Helping Juries and Officers of the Courts Make Sense of Statistics in Forensic Science:

Update from the Working Group on Presenting Forensic Science Evidence Using Quantitative and Qualitative Terms (QQWG)

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QQWG

- ✓What are they doing?
- ✓Who are they?
- ✓Why?

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QQWG: What are they doing?

Mission: Identify methods to **best convey relevant qualitative and qualitative information** (such as statistics, verbal scales, expressions of uncertainty or error probabilities in measurements) to lay jurors and officers of the court.

Deliverable: A report that provides recommendations on how scientists can present qualitative and quantitative data or conclusion in a reasonably transparent, fair, and comprehensible manner. These recommendations will be useful in standardizing and optimizing the presentation of forensic science evidence to law enforcement, officers of the court, and jurors.

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QQWG: Who are they?

- NIST OLES collaboration with the Pennsylvania State University
- Sponsored by NIJ
- Selected a working group made up forensic practitioners, legal scholars, psychologists, researchers, and statisticians

PENNSTATE

NIJ
NATIONAL INSTITUTE of JUSTICE

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QQWG Members

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QQWG Management Team

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QQWG: Why?

Consider this example from a study to ascertain the effectiveness of the format and terminology used by the National Weather Service[1]

Today the meteorologist says, "chance of rain 60%." You understand this to mean:

A. *Rain will occur 60% of the day.*
B. *At a specific point in the forecast area (for example, your house), there is a 60% chance of rain occurring.*
C. *There is a 60% chance that rain will occur somewhere in the forecast area during the day.*
D. *60% of the forecast area will receive rain and 40% will not.*

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[1]http://pajk.arh.noaa.gov/Articles/articles/survey/poptext.html

Answer is B. Less than 9% surveyed answered correctly

Statistical Numeracy

- ✓ There is evidence that individual differences in numeracy affect judgment and decision making
- ✓ Innumeracy is widespread
  - Studies show that approximately half of the U.S. population have only very basic or below basic quantitative skills
- ✓ Misunderstandings arise from nontransparent framing of the information
- ✓ Limited research on which presentation formats are most beneficial for individuals at different levels of numerical ability

Berlin Numeracy Test

- Provides a fast and psychometrically sound instrument for assessment of statistical numeracy and risk literacy
- Purports to test the ability to understand numerous day-to-day risks (for example in connection with medical diagnoses and drug treatments) or statistical probabilities (such as weather forecasts)
- The test usually takes about 3 minutes
- Instructions: Do not use a calculator but feel free to use your own scratch paper for calculations

NOTE: The Berlin Numeracy Test is one of many test available to test numeracy skills… I choice to use this test because of its short format. I adapted the test for demonstrations purposes given the time constraints of this presentation.

Berlin Numeracy Test

1. Imagine we are throwing a five-sided die 50 times. On average, out of these 50 throws how many times would this five-sided die show an odd number (1, 3 or 5)?

a) 5 out of 50 throws

b) 25 out of 50 throws

c) 30 out of 50 throws

d) None of the above

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Berlin Numeracy Test

2. Out of 1,000 people in a small town 500 are members of a choir. Out of these 500 members in the choir 100 are men. Out of the 500 inhabitants that are not in the choir 300 are men. What is the probability that a randomly drawn man is a member of the choir? Please indicate the probability in percent

a) 10%

b) 25%

c) 40%

d) None of the above

Berlin Numeracy Test

3. Imagine we are throwing a loaded die (6 sides). The probability that the die shows a 6 is twice as high as the probability of each of the other numbers. On average, out of these 70 throws, about how many times would the die show the number 6?

a) 20 out of 70 throws

b) 23 out of 70 throws

c) 35 out of 70 throws

d) None of the above

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Berlin Numeracy Test

Scoring = Count total number of correct answers.

