Texas Forensic Science Commission

Justice Through Science

FINAL REPORT ON COMPLAINT NO. 23.67; TIFFANY ROY; (TIMOTHY KALAFUT, PH.D.; EVALUATION OF BIOLOGICAL/DNA RESULTS GIVEN ACTIVITY LEVEL PROPOSITIONS)

July 26, 2024

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EXECUTIVE SUMMARY

On May 11, 2022, professional cyclist Anna Moriah "Mo" Wilson was shot and killed at a friend's home when she was visiting Austin for a cycling race. The State's prevailing trial theory was that Kaitlin Armstrong murdered Wilson out of jealousy when Armstrong discovered her boyfriend Colin Strickland had spent time with Wilson earlier on the day of the murder. Hours before Wilson was killed, she and Strickland went to Deep Eddy, a local public swimming pool. The two had dinner before Strickland drove Wilson back to her friend's home on his motorcycle. Strickland denied entering the home when he dropped Wilson off. Later, police responded to the scene and discovered Wilson had been shot multiple times. Wilson's racing bicycle was missing from her friend's home, and investigators found the bicycle discarded outside. They swabbed the handlebars and seat and submitted the swabs to the Texas DPS crime laboratory for DNA testing.

Samantha Perkins, the DPS analyst who performed the DNA testing, determined both items of evidence (the swabs from the seat and handlebars) were best explained as 3-person mixtures. She testified the DNA evidence was 224 billion times more probable if Wilson, Armstrong, and an unrelated, unknown person were contributors to the mixture from the bicycle seat than if Wilson and two unrelated, unknown people were contributors. With respect to the handlebars, she testified the DNA evidence was 49,400 times more probable if Wilson, Armstrong, and an unknown, unrelated person were contributors to the mixture than if Wilson and two unrelated, unknown people were contributors. Strickland was excluded as a contributor for both mixtures. There was no dispute at trial regarding the DNA mixture interpretation reported by Texas DPS.

During trial, after the DNA comparison results were in evidence, the defense called an expert (Matthew Quartaro) to testify that there are ways DNA can be transferred to an item other than by direct contact with that item. The purpose of the testimony was to raise doubt about the State's theory that the DNA evidence demonstrated Armstrong removed the bicycle from the home around the time of the murder. Because Armstrong and Wilson had both ridden on Strickland's motorcycle and used the same helmet at different points in time, the defense suggested the possibility (through their questioning of Quartaro) that Armstrong's DNA could have been transferred to the bicycle without direct contact. Quartaro testified that it was "possible" that Armstrong's DNA was transferred to the bicycle "without her even touching it."

In rebuttal, the State called Dr. Timothy Kalafut, and his testimony included an evaluation of the DNA evidence given competing activity level propositions prepared in advance of trial. Dr. Kalafut opined that the DNA evidence was "much more likely" if Armstrong had a direct interaction with the bicycle than if the DNA was transferred through a series of indirect activities.

On November 16, 2023, Kaitlin Armstrong was convicted of murdering Mo Wilson and sentenced to 90 years in prison. After trial, a DNA consultant (Tiffany Roy) filed a complaint about the rebuttal testimony of Dr. Kalafut. The complaint asserts that his activity level analysis and testimony departed from "established best practices," including preparing a written report; researching relevant literature; assigning probabilities based on the literature; delineating the specific studies relied upon in formulating an opinion; and selecting balanced propositions.

The Commission accepted the complaint for investigation to make observations regarding the integrity and reliability of the evaluation given activity level propositions and related testimony, and to discuss best practices and related recommendations. To the Commission's knowledge, this is the first time a DNA expert in Texas has testified to an evaluation given activity level propositions intentionally prepared before trial.

Traditional DNA analysis and comparison results *help* answer the question of "who" may or may not be a source of DNA extracted from an item of evidence. An evaluation of DNA results in light of activity level propositions may *help* answer the questions of 'when" and "how" DNA was deposited on an item of evidence. However, the education and training for evaluating DNA comparisons is vastly different from the education and training required to perform an evaluation of DNA results given activity.

Currently, DNA analysts often respond to questions at trial regarding whether certain activities (especially regarding DNA transfer mechanisms) are "possible" or not. In the American system, the jury is then entrusted with the combining what they hear about the DNA test results together with other evidence to reach a verdict regarding guilt or innocence. The international framework for evaluative reporting (given activity level propositions) cautions against DNA analysts responding "Yes" or "No" to "is it possible" questions regarding specific case facts. Recent publications, including reports from the National Institute for Standards and Technology (NIST) human factors and scientific foundation review series describe the risk of these responses being misunderstood by the factfinder. While the Commission agrees with these observations at a theoretical level, one key takeaway from this investigation is the serious risk that without adequate foundational understanding in the form of education and training, the DNA community will replace one less-than-desirable approach (answering hypothetical "is it possible" questions about activity in the case without sufficient basis) with another (ad hoc pseudo evaluations of findings given activity level propositions lacking transparency and traceability of analysis).

To date, evaluations given activity level propositions prepared in advance of trial are mostly performed outside of the United States, in parts of Europe, Australia and the United Kingdom. As a result, the report refers extensively to published international guidance from the International Society of Forensic Genetics (ISFG) and the European Network of Forensic Science Institutes (ENFSI). It is the guidance from these authorities that Dr. Kalafut asserts he followed when performing his analysis.

The report highlights ten unresolved issues apparent from this case, which represent a significant but non-exhaustive list. The Commission observes these issues will require attention *before* evaluations given alleged activities (such as what was attempted in this case) could be successfully integrated by DNA analysts in forensic laboratories. Discussion in the report covers the following subject areas:

1. Procedural and structural differences between the criminal courts in the United States and other countries engaged in evaluations given activity level propositions;

2. Why introducing probability assignment(s) considering alleged activities at trial with no opportunity for review contradicts international guidance;

3. Importance of a written report to ensure transparency;

4. Apparent misunderstanding regarding what constitutes a well-formulated activity level proposition, a foundational component in an evaluation;

5. Critical need for experts to understand how to assess suitability and provide traceability in evaluations given activity level propositions;

6. The need to evaluate the sufficiency of published data on transfer, persistence, prevalence and recovery (TPPR) generally;

7. Identification of appropriate data options in the absence of published literature;

8. Whether numerical likelihood ratios should be required;

9. What type of education and training should be required;

10. What quality measures should be required, including the role of accreditation;

The report also makes the following observations: this case would have been better served by—and indeed international guidance calls for—a written report; there is a real question regarding what quality and quantity of literature would be sufficient to support Dr. Kalafut's testimony in this case; the "evidence reconciliation" document in the "case file" lacked the traceability one would hope to observe in an evaluation of findings given activity level propositions; the "evidence reconciliation" document in the "case file" includes mathematical calculations but does not clearly articulate the underlying formula/model for the calculations (applicable guidance is clear that the development of a formula/model, or alternatively a Bayesian network should be done first, with calculations performed second to allow for checks of coherence and plausibility, including the review of conditional independence assumptions because of the hierarchical/cascaded nature of the events being modeled); and finally the case file did not include well-formulated activity level propositions, which is a foundational step in the process.

The report includes recommendations the Commission believes represent a logical next step for foundational issues in the area of interpretations and reporting given activity level propositions:

1. With respect to the published literature on TPPR, agencies with research expertise responsibility (such as NIST, ISFG/ENFSI etc.) should conduct a scientific foundational-type review including a public comment phase, to evaluate and report on the state of published literature and offer recommendations.

However, unlike prior NIST scientific foundational reviews (and more akin to the approach in the human factors series), the author group for this report should include a diverse group of criminal justice partners including legal, statistics and human factors experts, particularly those who have studied the impact of different types of expert testimony on judges and juries.

The work of this group review should include, at a minimum, the following areas:

- Principles in TPPR and a framework for assessing TPPR literature for purposes of assigning probabilities considering TPPR factors.

- To the extent shortcomings in published data on TPPR exist—and acknowledging there is no such thing as a perfect body of empirical research—guidance on appropriate study design and related issues.

- A survey of the similarities and differences in legal systems where evaluations given activity level propositions are performed including: (a) foundational concepts; (b) roles and responsibilities of parties and experts; and (c) procedural rules, and the potential impact of these issues on the successful communication of evaluations to end-users.

- An evaluation of whether numerical likelihood ratios (derived manually or using Bayesian networks or other similar tools) are essential components of scientific reporting when DNA evaluations given activity level propositions are performed. If qualitative likelihood ratios are permitted (without a numerical LR), an appropriate framework and limitations should be developed.

- Guidance on what would constitute an appropriate method (and adequate internal validation of the method) used to ensure competent application of evaluations given activity level propositions; this guidance should be articulated through clear, specific and robust OSAC Registry standards or other appropriate documents.

Assuming a foundational basis could be established to allow evaluations given activity level propositions *and* reporting and testimony on this topic could be integrated in the work of Texas laboratories, the report makes the following recommendations with respect to implementation in the areas of education, training, quality assurance, reporting, and testimony.

Clear, specific and robust standards must be articulated by the Commission in collaboration with the work of the OSAC DNA Human Forensic Biology subcommittee (with a near-term goal

of publishing at least a technical guidance document) including but not limited to the following areas:

1. Education, training, and experience needed to be qualified as an expert;

2. Specific guidance for effective method validation at operational laboratories;

3. Quality control measures including but not limited to competency and proficiency testing (established in collaboration with the accrediting bodies);

4. Components of an effective report;

5. Guidelines for and limitations of testimony;

6. Education and training needed for lawyers and judges.

The report emphasizes that efforts in this area must include the active participation and engagement of end-users with legal, statistics and human factors expertise (specifically those with expertise on juror understanding of scientific testimony).

Due to the foundational nature of the above recommendations and the extended period expected to implement them, the report advises that all Texas FSSP's adopt a policy similar to the one outlined below in the interim. This recommendation observes the principle that while scientists may discuss scientific background knowledge to aid the factfinder, they should not give an opinion on what is the "most likely way of transfer" in a case (direct or indirect) as this amounts to an opinion on the activities themselves. While the language need not be copied verbatim, a concept similar to this language should be adopted by all FSSP's. **The Commission will request that ANAB and A2LA add this item to the Texas accreditation checklist for assessments of forensic DNA laboratories beginning in July 2025 (this date may be adjusted based on feedback from the Texas Association of Forensic Quality Managers):**

> When asked hypothetical questions that require the consideration of transfer, persistence, prevalence, and recovery (TPPR) testifying witnesses should endeavor to communicate that the DNA comparison results (or lack thereof) do not answer the questions of "how" or "when" DNA was deposited or speak to its absence. Such testimony could potentially lead to evidence being misleading, overvalued, or undervalued.
>
> Whenever possible, testifying experts should reiterate that while they may be able to provide limited general information about TPPR, answering questions about how or when the DNA was deposited (or is absent) in the particular case, is outside the testifying witness' purview. To help address questions about how or when the DNA was deposited in the case, a separate evaluation would be needed.

