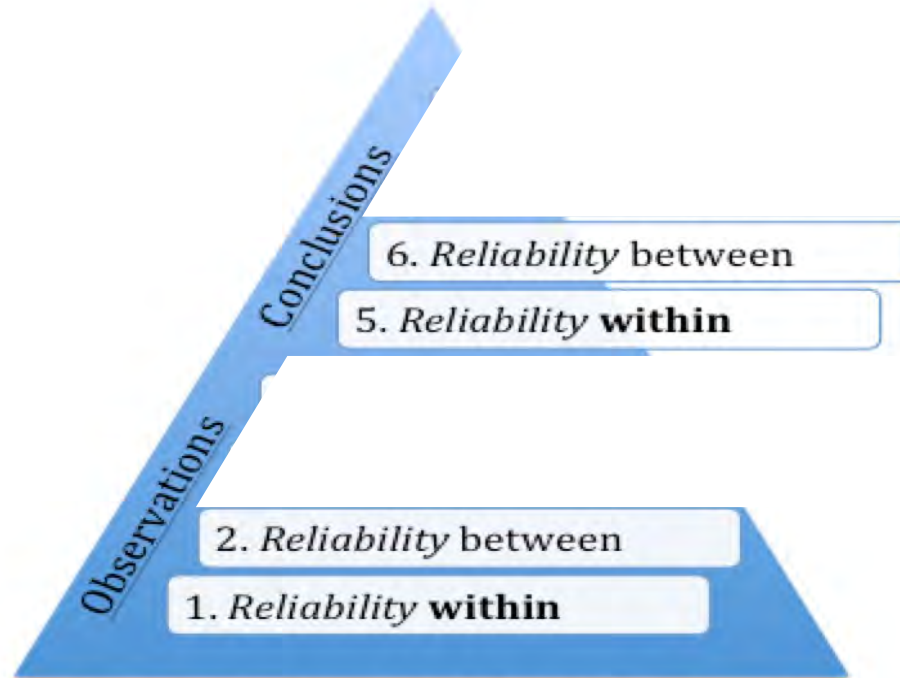
Repeatability and Reproducibility of Decisions by Latent Fingerprint Examiners

Bradford T. Ulery¹, R. Austin Hicklin¹, JoAnn Buscaglia^{2*}, Maria Antonia Roberts³



AND, EXPANDED TO THE 'OBSERVATION' LEVEL:

NOISE VS. BIAS



Dror HEP Hierarchy of Expert Performance

THIS 2006 FINDING, HAS BEEN REPLICATED...
AND, EXPANDED TO THE 'OBSERVATION' LEVEL:

Fingerprinting



Contents lists available at [ScienceDirect](#)

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint



Cognitive issues in fingerprint analysis: Inter- and intra-expert consistency and the effect of a 'target' comparison

Itiel E. Dror^{a,b,*}, Christophe Champod^c, Glenn Langenburg^{c,d}, David Charlton^{e,f}, Heloise Hunt^a, Robert Rosenthal^g

THIS 2006 FINDING, HAS BEEN REPLICATED...
AND, EXPANDED TO THE ‘OBSERVATION’ LEVEL:

Fingerprinting

Table 4

The differences in number of minutiae observed by the same examiner at different times. The bottom row is the mean difference per latent mark (A–J), and the right most column is the mean difference per examiner (1–10).

Examiner	Latent mark										Mean
	A	B	C	D	E	F	G	H	I	J	
1	1	1	4	1	1	2	3	2	0	1	1.6
2	8	3	5	1	1	2	2	5	2	2	3.1
3	1	3	3	3	6	4	9	9	1	2	4.1
4	2	3	2	5	0	1	1	0	0	1	1.5
5	6	2	2	3	4	1	3	3	0	3	2.7
6	9	4	2	1	4	6	0	5	1	1	3.3
7	0	4	5	2	4	3	3	7	0	0	2.8
8	3	1	4	0	6	2	1	4	2	0	2.3
9	4	3	9	0	4	4	3	1	1	3	3.2
10	1	0	0	1	4	1	4	1	0	0	1.2
Mean	3.5	2.4	3.6	1.7	3.4	2.6	2.9	3.7	0.7	1.3	2.58