Correct answers are: 1 = c; 2 = b; 3 = a

≤1	Your numeracy score is similar to those in the bottom 25% of college educated individuals.
2	Your numeracy score is better than about 50-75% of all college educated individuals.
3	Your numeracy score is better than about 75-100% of all college educated individuals.

www.riskliteracy.org

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QQWG – Various Presentation Approaches

- ✓ **Features only**
- ✓ **Qualitative**
  - Consistent with, cannot exclude, could of
  - Unusual, rare (Dlugosz)
  - Strength of evidence (support, likelihood ratio, RvT)
  - Source attribution (identification) + degree of confidence or uniqueness
- ✓ **Quantitative**
  - Probability of match (transposition risk)
  - Likelihood ratio (sometimes as verbal equivalent)
  - Posterior probability (sometimes translated into qualitative terms)
  - Fixed or variable priors
- ✓ **Testimony about probability of errors**
  - Proficiency test results
  - Not possible

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QQWG- Many Questions Left to Tackle

- When probabilities are used, how should they be stated and characterized?

- Are verbal scales appropriate or preferable to numbers?
  - Can they be standardized across forensic disciplines?
  - How best to map likelihood ratios to verbal scales

- What visual aids, illustrations, or analogies, if any, would be, on balance, helpful?

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QQWG- Report Outline

Chapter 1 – Introduction

Chapter 2 – Current Situation

Chapter 3 – Psychology of Effective Communication

Chapter 4 – Nature of Forensic Inference

Chapter 5 – How to Present Qualitative and Quantitative Information

Chapter 6 – How to Implement the Recommendations

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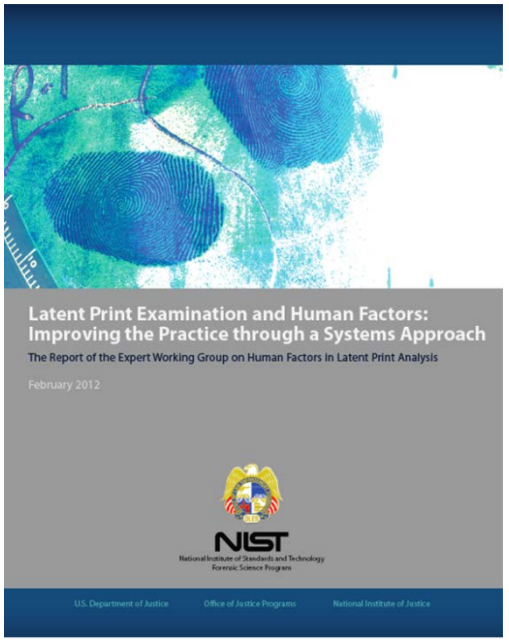
Expert Working Group on Human Factors in Handwriting Analysis

- 2nd in the working group series charged with conducting a scientific assessment of the effects of human factors on forensic analysis and developing recommendations to reduce the risk of error

- Supported by NIST and NIJ

- Find the original report related fingerprint analysis at www.nist.gov/oles



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Stay Tuned!

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Special thanks to working group member **Valerie Reyna** for providing the background information used in this talk.

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References

- Saviers, A. & VanBussum,L. “Juneau Public Questionnaire: Results, Analyses and Conclusions,” National Oceanic and Atmospheric Administration 1996-97, http://pajk.arh.noaa.gov/info/articles/survey/intro.htm.
- Reyna, V. F., Nelson, W. L., Han, P. K., & Dieckmann, N. F. (2009). How numeracy influences risk comprehension and medical decision making. Psychological Bulletin, 135, 943–973.
- Lipkus, I. M., Samsa, G., & Rimer, B. K. (2001). General performance on a numeracy scale among highly educated samples. Medical Decision Making, 21, 37–44.
- Cokely, E.T., Galesic, M., Schulz, E., Ghazal, S., & Garcia-Retamero, R. (2012). Measuring risk literacy: The Berlin Numeracy Test. *Judgment and Decision Making, 7,* 25-47.

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