Finally, with respect to both licensed DNA analysts *and* experts operating in Texas outside of an accredited laboratory setting—and acknowledging the Court of Criminal Appeals has yet to determine whether evaluations given activity level propositions must be performed in an

accredited laboratory setting to be admissible under article 38.35 of the Texas Code of Criminal Procedure—the Commission recommends the following:

1. To the extent applicable, follow the principles set forth in the Texas Code of Professional Responsibility for Forensic Analysts and Crime Laboratory Management. The Code sets general expectations for sound and professionally responsible scientific practice;

2. Obtain education and training at the level discussed by Taylor and Kokshoorn in *Forensic DNA Trace Evidence Interpretation* (2023), *before* offering services as an expert in an evaluation of biological results given activity level propositions.

3. Issue a written report containing balanced, logical, transparent and robust evaluations, being clear about their assumptions and the (statistical) model used to assign probabilities;

4. Provide traceability of analysis by clearly articulating the source of knowledge for assigning probabilities, including limitations of those sources of knowledge;

5. Communicate to lawyers that transparency (including a written report and the other items outlined in ISFG and ENFSI documents referenced here) is a cornerstone of international guidance on evaluative reporting given activity level propositions, especially where those documents are cited as the scientific basis for performing the evaluation;

6. To the extent possible, integrate periodic proficiency testing, technical review, methods for mitigating cognitive bias, and other elements of a quality system found in accredited laboratories;

7. Decline to offer ad-hoc pseudo evaluations on the stand by following the *ENFSI 2022 Best Practices Manual* on how to respond in circumstances where additional information would be needed to provide a proper evaluation.

Finally, the report notes that the Commission will consult with NIST (and other state, federal and/or international partners as appropriate) for assistance in implementing recommendations and update Texas stakeholders accordingly.

I. COMMISSION BACKGROUND

A. History and Composition of the Texas Forensic Science Commission

The Texas Forensic Science Commission (Commission) was created during the 79th Legislative Session in 2005 with the passage of HB-1068. The Act amended the Code of Criminal Procedure to add Article 38.01, which describes the composition and authority of the Commission.[1] During subsequent legislative sessions, the Legislature further amended the Code of Criminal Procedure to clarify and expand the Commission's jurisdictional responsibilities and authority.[2]

The Governor of Texas appoints all nine Commission members, each of whom serves a staggered two-year term.[3] Seven of the nine commissioners are scientists or medical doctors and two are attorneys (one prosecutor nominated by the Texas District and County Attorney's Association and one criminal defense attorney nominated by the Texas Criminal Defense Lawyer's Association).[4] The Commission's Presiding Officer is Jeffrey Barnard, MD, Chief Medical Examiner of Dallas County and Director of the Southwestern Institute of Forensic Science.

B. Jurisdiction

Texas law requires the Commission to investigate in a timely manner, any allegation of professional negligence or professional misconduct that would substantially affect the integrity of:

(A) the results of a forensic analysis conducted by a crime laboratory;

(B) an examination or test that is conducted by a crime laboratory and that is a forensic examination or test not subject to accreditation; *or*

[1] Tex. Code Crim. Proc. art. 38.01.
[2] Act of September 1, 2013, 83rd Leg., R.S., ch. 782, §§ 1-4 (S.B. 1238) (codified at Tex. Code Crim. Proc. art. 38.01); Act of September 1, 2015, 84th Leg., R.S., ch. 1276, §§ 1-7 (S.B. 1287) (codified at Tex. Code Crim. Proc. art. 38.01)
[3] Tex. Code Crim. Proc. art. 38.01 § 3.
[4] *Id.*

(C) testimony related to an analysis, examination or test described by paragraph (A) or (B).”[5]

For unaccredited entities such as the forensic expert who is the subject of this complaint, the Commission’s investigative report is limited to:

- observations regarding the integrity and reliability of the forensic analysis conducted;
- best practices identified by the Commission during the investigation; and
- other recommendations deemed relevant by the Commission.[6]

In addition to its investigative authority, the Commission is also charged with accrediting crime laboratories and other entities that conduct forensic analyses of physical evidence.[7] The term “crime laboratory” includes a public or private laboratory or other entity that conducts a forensic analysis subject to article 38.35 of the Code of Criminal Procedure.[8] As part of its accreditation jurisdiction, the Commission may “validate or approve specific forensic methods or methodologies,” and “establish procedures, policies, standards, and practices to improve the quality of forensic analyses conducted in this state.”[9]

C. Additional Limitations

In addition to the scope of the report outlined above, the Commission’s jurisdiction has other important limitations. For example, no finding by the Commission constitutes a comment upon the guilt or innocence of any individual.[10] The Commission’s written reports are not admissible in a civil or criminal action. The Commission does not have the authority to subpoena

[5] *Id.* at art. 38.01 § 4(a)(3).
[6] *Id* at § b-1.
[7] *Id.* at § 4-d(b).
[8] *Id.* at art. 38.35 (a)(1).
[9] *Id.* at art. 38.01 § 4-d(b-1)(2) and (3).
[10] *Id*. at § 4(g).

documents or compel testimony. As a result, information the Commission receives during an investigation is dependent upon the willingness of stakeholders to submit materials and respond to questions. The information gathered by the Commission is not subject to the standards for admission of evidence in a courtroom. No individuals testified under oath or were limited by the Texas Rules of Evidence (*e.g.,* against the admission of hearsay or subject to cross-examination under a judge's supervision).

II. SUMMARY OF COMPLAINT

On December 1, 2023, Ms. Tiffany Roy (a forensic DNA consultant) filed a complaint regarding rebuttal testimony provided by Dr. Timothy Kalafut in a Travis County murder case styled *State of Texas v. Kaitlin Armstrong*.[11] The complaint attached the transcript of Dr. Kalafut's November 15, 2023, testimony offering his opinion regarding the probability of the DNA evidence obtained from murder victim Anna Moriah "Mo" Wilson's bicycle given mutually exclusive activity propositions (*i.e.,* competing theories on *how* the DNA was deposited on the bicycle). Ms. Roy asserts that Dr. Kalafut's activity level analysis and testimony departed from "established best practices," including:

- preparing a written report;
- researching relevant literature;
- assigning probabilities based on the literature;
- delineating the specific studies relied upon in formulating an opinion; and
- selecting balanced propositions.[12]

[11] *See,* Complaint at **Exhibit A**.

[12] In her complaint and related communications, Ms. Roy references the following: (1) Gill, P., et al., *DNA Commission of the International Society for Forensic Genetics: Assessing the Value of Forensic Biological Evidence – Guidelines Highlighting the Importance of Propositions. Part II: Evaluation of Biological Traces Considering Activity Level Propositions* (hereinafter referred to as "*ISFG 2020 Guidelines*"), Forensic Science International: Genetics 44 (2020) 102186. DOI: https://www.fsigenetics.com/article/S1872-4973(19)30424-7/fulltext; (2) *European Network of Forensic Science Institutes Guideline for Evaluative Reporting in Forensic Science: Strengthening the Evaluation of Forensic Results Across Europe* (version 3) (2015) (hereinafter referred to as "*ENFSI 2015 Guideline for Evaluative Reporting*"); and (3) National Institute for Standards and Technology, *Forensic DNA Interpretation and Human Factors: Improving Practice Through a Systems Approach* (2024) (hereinafter referred to as "*NIST EWG Report on Human Factors in DNA*") https://www.nist.gov/programs-

Additionally, Ms. Roy complains that neither defense counsel for Armstrong nor the defense expert in the case, Mr. Matt Quartaro, was provided a copy of Dr. Kalafut's report or a description of the basis for the opinions Dr. Kalafut expressed at trial. Ms. Roy asserts that Mr. Quartaro was unaware any witness would be called to rebut his testimony. Ms. Roy further asserts this lack of disclosure made it impossible for the defense to meaningfully challenge Dr. Kalafut's activity level evaluation and related testimony.

III. CRIMINAL OFFENSE AND RELATED PROCEEDINGS[13]

On May 11, 2022, professional cyclist Anna Moriah "Mo" Wilson was visiting Austin and preparing to compete in a gravel race when she was shot and killed at her friend Caitlin Cash's home. The State's prevailing trial theory was that Kaitlin Armstrong, who at the time lived with her boyfriend professional cyclist Colin Strickland, murdered Wilson out of jealousy when Armstrong discovered that Strickland and Wilson had spent time together earlier that day.

Hours before she was killed, Wilson went with Strickland to Deep Eddy, a popular public swimming pool in Austin. The two ate dinner together and Strickland drove Wilson back to Cash's apartment on his motorcycle. Strickland denied going into Cash's home when he dropped Wilson off. Police responded to the scene and discovered Wilson had been shot multiple times. Wilson's racing bicycle was missing from Cash's home. Investigators later found the bicycle discarded outside. They collected DNA swabs from the handlebars and seat. Police named Armstrong as a person of interest after a neighbor's home security monitoring system showed a black Jeep Grand

projects/expert-working-group-human-factors-forensic-dna-interpretation. The Commission notes that while Ms. Roy referred to the NIST EWG Report on Human Factors in DNA in her complaint, the report was published until May 2024, which was *after* this complaint was filed and *well after* the case that is the subject of this complaint was tried.

[13] The facts recited in this report are derived from a combination of the probable cause affidavit, transcripts and pleadings in the *State of Texas v. Kaitlin Armstrong*, Cause No. D1-DC-22-301129, in the 403rd Judicial District Court of Travis County, Texas.

Cherokee (like Armstrong's vehicle) driving by Cash's home shortly before the shooting. Police took Armstrong into custody on an unrelated outstanding misdemeanor warrant. They then released her from custody because of a discrepancy involving her birthdate on the misdemeanor warrant. After further investigation, police issued an arrest warrant for Armstrong on May 17, 2022. She was arrested in Santa Teresa, Costa Rica on June 29, 2022. On November 16, 2023, a Travis County jury convicted Armstrong of murder and sentenced her to 90 years in prison.