Cognitive issues in fingerprint analysis: inter- and intra-expert consistency and the effect of a ‘target’ comparison

Itiel E. Dror^{a,b,*}, Christophe Champod^c, Glenn Langenburg^{c,d}, David Charlton^{e,f}, Heloise Hunt^a,

THIS 2011 FINDING, HAS BEEN REPLICATED...

DNA

Science and Justice 51 (2011) 204–208



Contents lists available at [SciVerse](#) [ScienceDirect](#)

Science and Justice

journal homepage: www.elsevier.com/locate/scijus



Subjectivity and bias in forensic DNA mixture interpretation ☆

Itiel E. Dror ^{a,b,*}, Greg Hampikian ^c

Again...

‘noise’, inconsistency, lack of reliability, reproducibility, repeatability, etc.

THIS 2011 FINDING, HAS BEEN REPLICATED...

DNA

- In 2018 NIST published its MIX studies

Forensic Science International: Genetics 37 (2018) 81–94



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Contents lists available at ScienceDirect

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsigen

"variations observed among laboratory results"

NIST interlaboratory studies involving DNA mixtures (MIX05 and MIX13):
Variation observed and lessons learned

John M. Butler^{a,*} Margaret C. Kline^b Michael D. Coble^{b,1}

THIS 2011 FINDING, HAS BEEN REPLICATED...

DNA

- In 2018 NIST published its MIX studies
- And more replications...

Forensic Science International: Genetics 35 (2018) 156–163



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Contents lists available at [ScienceDirect](#)

“LR values obtained show a wide range of variation”

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsigen



Research paper

GHEP-ISFG collaborative exercise on mixture profiles (GHEP-MIX06).

Reporting conclusions: Results and evaluation



Footwear

1996 Study Case No.	Identification	Very Probable	Probable	Possible	Inconclusive
1	0	0	2	19	12
2	2	7	15	9	0
3	8	11	9	5	0
4	20	8	3	2	0
5	27	5	0	1	0
6	29	3	0	1	0



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Survey of the
laboratories

ious crime

Handwriting



Contents lists available at [ScienceDirect](#)

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint



Biasability and reliability of expert forensic document examiners

Itiel E. Dror^{a,*}, Kyle C. Scherr^b, Linton A. Mohammed^c, Carla. L. MacLean^d,
Lloyd Cunningham^e

Table 2

Decisions 1–4 are judgments supporting identification (1= Identification; 2= Highly probable wrote; 3= Probably wrote; 4= Indications wrote), whereas decisions 6–9 are judgments supporting elimination (6= Indications did not write; 7= Probably did not write; 8= Highly probable did not write; 9= Elimination).

Scale	Prosecution		Defense	
	Frequency	Percent	Frequency	Percent
1=Identification	0/13	0%	0/12	0%
2=Highly probable wrote	1/13	8%	1/12	8%
3=Probably wrote	2/13	15%	2/12	17%
4=Indications wrote	5/13	39%	4/12	33%
5=Inconclusive	0/13	0%	0/12	0%
6=Indications did not write	1/13	8%	1/12	8%
7=Probably did not write	3/13	23%	1/12	8%
8=Highly probable did not write	1/13	8%	3/12	25%
9=Elimination	0/13	0%	0/12	0%

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Digital Forensic

Forensic Science International: Digital Investigation 37 (2021) 301175



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Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Forensic Science International: Digital Investigation

journal homepage: www.elsevier.com/locate/fsidi



**“Results showed low reliability between DF examiners in
observations, interpretations, and conclusions”**

A hierarchy of expert performance (HEP) applied to digital forensics:
Reliability and biasability in digital forensics decision making

Nina Sunde ^{a,*}, Itiel E. Dror ^b



Forensic Anthropology

Received: 2 March 2021

Revised: 3 May 2021

Accepted: 5 May 2021

DOI: 10.1111/1556-4029.14761

PAPER

Anthropology



A hierarchy of expert performance as applied to forensic anthropology

Stephanie Hartley MA^{1,2} | Allysha Powanda Winburn PhD¹ 

Firearms

Received: 17 February 2021

Revised: 25 April 2021

Accepted: 3 May 2021

DOI: 10.1111/1556-4029.14758

PAPER

Criminalistics

**“The results from this study showed that there are differences
in examiner conclusions when examining the same evidence”**

Evaluating firearm examiner conclusion variability using cartridge case reproductions

Eric F. Law PhD | Keith B. Morris PhD

JOURNAL OF
FORENSIC SCIENCES



Bloodstain Pattern Analysis (BPA)



Forensic Science International

Volume 325, August 2021, 110856



"The results show limited reproducibility of conclusions"

Accuracy and reproducibility of conclusions by forensic bloodstain pattern analysts

R. Austin Hicklin ^a  , Kevin R. Winer ^b, Paul E. Kish ^c, Connie L. Parks ^a, William Chapman ^a, Kensley Dunagan ^a, Nicole Richetelli ^a, Eric G. Epstein ^a, Madeline A. Ausdemore ^a, Thomas A. Busey ^d

Forensic Psychology

Psychology, Public Policy, and Law
2018, Vol. 24, No. 1, 11–23

© 2017 American Psychological Association
1076-8971/18/\$12.00 <http://dx.doi.org/10.1037/law0000140>

(In case you are thinking...: “These data is forensic ‘psychology’, not forensic ‘science’.... “)

I have already presented data from fingerprinting, firearms, DNA...

A Hierarchy of Expert Performance Applied to Forensic Psychological Assessments

The data show:

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Daniel C. Murrie
University of Virginia

- **Competence assessment: Experts (3) reached different conclusions in 29% of the cases**
- **Legal sanity assessment: Experts (3) reached different conclusions in 45% of the cases**
- **Conditional release of a patient who had been hospitalized by reason of insanity (NGRI): Experts (3) reached different conclusions in 47% of the cases.**

Toxicology

Forensic Science International: Synergy 2 (2020) 339–348



Contents lists available at [ScienceDirect](#)

Forensic Science International: Synergy

journal homepage: <https://www.journals.elsevier.com/forensic-science-international-synergy/>



The effect of contextual information on decision-making in forensic toxicology

Hilary J. Hamnett ^{a,*}, Itiel E. Dror ^b



Forensic Pathology

Received: 26 November 2020

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Accepted: 11 February 2021

DOI: 10.1111/1556-4029.14697

PAPER

General



Cognitive bias in forensic pathology decisions

Itiel Dror PhD¹ | Judy Melinek MD² | Jonathan L. Arden MD³ | Jeff Kukucka PhD⁴ |
Sarah Hawkins JD⁵ | Joye Carter MD, PhD⁶ | Daniel S. Atherton MD⁷

“Inconsistency is the most consistent finding in forensic science”

Presented data (mine, and of others), about conclusions and observations:

- Fingerprinting
- DNA
- Footwear
- Handwriting
- Digital
- Anthropology
- Firearms
- Bloodstain Pattern Analysis (BPA)
- Forensic psychology
- Toxicology
- Pathology

What is the *most consistent* finding in forensic science?

“Inconsistency is the most consistent finding in forensic science”

- This is true (as I have shown) whether you use categorical decisions, verbal scales, or statistics.
- Of course, these issues (‘noise’, inconsistency, lack of reliability, reproducibility, repeatability, etc.), arise in the more difficult/challenging cases.
- When they are easy, self-evident, then these issues are diminished, but no expertise is required either, as novices can do the task.

→ How to reduce these ‘noise’, inconsistency, lack of reliability, reproducibility, repeatability, etc. ?