IV. COMMISSION INVESTIGATIVE PROCESS

A. Notice and Response by Dr. Kalafut

On December 1, 2023, the Commission notified Dr. Kalafut of Ms. Roy's complaint and advised him that it would be considered at the Commission's January 26, 2024, quarterly meeting.[14] On January 19, 2024, he submitted a formal response to the Commission, including supporting material for his assertion that he complied with internationally published guidance on evaluative reporting given activity.[15] Dr. Kalafut also addressed the Commission during its January 26, 2024, quarterly meeting, acknowledging the importance of the subject matter and urging the Commission to provide the DNA community with guidance on the subject.[16]

B. Commission's Decision to Accept the Complaint

On January 26, 2024, the Commission voted to accept the complaint for the purposes of 1) making observations regarding the DNA evaluations given activity level propositions and related testimony,[17] and 2) offering guidance to the DNA community in Texas on the subject of evaluations

[14] Dr. Kalafut informed the Travis County District Attorney's Office (TCDAO) of the complaint on December 4, 2023.
[15] *See,* Complaint Response at **Exhibit B**.
[16] Recordings of Commission quarterly meetings may be found on the Commission's website here: https://www.txcourts.gov/fsc/meetings/
[17] The most complete description is "evaluation of biological/DNA results given activity level propositions." However, for brevity it will be referred to throughout this report as an "evaluations given activities," or "evaluations given activity level propositions."

given activities. The Commission approved an investigative panel consisting of Commissioners Michael Coble, Ph.D., Erika Ziemak, M.S., and Mark Daniel, J.D.

While evaluations given disputed activities have been performed by experts in the United Kingdom, parts of Europe and Australia for a number of years, to the Commission's knowledge, this is the first time a DNA expert in Texas has testified to an evaluation given activity level propositions intentionally prepared before trial. The Commission accepted the complaint to highlight areas where international guidance on this subject is useful as well as areas where the rules of criminal procedure applicable in U.S. criminal courts make complying with the guidance challenging. The complaint provides an opportunity for the Commission to explore a potential path forward for DNA analysts in Texas, and to describe the current status of similar efforts at the federal level in the United States—led primarily by the National Institute of Standards and Technology (NIST) through the Organization of Scientific Area Committees for Forensic Science (OSAC), the NIST Expert Working Group on Human Factors series, and the NIST Scientific Foundational Review series.[18]

The Commission is mindful that DNA analysts anxiously await the Commission's guidance as they attempt to navigate challenging questions about how or when DNA may or may not have been deposited on items of evidence in a way that is scientifically appropriate and helpful to the

[18] Information about the OSAC Registry of Standards may be accessed here: https://www.nist.gov/organization-scientific-area-committees-forensic-science/osac-registry#bio. Information about the NIST Scientific Foundational Review series including NIST's draft report on DNA mixture interpretation may be accessed here: https://www.nist.gov/spo/forensic-science-program/dna-mixture-interpretation-nist-scientific-foundation-review. Information about the NIST Expert Working Group (EWG) Human Factors series including the May 2024 report may be found here: https://www.nist.gov/programs-projects/expert-working-group-human-factors-forensic-dna-interpretation

trier of fact, without over or understating the value of the evidence considering the propositions regarding activity.[19]

C. Review Process

During the preparation of this report, Commission staff reviewed an extensive body of literature as well as case records from the laboratory, materials submitted by the parties, and transcripts. The Commission also received input from various experts on the subject of DNA analysis and assessments given activity level propositions.[20] Both Dr. Kalafut and Ms. Roy were provided copies of the report in draft form and given the opportunity to offer feedback for consideration by the Commission.

D. THE ROLE OF THE DNA ANALYST GENERALLY

1. Helping to Answer the "Who" Question with DNA Testing of Evidence

DNA analysts in most accredited laboratories in the United States are trained to perform certain key tasks, including:

- Handling evidence appropriately to avoid contamination or loss;
- Screening evidence for purposes of assessing which items are most likely to yield DNA results that might help the trier of fact address the questions in the case;
- Performing physical testing of the evidence including extraction, quantitation, and amplification;
- Interpreting data resulting from the DNA testing process;
- Reporting the interpretation to criminal justice partners;

[19] In December 2023, the Commission hosted a workshop in Waco, Texas during which analysts from across the state shared their experiences being asked and responding to questions involving activity which happens often in criminal cases. During the meeting, it was clear that analysts are fully engaged on the subject of how best to address these questions and would value further guidance.

[20] Special thanks to the following individuals for sharing their expertise, perspective and ideas with Commission staff: Alex Biedermann; Dawn Boswell; John Buckleton; John Butler; Simone Gittelson; Tacha Hicks; Ted Hunt; Jarrah Kennedy; John Paul Jones, JD Schmid; Duncan Taylor; Melissa Taylor; Jonathan Whitaker; and Bill Wirskye.

- Explaining the interpretation to criminal justice partners such as law enforcement agencies, lawyers, the judge and jury if the case goes to trial.

For example, in the Armstrong case, Samantha Perkins, the DNA Supervisor and Technical Leader of the Texas Department of Public Safety Capitol Area Regional Crime Laboratory,[21] performed the DNA testing and interpreted the resulting data. DPS was asked to perform DNA testing on swabs collected from Wilson's bicycle handlebars and seat. Ms. Perkins determined the DNA mixture profile from the bicycle seat was best explained as a mixture of three contributors.[22] Using STRmix™ software to calculate a likelihood ratio, she reported the DNA evidence was 224 billion times more probable if Wilson, Armstrong, and an unknown person were contributors to the mixture than if Wilson and two unknown people were contributors. With respect to the bicycle handlebars, Ms. Perkins also determined the best explanation of the evidence profile was a three-person mixture. She reported the DNA evidence was 49,400 times more probable if Wilson, Armstrong and an unknown person were contributors to the mixture than if Wilson and two unknown people were contributors.

It is critically important to understand that these DNA results help answer the question of *whose* DNA may or may not have been detected on the bicycle. However, they do not answer the question of *how or when* the DNA got on the bicycle.

[21] Samantha Perkins is a forensic DNA analyst in good standing licensed by the Commission who works for Texas DPS, a crime laboratory accredited by ANSI National Accreditation Board (ANAB) and the Commission.

[22] Quantitation values were as follows: Seat: 0.0138 ng/uL = 13.8 pg/uL x 15uL (maximum template added to the PCR reaction) = 207 pg total template input. Assuming the STRmix™ % contributor estimation of the Armstrong to the 3-person mixture from the deconvolution (~20 % according to the "Evidence Reconciliation Document"): 207 pg x 0.20 = an estimated 41.4 pg of input DNA from Armstrong amplified. Handlebar: 0.0343 ng/uL = 34.3 pg/uL x 15uL (maximum template added to the PCR reaction) = 514.5 pg total template input. Assuming the STRmix™ % contributor estimation of the Armstrong to the 3-person mixture from the deconvolution (~5 % according to the "Evidence Reconciliation Document"): 514.5 pg x 0.05 = an estimated 25.7 pg of input DNA from Armstrong amplified.

2. Helping to Answer "How or When" Questions

For criminal justice partners charged with addressing the ultimate question of guilt or innocence and appellate judges who review pleadings in post-conviction contexts, the "how" or "when" questions about the deposition of DNA evidence may be of equal or greater interest than the "who" question. It follows that DNA analysts are often asked questions about how or when the DNA may have been deposited, whether it could have persisted over time, after laundering, and so on. DNA analysts may also be asked questions about why there was no DNA detected or why there was an "absence of DNA" in a case. In order to adequately address these questions, the expert must consider additional information and factors beyond what is needed to assess whose DNA may be present (DNA results or comparison). For purposes of this report, we refer generally to these types of questions as "TPPR" questions. TPPR is "an acronym (for transfer, persistence, prevalence and recovery) that is used to refer to the four main factors to be considered in addition to background DNA."[23]

While it is true that DNA analysts receive some training on TPPR concepts, and that training and related experience may make them more qualified than the average layperson to understand TPPR concepts, expertise in the testing of physical evidence for DNA *does not automatically convey* expertise in evaluations given activity level propositions. In a 2017 paper by Van Oorschot et al., the authors implore the forensic DNA community to understand and acknowledge the distinction:

[23] Background DNA is defined by Bas Kokshoorn and Duncan Taylor as any source of unknown DNA that was recovered from a surface and that was deposited through an unknown mechanism. *See*, *Forensic DNA Trace Evidence Interpretation: Activity Level Propositions and Likelihood Ratios*, 69 (CRC Press 2023) (hereinafter referred to as "*Forensic DNA Trace Evidence Interpretation* (2023)"). Earlier definitions for the term "background DNA" may be found in the *ISFG 2020 Guidelines* (https://doi.org/10.1016/j.fsigen.2019.102186.) and by Evett IW, in *The Theory of Interpreting Scientific Transfer Evidence*, Forensic Science Progress. (1990) 4:141-79.

> The forensic community needs to acknowledge that the expertise required to perform activity level assessments in relation to DNA-TPPR is distinct from that required for sub-source level evaluations, and that expertise does not necessarily transfer between the two tasks.[24]

3. Understanding the Hierarchy of Propositions

Leading international authorities on the interpretation of forensic science evidence have developed a logical framework called the *hierarchy of propositions* to help scientists and the courts understand the meaning and limitations of forensic findings within the context of a case.[25] DNA (and other forensic) results on their own have no intrinsic meaning; they must be assessed in context.[26] The term "sub-source" generally refers to the level on the hierarchy of propositions that addresses the question of "whose DNA is it?" The term "activity" refers to the level on the hierarchy of propositions that addresses the question of "how" DNA may have been deposited. Examples of the hierarchy of propositions are provided in the table attached as **Exhibit F**, excerpted from the *ENFSI Best Practice Manual for Human Forensic Biology and DNA Profiling*

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[24] Van Oorschot, R.A.H., Szkuta B., Ballantyne K.N., Goray M., *Need for Dedicated Training, Competency Assessment, Authorisations and Ongoing Proficiency Testing for Those Addressing DNA Transfer Issues,* Vol. 6 Forensic Science International: Genetics Supplement Series, e32-e34 (2017), https://www.fsigeneticssup.com/action/showPdf?pii=S1875-1768%2817%2930233-0.

[25] *See*, Cook, R., Evett IW, Jackson G, Jones PJ, Lambert JA (1998) *A Hierarchy of Propositions: Deciding Which Level to Address in Casework*. Science & Justice 38(4): 231-239; Evett IW, Jackson G, Lambert JA (2000) *More on the Hierarchy of Propositions: Exploring the Distinction Between Explanations and Propositions*. Science & Justice; 40(1): 3-10; Gill P (2001) *Application of Low Copy Number DNA Profiling*. Croatian Medical Journal 42(3):229-232 (introducing concept of sub-source DNA); Taylor D, Kokshoorn B, Biedermann A (2018) *Evaluation of Forensic Genetics Findings Given Activity Level Propositions: A Review*. Forensic Science International: Genetics 36:34-49 (introducing concept of sub-sub-source DNA). Descriptions of the hierarchy of propositions in this report are taken from the *ENFSI Best Practice Manual for Human Forensic Biology and DNA Profiling* (ENFSI-DNA-BPM-03) (approved by ENFSI Board on November 29, 2022). (referred to as the "*ENFSI 2022 Best Practice Manual")*.

[26] A simple example would be a scenario where a DNA profile is obtained from an item in a home. Depending on the circumstances, DNA results *on their own* may have little to no probative value if the person of interest and victim live together. The concept of considering DNA results *in the context of a case* focuses on understanding the limitations of what the DNA test results signify. This should not be confused with a separate human factors concept in forensic science literature that recommends DNA analysts be shielded from potentially biasing contextual or task-irrelevant information. The two concepts—understanding the limits of DNA testing results within the context of a case and shielding analysts from potentially biasing task-irrelevant contextual information—are distinct.

(approved by the ENFSI Board in 2022 and referred to in this report as the "*ENFSI 2022 Best Practice Manual*").

There are three main levels in the hierarchy of propositions that are considered by DNA analysts: **Sub-source**, **Source**,[27] and **Activity**.[28] The questions associated with these three levels are as follows:

1.	Sub-source:	Is a given person the source of the DNA or not?
2.	Source:	Is a given person the source of the known biological material (*e.g.,* the semen) or not?
3.	Activity:	Has a given person done one activity or another? Alternatively, has the activity in question been carried out by Person A or Person B?

It is also possible to consider only part of the mixture: in that case one would consider sub-sub-source level propositions where the issue is whether part of the DNA mixture is from a given person or not (*e.g.,* Person A is the major contributor or an unknown unrelated person is).[29] In both international and United States legal systems, DNA analysts regularly perform evaluations given sub-source level propositions which allow them to assess the value of DNA comparisons and thus help the trier of fact address the specific question: "Is a given person the source of the DNA or not?" A key purpose of the hierarchy of propositions framework is to help forensic scientists clearly distinguish which of the questions of interest listed above the laboratory's DNA testing

[27] The term "sub-sub-source" refers to the question of whether a person of interest may be the donor of the "major component" of a DNA profile while the term "source" refers to the specific cellular source of DNA (*i.e.,* the question of whether the DNA derived from blood, semen, saliva, or non-body-fluid sources such as DNA deposited by touch or another means). *See, e.g.,* Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023), *supra* n. 23, at 20-22. In this report, we focus on "sub-source" and "activity," as those are the levels of the hierarchy at issue in the complaint.

[28] One type of activity question is whether a person has done one activity or another. The other type is whether the activity was carried out by person A or person B. These are referred to as questions relating to the activity or actor, respectively. *See*, Kokshoorn, et al., *Activity Level DNA Evidence Evaluation: On Propositions Addressing the Actor or the Activity.* Forensic Science International,
Volume 278, 2017, at 116-117, ISSN 0379-0738, https://doi.org/10.1016/j.forsciint.2017.06.029.

[29] Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023)*, supra* n. 23 at 20-22.

alone can help answer and which it cannot, both for their own understanding and for communicating scope and limitations of DNA comparisons to end-users in the criminal justice system.[30]

When it comes to helping address questions about DNA transfer (*i.e.,* questions or issues that reside at the **Activity** level of the hierarchy), the international community does not share a common approach. Current published international guidance asserts that there are circumstances in which a DNA scientist can use his or her expert knowledge on TPPR to help the court understand the value of the findings given mutually exclusive activity level propositions.[31] However, in the United States, consensus on how such assessments should be made, reported, and testified to has not been established much less integrated by DNA practitioners or legal system end-users. The differences in current approach between practitioners in the United States and their counterparts abroad are due to many factors including but not limited to the high throughput demands on operational laboratories in the United States and differences in the way the respective legal systems consider forensic evidence and related expert testimony.

4. The Specific "How and When" Questions of Interest in this Case

In the Armstrong case, these "how" (*i.e.,* activity level) questions arose in relation to DNA results obtained from testing performed on swabs from Wilson's bicycle handlebars and seat. Because investigators found Wilson's bicycle discarded outside the home where she was murdered

[30] *See*, Hicks, T., et al. (2022) *A Logical Framework for Forensic DNA Interpretation*, Genes 13, no. 6: 957. https://doi.org/10.3390/genes13060957 (2022) at 9.

[31] *See, e.g.,* Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023), at 173-174. The Commission notes the issue is not without some dissent in Europe, the UK, and Australia, but a survey of dissenting expert opinions is beyond the scope of this report. Yang YJ, Prinz M, McKiernan H, Oldoni F (2022) *American Forensic DNA Practitioners' Opinion on Activity Level Evaluative Reporting*, Journal of Forensic Sciences 67: 1357-1369. doi:10.1111/1556-4029.15063; Prinz M, Pirtle D, Oldoni F (2024) *Global Survey on Evaluative Reporting on DNA Evidence with Regard to Activity-Level Propositions*, Journal of Forensic Sciences 69(3):798-813. doi: 10.1111/1556-4029.15488.

and because the probability of the DNA results from both the seat and the handlebars supported the proposition that the DNA mixture was from Armstrong, Wilson, and an unknown, unrelated person rather than from Wilson and two unknown, unrelated persons, the State used this evidence to attempt to convince the jury that Armstrong picked up and discarded the bicycle around the time she murdered Wilson. The defense, in response, attempted to instill doubt in the minds of the jury about whether the DNA testing results demonstrated Armstrong's presence at the crime scene. They did this through a series of questions suggesting ways DNA might be transferred to an item other than by direct contact with that item. Because Armstrong and Wilson had both ridden on Strickland's motorcycle and used the same helmet (though at different points in time), the defense's line of questioning focused on the various possible ways Armstrong's DNA might have been transferred without direct contact, including via the helmet.

The Commission notes that this line of questioning is typical in U.S. criminal cases. What is not typical is what happened next: the State's rebuttal testimony included an expert evaluation of the DNA evidence given activities prepared in advance of trial. When the State initially contacted Dr. Kalafut, they intended to utilize him as a consulting expert for their cross-examination of Mr. Quartaro. As part of this process, Dr. Kalafut performed an evaluation given activity level propositions and articulated his expert opinion in a document titled "evidence reconciliation." The State provided two competing explanations based on their understanding of the facts.[32] The first explanation was that Armstrong picked up Wilson's bicycle around the time of the murder. The second, alternative explanation, was that Armstrong's DNA was deposited on

[32] Under the hierarchy of propositions framework, it is recognized that explanations may be speculative. Contrary to propositions, they do not depend on case information and are not necessarily mutually exclusive. *See*, Hicks, T.; Buckleton, J.; Castella, V.; Evett, I.; and G. Jackson. *A Logical Framework for Forensic DNA Interpretation*. Genes 2022, 13, 957. https://doi.org/10.3390/genes13060957, *citing* Evett et al. *More on the Hierarchy of Propositions: Exploring the Distinction Between Explanations and Propositions*, Science & Justice 2000: 40: 3-10.

Strickland's motorcycle because she had ridden on it previously, and Wilson "picked up" Armstrong's DNA from also having ridden on the motorcycle. The State contacted Dr. Kalafut for assistance at the beginning of the trial, which according to his testimony was "within three weeks" of the date he testified.[33]

On the morning of trial when Dr. Kalafut was driving to Austin to testify, an assistant district attorney from TCDAO informed him that another possible explanation suggested by the defense through their questioning of Mr. Quartaro was that Wilson and Armstrong both wore the same motorcycle helmet at different points in time, and the sharing of a motorcycle helmet could have resulted in the transfer of the DNA obtained from the bicycle handlebars and seat. To be clear, no alternative explanation was specifically proffered by the defense. Nor were they under any obligation to offer any specific alternative. Rather, the State supplied the information to Dr. Kalafut based on their understanding of the case facts and in response to the line of questioning raised by the defense as the trial progressed.[34]

[33] When asked when the prosecution reached out to him to discuss the case, Dr. Kalafut responded "[m]aybe within the last three weeks." *See,* Kalafut Transcript Volume 21, p. 276 of the Reporter's Record in the *State of Texas v. Kaitlin Armstrong*, Cause No. D1-DC-301129, in the 403rd Judicial District Court of Travis County, Texas, occurring on November 15, 2023. **(Exhibit E)**.

[34] In the United Kingdom, which also has an adversarial legal system in which the defense is not required to proffer an alternative proposition, the Forensic Science Regulator (FSR) addresses the issue as follows: "When no defence proposition has been offered, the expert should generally adopt, on behalf of the defendant, one or more alternative propositions, which should be relevant to the facts in issue." This may include a simple negation of the prosecution's proposition, though the FSR warns that doing so often maximizes the value of the LR, stating that *"As a result, this limitation should be stated clearly within the expert's report, with an explicit offer to re-evaluate should an alternative proposition be provided."* [emphasis added] *See*, FSR Codes of Practice and Conduct, Section 8.2.9 at 25.

E. TRIAL TESTIMONY

1. Three Different DNA Expert Witnesses: A Summary of Their Roles

In summarizing the trial transcript, we focus primarily on the line of questioning regarding *how or when* the DNA was deposited on Wilson's bicycle handlebars and seat. Following are key takeaways from the testimony of each expert witness:[35]

1. *Samantha Perkins*: Relayed the findings of the DPS laboratory's DNA testing by providing likelihood ratios generated by STRmix™ for swabs from Wilson's bicycle handlebars and seat.[36] Ms. Perkins explained (correctly) that the laboratory's results helped answer the question of *whose* DNA contributed to the DNA mixtures from those items, not *how* the DNA was deposited on them.

2. *Matthew Quartaro*: Responded to extensive questioning and various hypothetical explanations regarding possible DNA transfer scenarios after responding "yes," to the question of whether he was an expert in "transfer DNA." He attempted to differentiate his general knowledge on the subject of transfer from the expertise one would need to report an evaluation given alleged activities (*i.e.,* taking formally into account the possible different routes of transfer in their evaluation). Mr. Quartaro expressed a lack of familiarity with the hierarchy of propositions and opined that it was "possible" that Armstrong's DNA was transferred to the bicycle "without her even touching it."

3. *Timothy Kalafut*: Called for the purpose of rebutting defense testimony on various DNA transfer scenarios elicited from Mr. Quartaro. Dr. Kalafut offered an evaluation given activity using a probabilistic approach, which he explained (in response to this complaint) was based on the Case Assessment and

[35] The testimony of Samantha Perkins, Matthew Quartaro, and Dr. Timothy Kalafut are attached as **Exhibits C**, **D**, and **E**, respectively.

[36] For the reader's ease of reference, we repeat the STRmix™ results and quantitation data here: Reported LR for bicycle handlebar swabs: The probability of obtaining the profile if the DNA came from Wilson, Armstrong, and one unrelated, unknown individual is *49,400 times greater* than the probability of obtaining the profile if the DNA came from Wilson and two unknown, unrelated individuals. Reported LR for bicycle seat swabs: The probability of obtaining this profile if the DNA came from Wilson, Armstrong, and one unrelated, unknown individual is *224 billion times greater* than the probability of obtaining the profile if the DNA came from Wilson and two unknown, unrelated individuals. Quantitation values were as follows: Seat: 0.0138 ng/uL = 13.8 pg/uL x 15uL (maximum template added to the PCR reaction) = 207 pg total template input. Assuming the STRmix™ % contributor estimation of the Armstrong to the 3-person mixture from the deconvolution (~20 % according to the "Evidence Reconciliation Document"): 207 pg x 0.20 = an estimated 41.4 pg of input DNA from Armstrong amplified. Handlebar: 0.0343 ng/uL = 34.3 pg/uL x 15uL (maximum template added to the PCR reaction) = 514.5 pg total template input. Assuming the STRmix™ % contributor estimation of the Armstrong to the 3-person mixture from the deconvolution (~5 % according to the "Evidence Reconciliation Document"): 514.5 pg x 0.05 = an estimated 25.7 pg of input DNA from Armstrong amplified.