How to reduce these 'noise', inconsistency, lack of reliability, reproducibility, repeatability, etc. ?

First, how NOT to....:

- Flip a coin: 'heads' = match, 'tails' = exclusion! 😊
- Or, similarly, give them irrelevant biasing information, so they all arrive at the same conclusions...!
- WRONG way to deal with these issues, but... it has been done...:

How to reduce these 'noise', inconsistency, lack of reliability, reproducibility, repeatability, etc. ?

First, how NOT to...

So, what can/should be done?

Optimize/prioritize the order (sequence) of information

I will:

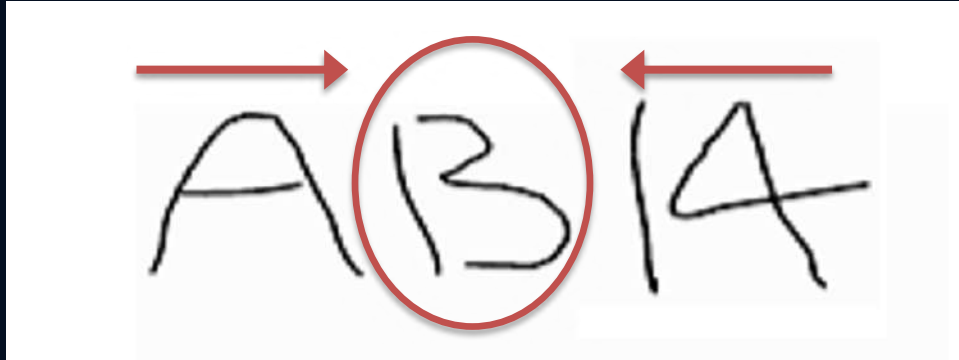
1. Show that order is important
2. Show how to optimize/prioritize the order (sequence)

It is NOT about depriving examiners of information they need, but presenting it in the 'right' sequence (& I need to show what 'right' is).

1. Show that order is important

- Long and well established research demonstrates that order impacts how/if we remember things, e.g., the primacy effect.
- Moreover, not only we remember it well, but it has far reaching implications on how further information is subsequently processed.
 - Generates ideas/hypothesis
 - Selective cognitive attention
 - Confirmation bias
 - Escalation of commitment
 - ...
 -

Illustration:



Transferring academic knowledge
of the brain into the real world

1. Show that order is important

- The impact of sequencing has been shown, time & again, in many domains, e.g.:
 - Food tasting (M.L. Dean, Presentation order effects in product taste tests. 1980, J. Psychol., 105,107-110).
 - Jury decision-making (R.G. Lawson, Order of presentation as a factor in jury persuasion. 1967, Kentucky Law Journal, 56, 523-555).
 - Countering conspiracy arguments (such as anti-vaccine conspiracy theories (D. Jolley, K.M. Douglas, Prevention is better than cure: addressing anti-vaccine conspiracy theories 2017, J. Appl. Soc. Psychol. 47, 459-469).

How to reduce these 'noise', inconsistency, lack of reliability, reproducibility, repeatability, etc. ?

First, how NOT to...

So, what can/should be done?

Optimize/prioritize the order (sequence) of information

I will:

1. Show that order is important
2. Show how to optimize/prioritize the order (sequence)

It is **NOT** about depriving examiners of information, but presenting it in the 'right' sequence (& I need to show what 'right' is).

2. Show how to optimize/prioritize the order (sequence)

- All have the same order...
- But what order?
- Not 'random' (artificial)
- Clear (suggested) criteria:
 1. Objectivity
 2. Relevance
 3. Biasability

Objectivity

- Some evidence is more objective than other...
 - E.g., video footage vs. eyewitness
 - E.g., a sober eyewitness vs. an intoxicated eyewitness
- Obviously, start with the more objective...!

Relevance

- Some evidence is more relevant than other...
 - E.g., an empty prescription drug box is more relevant than the neighbor saying the deceased looked depressed
- Obviously, start with the more relevant...!