> Interpretation model used in the UK.[37] He stated the DNA evidence was *more likely* "…if it was a direct interaction with the bicycle by the defendant than if it was this series of indirect activities." He further testified "the evidence was *much more likely* if the first proposition that the defendant grabbing the bicycle to do something with it than if this other chain of events happened."[38]

The Commission observes that each of these experts endeavored to provide testimony they believed was appropriate and helpful to the trier of fact. Each expert's testimony—from Ms. Perkins to Mr. Quartaro to Dr. Kalafut—reveals important information about current understanding of the evaluation of DNA results given activity level propositions. These testimonies offer tremendous educational value and an opportunity to address how Texas DNA experts should move forward and under what circumstances.

Although Ms. Perkins is not the subject of this complaint, questions regarding activity began during her testimony, and other DNA analysts in Texas would benefit from reading her transcript. She explained that while she could respond to questions about transfer DNA and the persistence of DNA generally, she was not trained to perform activity level evaluations or testify

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[37] The "formal process of conducting CAI is most useful in a structure where the evaluation is destined to be carried out considering activity level propositions from the start. The effectiveness of carrying out CAI is diminished when the forensic work is carried out considering sub-source level propositions first and then a decision on whether to evaluate considering activity level propositions is made afterwards. In effect it is likely that the decision to carry out the higher-level evaluation is done with an intuitive feeling that the observations have some power to discriminate between the propositions." *See*, Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023), at 32. Stated differently, ". . .[t]he fact that the scientist's expectations were formulated before the exam serves to make them more convincing . . .." Also, "[t]he important thinking has been done . . .and the expectations were not findings led." Thus, the recommendation that scientists conduct evaluations given activity before (or blinded to) the results of DNA analysis (wherever possible) insulates the process from the understandable critique that the expectations were "findings led." *See*, Cook R., Evett I.W., Jackson G., Jones P.J., and J.A. Lambert, *A Model for Case Assessment and Interpretation*, Science & Justice, 1998, 38, 153, 156.

[38] As Dr. Kalafut acknowledged in his response to the complaint, the term "transfer" should not be used in activity level propositions per international guidance. *See*, at section 4.3.3. "[w]e recommend avoiding the use of the terms 'primary or secondary' transfer in propositions, or their corollaries (direct/indirect) . . .. Moreover, because of the vagueness of the words, it is best to focus on the activities." *ISFG 2020 Guidelines* at Recommendation 6: "The scientist should avoid the use of the term 'transfer' in propositions. Instead, there should be a focus on the alleged activities." *See also*, Kalafut Transcript Vol.21, p.20-23 of the Reporter's Record in the *State of Texas v. Kaitlin Armstrong*, Cause No. D1-DC-301129, in the 403rd Judicial District Court of Travis County, Texas, occurring on November 15, 2023.

regarding whether a particular scenario is more likely or not.[39] She testified that DNA "does not tell us" when it was deposited or "how it got there."[40] The defense attorney asked her to explain "transfer DNA" (direct, secondary, and tertiary).[41] She agreed with the general assertion that DNA can be transferred more than once, and transfer may occur between a person and an object or between two persons.[42] She clarified that her testing did not allow her to distinguish between DNA that was transferred directly and DNA that was present as a result of a secondary transfer.[43] She explained there is a significant body of literature on the subject of DNA transfer (and related issues) but emphasized the limitations of those published studies which may or may not replicate the exact scenario of a given case.[44] The Commission observes that Ms. Perkins endeavored throughout her testimony to respond to questions in a forthright manner and to stay within the limits of her expertise.[45]

F. GENERAL APPROACHES TO ASSESSING AND INTERPRETING EVIDENCE

1. Conclusion-Based vs. Strength-of-Evidence-Based Reporting: Introduction of the Likelihood Ratio in Forensic Laboratories for Reporting of DNA Results

There are two main ways to report forensic results for comparison disciplines including DNA analysis: conclusion-based and strength-of-evidence-based. For decades, the vast majority of DNA analysts in the United States reported conclusion-based decisions consisting of three categories: "cannot be excluded," "cannot be included," or "inconclusive." The first category was

[39] *See*, **Exhibit C**, Vol.20, p. 101 of the Reporter's Record in the *State of Texas v. Kaitlin Armstrong*, Cause No. D1-DC-301129, in the 403rd Judicial District Court of Travis County, Texas, occurring on November 14, 2023.
[40] *Id*. at 125.
[41] *Id.* at 127-128.
[42] *Id.* at 128.
[43] *Id.* at 129.
[44] *Id.* at 130.
[45] *See*, Tex. Admin. Code, § 651.219(b)9, prohibiting analysts from offering "opinions or conclusions that are outside one's expertise," and to "testify in a manner which is clear, straightforward and objective, and avoid phrasing testimony in an ambiguous, biased or misleading manner." *Id.* at § 651.219(b)13.

often accompanied by statistics intended to indicate the relative strength of the association, expressed as a Combined Probability of Inclusion/Exclusion (CPI/CPE) or a Random Match Probability (RMP). The exception to this general rule for the DNA community in the United States was in the area of paternity testing, where likelihood ratios have been reported for many years.

Meanwhile, international DNA experts consistently urged practitioners worldwide to move to strength-of-evidence-based reporting in all areas of forensic science. The UK, Europe, Australia and New Zealand have used probabilistic reporting (likelihood ratios) in forensic science for many years. Only in the last decade have forensic laboratories in the United States embarked upon a major shift toward reporting likelihood ratios (LR) generated by probabilistic genotyping (PG) systems (*e.g.,* STRmix™ in Texas). In the context of DNA testing, the LR conveys the probability of the DNA comparison results under one proposition divided by the probability of the DNA comparison results under an alternative, mutually exclusive proposition with respect to *whose* DNA was obtained from an item of evidence.

One of the rationales underlying probabilistic reporting is that scientists should report on the strength of the findings from their testing, *not* on the strength of the propositions themselves which is perceived as the domain of the factfinder. However, the Commission observes a tension between what is legally permissible in the United States and what may be considered the preferred scientific path forward under international guidance. In U.S. courts (including state courts in Texas), qualified experts can legally testify about the propositions themselves (*see, e.g.,* Rule 704 of Texas and Federal Rules of Evidence, respectively). Indeed, the United States Supreme Court's recent ruling in *Diaz v. United States*, 144 S. Ct. 1727 (2024) speaks to the wide latitude of experts to express opinions on ultimate issues. However, just because an expert is permitted to opine on the ultimate issue, does not necessarily mean it is scientifically or professionally appropriate to do

so. Under the international guidance referred to throughout this report, which is built on a Bayesian foundation, the scientist is admonished to refrain from commenting "on the propositions themselves," as this is the domain of the factfinder. Regardless, it is important to understand the distinct roles described in the literature on evaluative reporting have their origin in scientific concepts, not U.S. legal rules.

With the introduction of probabilistic genotyping systems in the United States and the integration of those systems into most Texas laboratories,[46] the concept of probabilistic reporting has been mostly accepted as the preferred approach for forensic DNA testing. As noted by Kaye et al., "the shift to a probabilistic approach is supported by statistical,[47] scientific or laboratory

[46] Not all Texas FSSPs have fully implemented STRmix™, but all are in the process of acquisition, validation, or implementation.

[47] Kaye, David H., Antill, Gregory, Emmerich, Elaine, Ishida, Charlotte, Lowe, Marnie and Perler, Rachel, *Toolmark-Comparison Testimony: A Report to the Texas Forensic Science Commission* (May 2, 2022). Available at SSRN: https://ssrn.com/abstract=4108012 or http://dx.doi.org/10.2139/ssrn.4108012, *citing* Am. Stat. Ass'n Position on Statistical Statements for Forensic Evidence, Am. Stat. Ass'n 1, 2-4 (Jan. 2, 2019), https://www.amstat.org/asa/files/pdfs/POL-ForensicScience.pdf: To evaluate the weight of any set of observations made on questioned and control samples, it is necessary to relate the probability of making these observations if the samples came from the same source to the probability of making these observations if the questioned sample came from another source in a relevant population of potential sources. . . . We . . . strongly advise forensic science practitioners to confine their evaluative statements to expressions of support for stated hypotheses: *e.g.,* the support for the hypothesis that the samples originate from a common source and support for the hypothesis that they originate from different sources.

associations[48] and agencies[49] as well as from scholars of law and statistics."[50] It is unlikely this trend will be reversed but rather may even expand to other comparative forensic disciplines in the United States, especially with the incorporation of 3D-imaging technologies (*e.g.,* for firearm and toolmark comparison).

Notwithstanding this (mostly accepted) evolution toward probabilistic (LR) reporting for DNA testing results in the United States, the rollout of LRs for DNA testing has not been without challenges, in part because legal end-users and juries are not accustomed to hearing results framed in terms of a ratio of probabilities considering two propositions, and experts struggle to convey the concepts clearly, even with training. For the first few decades of forensic DNA testing in the United States, if certain parameters were met in a DNA comparison, laboratories could include a statement in their reporting that an individual *was the source of the DNA* extracted from an item. Lawyers

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[48] Colin Aitken et al., Fundamentals of Probability and Statistical Evidence in Criminal Proceedings: Guidance for Judges, Lawyers, Forensic Scientists and Expert Witnesses (2010), http://www.rss.org.uk/Images/PDF/influencing-change/rss-fundamentals-probability-statistical-evidence.pdf (committee of the Royal Statistical Society); Ass'n of Forensic Sci. Providers, Standards for the Formulation of Evaluative Forensic Science Expert Opinion, 49 Sci. & Just. 161 (2009); Eur. Network of Forensic Sci. Insts., ENFSI Guideline for Evaluative Reporting in Forensic Science 10 (2015), http://enfsi.eu/wp-content/uploads/2016/09/m1_guide line.pdf ("Evaluative reports should address the probability of the findings given the propositions and relevant background information . . . ."); cf. Royal Society, Forensic DNA Analysis: A Primer for Courts 36 (2017) ("Likelihood ratios are generally accepted as being the most appropriate method for evaluating the evidential strength of DNA profiles."); Royal Society, Statistics and Probability for Advocates (2019), https://www.icca.ac.uk/wp-content/uploads/2019/11/RSS-Guide-to-Statistics-and-Probability-for-Advocates.pdf.

[49] Subcomm. on Reporting and Testifying of the National Commission on Forensic Science. Nat'l Comm'n on Forensic Sci., Views of the Commission: Statistical Statements in Forensic Testimony, U.S. Dep't Justice (Feb. 9, 2017), https://www.justice.gov/archives/ncfs/page/file/965931/download ("Forensic science practitioners should confine their evaluative statements to the support that the findings provide for the claim linked to the forensic evidence."); Nat'l Inst. of Forensic Sci. Austl. N.Z., An Introductory Guide to Evaluative Reporting 6 (2017), available at https://www.anzpaa.org.au/forensic-science/ourwork/products/publications: The fundamental principles of evaluative reporting or interpretation are . . . (iii) that the role of the expert is to comment on the probability of their findings, given these propositions and not on the propositions themselves. It is this last principle that allows the factfinders to combine aspects of evidence they hear during the course of the trial with their judgement in their deliberations. This framework of evidence evaluation is commonly referred to as evaluative reporting but may also be referred to as the likelihood ratio approach, logical thinking, or Bayesian inference.

[50] *E.g.,* Edward K. Cheng, The Burden of Proof and the Presentation of Forensic Results, 130 Harv. L. Rev. F. 154, 161-62 (2017) ("Scholars have long argued in favor of presenting forensic results using likelihood ratios, and indeed some forensic communities in Europe have embraced them . . . . The key is that likelihood ratios present a clear path to improving the use of forensics testimony in court.") (footnotes omitted); Colin G.G Aitken & 30 coauthors, Expressing Evaluative Opinions: A Position Statement, 51 Sci. & Just. 1 (2011), http://dx.doi.org/10.1016/j.scijus.2011.01.002.

(and indeed many scientists) favored these "source attribution" statements because they were perceived as straightforward and easy for non-scientists to understand. With probabilistic reporting, examiners do not testify that a likelihood ratio of any magnitude provides an absolute identification or source attribution of an individual to an evidentiary sample. As a result, analysts must explain that the likelihood ratio expresses if and to what extent the DNA results provide support for the proposition that a defendant is a source of DNA versus the proposition that an unknown, unrelated individual is. Adequately and clearly conveying the value of the results without categorical conclusions such as "the defendant is the source of the DNA obtained from Exhibit A" has not been an easy transition for many forensic laboratories.

A related educational challenge is the extent to which end-users understand the meaning of reported likelihood ratios or their limitations. As previously stated, the likelihood ratio represents the probability of observed evidence given two mutually exclusive propositions. It does not represent the probability that either proposition is true. Yet, most legal end-users are not fluent in Bayesian statistical concepts and may misunderstand the likelihood ratio as a statement about the probability of the propositions themselves. This misunderstanding is commonly referred to as transposing the conditional.[51]

It is against this backdrop that Texas considers the possibility of introducing another concept already utilized in some parts of Europe, the UK, and some parts of Australia that is a novel concept for U.S. laboratories and the U.S. criminal justice system: evaluative reporting regarding activity level propositions (*i.e.,* assisting the trier of fact in answering the question of

[51] A corollary to this is the "prosecutor's fallacy." An example would be reporting the findings as follows: "The probability that the DNA came from Mr. Suspect is one in a billion." Instead, one should report that the *probability of the findings if* the DNA came from a person unrelated to Mr. Suspect is one in a billion. *See, e.g., ENFSI 2022 Best Practice Manual.*

how or when the DNA was deposited, or the meaning of the results when there is an *absence* of DNA while considering the forensic scientists knowledge on TPPR.)[52]

Under international guidance on the subject, when a scientist performs an evaluation of forensic findings given activity, he or she should conduct the evaluation separate from the testing on physical evidence that typically helps to address the "who" questions (*i.e.,* the value of the DNA profile comparison), assigning the probability of the findings (*e.g.,* presence of DNA as a minor) given activity level propositions. Indeed, some laboratories outside the United States have "activity teams," consisting of DNA analysts trained to perform assessments considering TPPR separate and apart from the traditional DNA profile comparison.[53] Part of the rationale for requiring a formal and separate evaluation of DNA findings given activity level propositions is that without it, the trier of fact may misunderstand the significance of the likelihood ratio reported for the DNA comparison as applying to questions about what happened (activity). In the *NIST DNA Mixture Foundational Review Draft,* the authors cite Peter Gill who describes real cases in which a "probability is transposed from one level of the framework of propositions to a higher level."[54] As noted in the *NIST DNA Mixture Foundational Review Draft*, the risk is "increased by the fact that the vast majority of criminal cases in the United States are settled through plea bargaining.

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[52] *See*, Yang YJ, Prinz M, McKiernan H, Oldoni F (2022) *American Forensic DNA Practitioners' Opinion on Activity Level Evaluative Reporting,* Journal of Forensic Sciences, 67: 1357-1369. doi:10.1111/1556-4029.15063 Prinz M, Pirtle D, Oldoni F (2024) *Global Survey on Evaluative Reporting on DNA Evidence with Regard to Activity-Level Propositions*, Journal of Forensic Sciences 69(3):798-813. doi: 10.1111/1556-4029.15488.

[53] *See, e.g.,* van Oorschot RAH, Szkuta B, Meakin GE, Kokshoorn B, Goray M (2019) *DNA Transfer in Forensic Science: A Review*, Forensic Science International: Genetics 38:140–166; Kokshoorn B, Luijsterburg M (2023) *Reporting on Forensic Biology Findings Given Activity Level Issues in the Netherlands*, Forensic Science International 343: 111545. doi:10.1016/j.forsciint.2022.111545.

[54] *See*, Butler, J., et al. *Draft DNA Mixture Interpretation: A NIST Scientific Foundational Review* (2021) (hereinafter referred to as the "NIST DNA Mixture Foundational Review Draft"). https://doi.org/10.6028/NIST.IR.8351-draft, citing *Misleading DNA Evidence; Reasons for Miscarriages of Justice* (Gill 2014). *See also*, Gill, P. *Analysis and Implications of the Miscarriages of Justice of Amanda Knox and Raffaele Sollecito*, Forensic Science International: Genetics 23:9-18. (2016); Gill, P. DNA *Evidence and Miscarriages of Justice*, Forensic Science International 294: e1-e3 (2019).

Suspects and attorneys may overestimate [or misunderstand] the value of the DNA findings and accept a plea possibly even when innocent."[55] As Jackson and Biedermann observe:

> . . . at the end of the expert's evidence, the factfinder is left with, on the one hand, an impressive big number (the LR), also on the other hand, a list of possible explanations for the transfer (because of specified activities). How do they decide what the DNA evidence means, and how does the evidence impact their decision?[56]

Consider for example, a circumstance in which a woman is murdered, and the suspect is her boyfriend, with whom she lived. DNA analysis of the victim's fingernail scrapings shows a mixture of two contributors and does not exclude either the victim or the boyfriend. The victim washed her hair before she was murdered. A key aspect of the boyfriend's explanation of events turns on whether a viable theory could be that the DNA mixture from the victim's fingernail scrapings persisted as a result of casual contact or cohabitation, even after the victim washed her hair. The analyst who performed the DNA testing offered the following testimony, which she later retracted:

> It is my opinion that washing your hair, especially if a soap was used in a mechanical manipulation of the hair on the scalp and the scalp itself, would move the fingertips and there would be a greater likelihood of removing any—any debris than may be under the fingernails than simply washing the hands or running water over the hands.[57]

The analyst further opined that a mixture of DNA deposited under fingernails is "often normally the result of a physical struggle." This entire line of questioning became known during court proceedings as the "hair washing theory" and contributed to the conviction of Donald Nash

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[55] *See*, *NIST DNA Mixture Foundational Review Draft* at 136, *citing* Gramlich, J., *Only 2% of Federal Criminal Defendants Go to Trial, and Most who Do Are Found Guilty*, Pew 8102 Research Center (2019). Available at https://www.pewresearch.org/fact-tank/2019/06/11/only-2-of-federal-criminal8103 defendants-go-to-trial-and-most-who-do-are-found-guilty.

[56] Jackson G. & Biedermann A. "*Source" or "Activity" What Is the Level of Issue in a Criminal Trial?* Significance, 2019; 16(2):36-9. doi:10.1111/j.1740-9713.2019.01253.x.

[57] *See* Report of Special Master in https://www.scribd.com/document/466973443/Nash-Report-of-Special-Master-Missouri-Supreme-Court, adopted by the Supreme Court of Missouri on July 3, 2020.

who was later exonerated by the Supreme Court of Missouri in 2020.[58] It is precisely this kind of analyst testimony—which opines on modes of transfer and explanations of the DNA results in the context of the specific case—that international guidance cites as misleading and outside the purview of the DNA analyst.[59] Rather, the guidance points toward the need for an assessment of DNA results alongside TPPR factors for the analyst to help the trier of fact with the "how" or "when" questions at issue in the case.

To understand the difference between opinions at different levels of the hierarchy, compare the following statements regarding the DNA profiles obtained from the handle of a baseball bat used in the commission of a crime:

> 2. It is possible that the POI's DNA was deposited on the baseball bat without him touching it. *(Opinion on the activity itself)*.
>
> *3.* It is my opinion that the DNA results are 10 times more likely if the POI struck the victim with the baseball bat than if the POI had social interactions with the person who did. *(Opinion on the probability of findings given one proposition versus an alternative, mutually exclusive, proposition.)*

Notwithstanding international guidance on the appropriateness of these two statements (*i.e.,* the second may be appropriate if supported by sufficient data while the first is not), the current reality is that U.S. criminal trials will far more frequently feature the first type of statement than the second (*see, e.g.,* Mr. Quartaro's testimony in this case). To the Commission's knowledge, this case is the first time a DNA expert in Texas has attempted to offer a probabilistic evaluation of the results given activity level propositions prepared in advance of trial instead of the typically

[58] *Id.* The Commission acknowledges that the trial and appellate proceedings in this case are more complex than what is described in this report. However, the point of including this example is to highlight there is serious risk if an untrained analyst goes to court and relies only on anecdotal evidence, personal experience, or unsupported speculation to offer an opinion linking the presence of DNA to an activity question such as whether a struggle occurred or not.

[59] *See e.g., NIST EWG Report on Human Factors in DNA* at 173 and *ISFG 2020 Guidelines* Recommendation 1.

encountered scenario in which experts respond to attorney hypotheticals regarding the propositions themselves. The typical scenario occurs in part because DNA analysts in the United States:

- are still engaged in conversation about how to or when it may be appropriate to respond to hypothetical questions, and when such responses should be avoided as potentially misleading;

- have little access to appropriate education or training regarding how to properly perform evaluations of DNA findings given activity level propositions and report those evaluations using a ratio of probabilities (whether qualitative or quantitative);

- do not have a sufficiently deep understanding of the full body of knowledge available through relevant literature to evaluate the fit between the case they are working and the literature, in the absence of original experiments.