Biasability

- Some evidence is more biasing than other...
 - E.g., knowing how the prints were lifted is less biasing than knowing the race of the person.
- Obviously, start with the less biasing...!

2. Show how to optimize/prioritize the order (sequence)

- Clear (suggested) criteria:
 1. Objectivity
 2. Relevance
 3. Biasability
- These are each a continuum
- They interact with one another
- Always need to weigh 'risk' vs. 'benefit'. E.g., George Floyd autopsy:

VE



WITNESS:
R. ANDREW BAKER

EXAMINATION BY:
JERRY BLACKWELL

KARE 11 

1:36



How to reduce these 'noise', inconsistency, lack of reliability, reproducibility, repeatability, etc. ?

Optimize/prioritize the order (sequence) of information

Forensic Science International: Synergy 3 (2021) 100161



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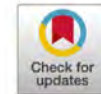
Contents lists available at [ScienceDirect](#)

Forensic Science International: Synergy

journal homepage: www.sciencedirect.com/journal/forensic-science-international-synergy



Linear Sequential Unmasking-*Expanded* (LSU-E): A general approach for improving decision making as well as minimizing noise and bias



For practical details guidance on implementing LSU-E, see:



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Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Forensic Science International: Synergy

journal homepage: www.sciencedirect.com/journal/forensic-science-international-synergy



A Practical Tool for Information Management in Forensic Decisions:
Using Linear Sequential Unmasking-Expanded (LSU-E) in casework

Adele Quigley-McBride^{a,*}, Itiel E. Dror^b, Tiffany Roy^c, Brandon L. Garrett^a, Jeff Kukucka^d

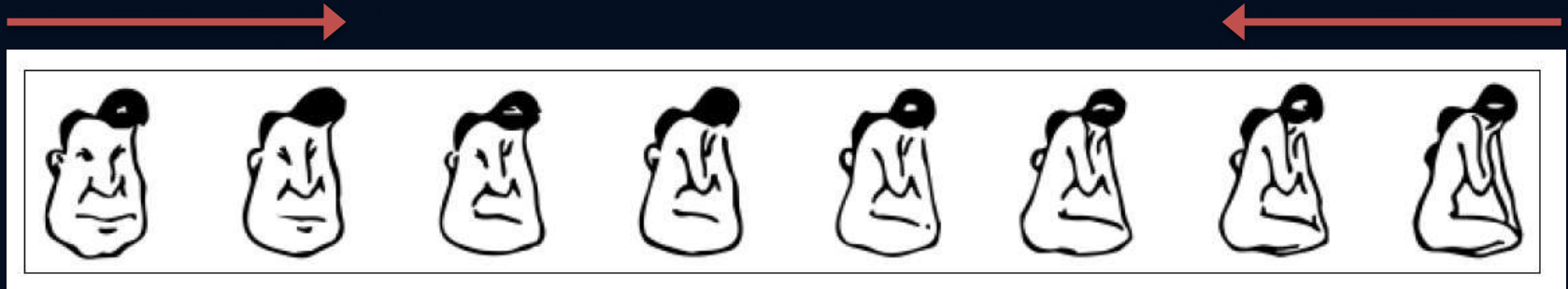
2

Case Identifier

Date: _____

[illegible]

Let me summarize and finish with:
another illustration of sequencing:
and then, with a few final words.



Transferring academic knowledge
of the brain into the real world

“Inconsistency is the most consistent finding in forensic science”

- This is true whether you use categorical decisions, verbal scales, or statistics.
- But, we can **reduce ‘noise’** (inconsistency, lack of reliability, reproducibility, repeatability), **as well as bias, by using LSU-E**
- This is just a step, one avenue, in considering the human element in forensic science
- Realizing the importance & pivotal role of cognitive & human factors in forensic science
- LSU-E is about considering and thinking about the order in which examiners are exposed to and consider information.
- And making it part of forensic labs SOPs.

Thank you very much!

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