In the recently published *NIST Expert Working Group Report on Human Factors in Forensic DNA Interpretation*, (hereinafter referred to as "*NIST EWG Report on Human Factors in DNA* ") the following recommendation is made with respect to laboratories in the United States: "DNA analysts should not opine about the possibility or probability of direct or indirect transfer having occurred in a case."[60] This recommendation conforms with existing international guidance and represents a shift in thinking regarding the role of the scientist (which again, according to the guidance, is to comment on the strength of the findings given competing propositions, not the propositions themselves).[61]

The recommendation is appropriate in that it seeks to avoid misunderstandings (and potential miscarriages of justice) that may occur when factfinders carry the DNA comparison results over to issues regarding alleged activities. However, several practical questions remain for DNA analysts in Texas (and across the United States) in attempting to comply with this recommendation, including:

[60] *See*, *NIST EWG Report on Human Factors in DNA* at 177.
[61] *See*, Recommendation 3 from the *ISFG 2020 Guidelines*, *supra* n.13.

- What should DNA analysts do if they are discouraged by prevailing scientific guidance from commenting on the possibility of transfer in a case, and there is no consensus in the United States regarding the appropriateness of addressing the probability of findings given activity level propositions?

- Assuming a consensus is reached adopting the approach used in parts of Europe/UK/Australia regarding assessing findings given activity level propositions, what should analysts say if they are not educated, trained, or licensed—or their laboratories accredited—to perform an assessment of their results considering TPPR, and there is no subset of experts in their laboratory qualified or authorized to offer such testimony?

- What are the risks that refusing to say anything about TPPR could in itself lead to factfinder misunderstanding of the significance of the results, or the misuse of the evidence by lawyers during opening or closing argument when the DNA analyst is not present to correct the misunderstanding?

- How or to what extent can analysts limit their testimony to general TPPR concepts without being perceived as evasive or uncooperative by lawyers and the trier of fact?

In the same *NIST EWG Report on Human Factors in DNA*, the authors suggest language for responding to case-specific TPPR questions in court:[62]

[62] *See, NIST EWG Report on Human Factors in DNA* at 176.

Table 1: Proposed responses to questions about how or when the DNA was deposited as described in the 2024 EWG Report on Human Factors in DNA *(used with permission from NISTIR 8503, Table 7.1, p. 176).*

Example of Questions Posed to DNA Experts	Proposed Ways for the Expert to Respond
In your opinion, is direct transfer more likely than indirect?	• DNA analysis does not allow a scientist to directly answer how the DNA was deposited (direct or indirect transfer). The DNA results presented in my report regard the comparison of DNA profiles and can only help answer questions about whose DNA may be present or not. • My testimony about the value of the DNA comparison is only meaningful to help the jury determine who the source of the DNA was. That testimony does not provide any information that addresses the issues of how or when.
Could this [alleged activity] have happened?	• Offering an opinion on this question would amount to speculating on what is alleged. It is not my role as a scientist to speculate about or determine what happened.
Is it possible that the DNA was deposited when the Person of Interest (POI) [engaged in an activity at the scene prior to or after the alleged event]?	• It is not my role to discuss the possibility of the alleged event (or any other event). My expertise is based upon DNA profile comparisons which can only assist in helping you answer questions about whose DNA is present or not. • Agreeing that something is "possible" is not the same as offering an opinion about the probability of the results in the context of case-specific circumstances. • Discussing whether something is possible does not help me convey the significance of the results in the context of this case. For example, getting struck by lightning or flipping a coin and getting "heads" are both possible but have very different probabilities.
Are there other explanations for the presence (or absence) of this DNA?	• It would be inappropriate and speculative for me to discuss why the DNA was or was not detected. • Answering this question would not allow me to convey a balanced assessment of the findings in the context of this case. • The only way I can evaluate the results is by considering at least two opposing views.

The *NIST EWG Report on Human Factors in DNA* provides that DNA analysts may use their expert knowledge to respond to general background questions regarding TPPR concepts if they refrain from discussing case-specific hypotheticals or commenting on the evidence in the case, which would require separate training. In the legal literature, this type of testimony is referred to as "framework testimony" or G2i (general to individual) testimony.[63]

The Commission acknowledges the difficulty inherent in drawing the line between providing general background and veering into case-specific hypotheticals. Indeed, the extremely challenging task for the DNA analyst in the U.S. criminal justice system given the current state of education and training is to: (1) communicate clearly that the results of DNA testing speak only to

[63] *See, e.g.,* Faigman, et al., *Group to Individual (G2i) Inference in Scientific Expert Testimony*, 81 U. Chi. L. Rev. 417 (2014).

"who," and not "how or when"; (2) respond honestly to questions regarding general TPPR concepts while still disclosing the limitations of their knowledge as it relates to the case itself; and (3) avoid being led into case-specific hypotheticals that amount to ad-hoc pseudo-evaluations on the stand of findings given activity level propositions. And all of this must be expressed in an adversarial setting under questioning from non-scientists in a way that lay jurors will understand.

The Commission observes that this shift in approach will require extensive training and integration by Texas FSSPs before any expert should be held accountable to the restriction against answering hypothetical "is it possible" questions in all cases. In other words, the Commission supports the international guidance and the *NIST EWG Report on Human Factors in DNA* recommendation at a philosophical level but believes that DNA analysts need significant education and training before they are held accountable to the recommendation.[64] Similarly, legal end-users would benefit from education and training given that they are responsible for presenting and evaluating the testimony, depending on their role.

In this case, Mr. Quartaro responded to hypotheticals regarding how or when the DNA was deposited in the case, a line of questioning DNA analysts in the United States are accustomed to—but if the U.S. is to move toward international guidance on evaluative reporting—will need to shift

[64] As observed by Berger et al., "[t]he main thrust of the evolution of what has come to be known as the Bayesian approach has centered on the UK, Europe and Australasia . . . the adoption of the ideas of the Bayesian approach and, more specifically the CAI model, has been patchy in those countries that are leading the movement. Furthermore, practitioners in the USA seem to be largely unaffected by it." The authors continue to submit that ". . . probabilities are personal, even when informed by data. The Bayesian approach does not give the expert the right to make up numbers as she pleases, but rather the duty to make sure the probabilities involved obey the laws of probability." In sum, the authors state that "The reason for this paper is to explain that the evaluation of evidence for a court of law is not just a matter of 'using likelihood ratios" but one of *working to a set of principles that are founded on logic*. To deny scientists the contemplation of the likelihood ratio—whether quantitative or qualitative—is to deny the central element of the logical structure." [emphasis added] Charles E.H. Berger, John Buckleton, Christophe Champod, Ian W. Evett, Graham Jackson, *Evidence Evaluation: A Response to the Court of Appeal Judgment in R v. T*, Science & Justice, Vol. 51, Issue 2 (2011).

away from.[65] An example of this would be Mr. Quartaro's testimony that it was "possible" for Armstrong's DNA to be on the bicycle "without her even touching it." International guidance suggests this type of statement is considered appropriate during the investigative phase but *not* during the trial phase. Under Recommendation 1 of the *ISFG 2020 Guidelines*: "Providing a list of possible explanations for the results may be relevant during the investigation phase, but not in court, as it does not allow an assessment of the value of evidence."[66] This recommendation would appear to specifically preclude providing the court with only "it is possible" explanations in the specific case.

In contrast, Dr. Kalafut testified in probabilistic terms. While this aspect of his testimony aligns with international guidance recommending evaluative reporting,[67] framing an opinion as strength-of-evidence reporting in probabilistic terms is only one concern (in this or any case) when testimony regarding the evidence given activity level propositions is offered.

Of equal or greater importance[68] is:

- Understanding how to assess suitability (*i.e.,* when it is appropriate (and when it is not) to conduct an evaluation given activity);
- Communicating about the robustness of the evaluation (*i.e.,* the empirical basis for an assessment given activity level propositions);[69]

[65] In Section VIII of this report, the hierarchy of propositions is discussed; Mr. Quartaro acknowledged his lack of familiarity with the concept of "sub-source" propositions and described "activity level propositions" as "sometimes trying to add mathematical calculations to figure out what may be more likely in a case." Mr. Quartaro's lack of awareness of these concepts is not surprising given they have not historically been a focus of DNA analyst training in the United States. *See*, **Exhibit D**: Quartaro Transcript Volume 21, p. 59-60 of the Reporter's Record in the *State of Texas v. Kaitlin Armstrong*, Cause No. D1-DC-301129, in the 403rd Judicial District Court of Travis County, Texas, occurring on November 15, 2023.
[66] *See, ISFG 2020 Guidelines* at Recommendation 1.
[67] *See*, *ISFG 2020 Guidelines* at Recommendation 3: Scientists must not give their opinion on what is the "most likely way of transfer" (direct or indirect), as this would amount to giving an opinion on the activities and result in a prosecutor's fallacy (*i.e.,* give the probability *that* X is true). The scientists' role is to assess the value of the *results* if each proposition is true in accordance with the likelihood ratio framework (the probability of the *results if* X is true and *if* Y is true). Again, the Commission notes that the "prosecutor's fallacy" is a scientific concept, not a legal one.
[68] *See*, ENFSI Guideline for Evaluative Reporting #1, Reporting Requirements: balance, logic, robustness and transparency at 10-11.
[69] *Id.* at #3, "The forensic practitioner should not mislead the recipient of expert information as to the basis of the personal assignment, and the extent to which the assignment is supported by scientific research," at 16.

- Maintaining transparency and traceability in analysis and reporting;
- Undertaking quality assurance measures, such as validation, technical review and other critical steps; and
- Ensuring education, training, and regular proficiency monitoring of experts.

It is these areas where the Commission observes that several critically important and unresolved questions remain. The following section describes ten urgent outstanding questions pertaining to the integration of evaluations given activity level propositions in the United States criminal legal system, as highlighted by the series of events in this case. It also explores the more general question of how forensic analysts should answer TPPR questions in any given case. This list is necessarily incomplete but emphasizes some primary issues for consideration.

G. IMPORTANT (UNRESOLVED) QUESTIONS REGARDING INTEGRATION OF EVALUATIONS GIVEN ACTIVITY LEVEL PROPOSITIONS IN THE U.S. LEGAL SYSTEM

Internationally, the most recognized authorities on how to approach the evaluation of DNA findings given activity level propositions are the DNA Commission of the International Society for Forensic Genetics (ISFG) and the European Network of Forensic Science Institutes (ENFSI).[70] The discussion in this section relies heavily on these sources as well as a book published in 2023 entitled, *Interpretation: Activity Level Propositions and Likelihood Ratios* by Duncan Taylor and Bas Kokshoorn.[71]

[70] As noted previously, two ISFG and ENFSI published documents on which the Commission relies are the *ISFG 2020 Guidelines* https://pubmed.ncbi.nlm.nih.gov/31677444/ and the *ENFSI Best Practice Manual for Human Forensic Biology and DNA Profiling* (Approved by the ENFSI Board on November 29, 2022) https://enfsi.eu/wp-content/uploads/2022/12/ENFSI-DNA-BPM-03.pdf The Commission also relies heavily on Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation: Activity Level Propositions and Likelihood Ratios* (CRC Press 2023).
[71] Duncan Taylor is the Chief Scientist of Forensic Statistics at Forensic Science South Australia, Adelaide, Australia. Bas Kokshoorn is a Principal Scientist at the Netherlands Forensic Institute (NFI) in The Hague.

Issue #1: Procedural and Structural Differences Between the Criminal Courts in United States and Other Countries

In Texas criminal proceedings, the defense's entire approach regarding *either* the source of DNA *or* the activity related to DNA evidence may shift leading up to and during trial depending on any number of factors including the efficacy and persuasiveness of the forensic evidence presented by the State during its case-in-chief.[72] The defense "theory" regarding case-related activities may also simply be *any theory other than the State's,* because it is the State who bears the burden of proving guilt beyond a reasonable doubt.

Defense questioning is often designed to raise doubt in the minds of the jury by invoking an entire spectrum of possible scenarios. Because it is widely accepted that the fundamental job of the defense attorney in the United States is to "poke holes" in and raise doubt about the State's theory and whether the State has met its burden of proof, it is difficult to envision a scenario in which courts would not permit lawyers to ask "is it possible" questions of the experts regarding the question of "how" or "when" DNA may have been deposited on an item. This is in part because of the bedrock notion that American juries are capable of considering defense questioning designed to raise alternative possibilities alongside all other information presented by the State and discerning whether any of the possibilities suggested by the defense succeed in raising doubt about the State's overarching theory. The defense is under no obligation to preview the line of

[72] During the drafting of this report, Commission staff consulted with numerous highly skilled and experienced trial lawyers, many of whom have served in both prosecutorial and defense capacities in and outside of Texas. Regardless of how long they served as prosecutors or defense lawyers (or both), they all had a similar perspective and shared numerous real case examples to illustrate the following points: the defense is under no obligation to offer an alternative proposition on either source or activity. Their role is to convince the trier of fact that the State has failed to meet its burden to prove guilt beyond a reasonable doubt. Good trial advocacy requires defense counsel to be flexible and responsive to developments in the days leading up to (and even during) trial. *This may include changing trial strategy midstream on a fundamental issue—such as whether to contest the question of "whose" DNA is on an item of evidence—or not.*

questioning they will pursue with an expert before trial. In fact, changing strategy as needed to zealously represent one's client is often just good trial advocacy.

In court systems outside of the United States (whether adversarial or inquisitorial), the approach to introducing scientific evidence is quite different. For starters, scientists in other systems are provided with case information in advance and given time to prepare.[73] Also, the court has a different role in the evaluation of evidence. For example, in the UK, a court may convene a conference of the experts before trial for the express purpose of sharing areas of agreement and disagreement of scientific opinion.[74] The court may require the participants to identify where the defense-sponsored expert opinion diverges from the prosecutor-sponsored expert opinion. The common duty of both experts throughout this process is to provide an "objective and unbiased opinion" to the court. This duty "overrides any obligation to the party from whom the expert is receiving instructions."[75] In the United States system, while both sides have a duty of candor to the tribunal, the defense expert's focus is typically on identifying weaknesses in the forensic evidence proffered by the State.

In sum, because most of the literature on the subject of evaluations given activity level propositions comes from authors outside the United States, a comprehensive survey of the similarities and differences between legal systems is needed before the United States proceeds down any specific path. A recommendation to this effect in set forth later in this report.

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[73] During the drafting of this report, the Commission's general counsel participated in a workshop hosted by NIST entitled, "Communicating Forensic Findings: Current Practices and Future Directions." During the meeting, participants from Europe, including Alex Biedermann (UNIL, Switzerland), Marjian Sjerps (NFI, the Netherlands) and Anders Nordgaard (Linkoping University, Sweden) shared the extensive training of lawyers and judges that has been undertaken in Europe to improve the process including timely access to information for forensic scientists, as it was not always the case that experts were given sufficient time to prepare.

[74] *See*, the Code for Crown Prosecutors, "Duty of an Expert Witness," accessible at: https://www.cps.gov.uk/legal-guidance/expert-evidence. [last accessed June 16, 2024.]

[75] *Id.*

Issue #2: Introducing Probability Assignment(s) Considering Alleged Activities at Trial with No Opportunity for Review Contradicts International Guidance

Assuming DNA analysts in the United States make the philosophical shift away from commenting on possible activities toward commenting on the probability of their findings given mutually exclusive activity level propositions, there are still procedural realities regarding how evaluations given activity are likely to be introduced in state court that fly in the face of the transparency principles articulated in ISFG and ENFSI guidance.

In this case, Dr. Kalafut was called by the State initially as a consulting expert to assist with cross-examination of Mr. Quartaro, and subsequently to rebut Mr. Quartaro's testimony on alternative possibilities for how the DNA evidence might have been deposited on Wilson's bicycle. The potential for meaningful challenge of the scientific opinion of a "rebuttal" expert witness is significantly reduced in comparison to the case-in-chief phase, where parties typically have notice of which experts will testify.

The international guidance referenced throughout this report certainly does not contemplate a scenario in which the existence of an expert on evaluative reporting given activity level propositions is unknown until shortly before the expert is called to testify. However, in practical application in Texas criminal courts, the State may not notify the defense of the intended expert testimony since the applicable Rules of Criminal Procedure *do not require that notice*.[76] Indeed, the very decision about whether to call the rebuttal expert (in this case, Dr. Kalafut) hinged on what the attorneys asked and what the opposing expert (in this case, Mr. Quartaro) said (or didn't say) when he was on the stand.[77] This is an important concept because in the United States

[76] The Commission has not surveyed the criminal procedure rules in other states or at the federal level to comment on the extent to which the information presented in this section applies in other jurisdictions but suffice it to say, Texas is not the only state with these (or similar) rules governing rebuttal witnesses.
[77] The State asserts they did not intend to call Dr. Kalafut as a testifying expert until Mr. Quartaro asserted that he was an expert on "transfer DNA."

criminal justice system as it currently stands, probabilistic assessments given activity level propositions may frequently appear as State-sponsored rebuttal to general questions raised by defense lawyers regarding DNA transfer for purposes of introducing reasonable doubt. In other words, the scenario in this case represents what would likely be a common scenario in state court proceedings. Accordingly, the legal rules governing rebuttal testimony in Texas merit attention:

a. Rules Governing Rebuttal Witnesses and Their Impact

Article 36.01 of the Texas Code of Criminal Procedure sets forth the order of proceedings in a Texas criminal trial. In pertinent part, Article 36.01 provides:

1. The State's attorney shall state to the jury the nature of the accusation and the facts which are expected to be proved by the State in support thereof.

2. The testimony on the part of the State shall be offered.

3. The nature of the defenses relied upon, and the facts expected to be proved in their support shall be stated by defendant's counsel.

4. The testimony on the part of the defendant shall be offered.

5. Rebutting testimony may be offered on the part of each party.

Under Texas law, "[t]he prosecution is entitled on rebuttal to present any evidence that tends to refute the defensive theory of the accused and the evidence introduced in support of it."[78] The purpose of rebuttal evidence is to counter testimony from another source.[79] When a party introduces matters into evidence, that invites the other side to reply to that evidence.[80]

In a case involving the introduction of extraneous offense rebuttal evidence, Judge Cochran of the Court of Criminal Appeals pointed out the potential perils of the rebuttal rules in a concurring

[78] *Durham v. State,* 2014 Tex. App. LEXIS 10154 (Tex. App.- Corpus Christi 2014), citing *Flannery v. State,* 676 S.W. 2d 369 (Tex. Cr. App. 1984).
[79] *Martin v. State*, 151 S.W.3d 369 (Tex. App. – Texarkana 2004).
[80] *Wheeler v. State*, 67 S.W. 3d 879, n.13 (Tex. Cr. App. 2002).

opinion, noting that just because the rules allow rebuttal evidence in the absence of any sort of notice or discovery, it is not always the most prudent course:

> [T]he letter of the law is not always a perfect reflection of the spirit of the law. The spirit of [the Rules of Evidence] is to ensure that Texas criminal proceedings are not a contest of clever gamesmanship or trial by ambush. …[O]ur Rules of Evidence are drafted to ensure that Texas criminal practitioners remain gentlemen and gentlewomen who do not spring evidentiary surprises on their adversaries.
>
> A number of our Rules of Evidence require advance notice when practicable and reasonable.[81] …. This requirement of advance notice, upon timely request, applies only to the State's case-in-chief because prosecutors are no more clairvoyant than the rest of the world. They cannot, and thus should not be required to, predict precisely what evidence the defense will introduce or what rebuttal evidence might be relevant as a result of a particular defense. Our law has long recognized this fact.[82]
>
> On the other hand, it is possible for prosecutors to manipulate the … purpose and applicability [of the Rules] simply by reserving [certain] evidence until its rebuttal case, when notice is not required. Although this strategy conforms to the letter of the law, it clearly violates the spirit.[83]

One of the cornerstones of the international guidance on evaluative reporting given activity level propositions is that both sides have the opportunity to review and challenge each expert's assessment and underlying data. As Professor Christophe Champod observes:

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[81] For example, Rule 201(c) entitles either party to be heard as to the propriety of taking judicial notice. So does Rule 202, as do Rules 203 and 204. Under Rule 412, the defense must give advance notice of its intent to offer evidence of a victim's previous sexual conduct and make a proffer of that evidence *in camera*. Rule 609(f) requires both the prosecution and defense to give advance notice of their intent to use prior convictions to impeach a witness. Rule 705(b) entitles either the prosecution or the defense to voir dire a proposed expert concerning the underlying facts and data he relied upon in forming his opinion before the witness testifies before the jury.

[82] *See, e.g., Elkins v. State, 543 S.W.2d 648, 649 (Tex. Crim. App. 1976)* (State is not required to disclose the identity of rebuttal witnesses); *Hoagland v. State, 494 S.W.2d 186, 189 (Tex. Crim. App. 1973)* (noting that the State cannot intend to introduce true rebuttal evidence before trial because the State does not know what theories the defendant will advance); *Washington v. State, 943 S.W.2d 501, 506* (Tex. App. - Fort Worth 1997, pet. ref'd) (to hold that State is required to give advance notice of rebuttal extraneous offenses under art. 37.07 "would require the State to predict all possible arguments that a defendant might raise and then notify the defendant of the evidence that would rebut those possible arguments"); *Doyle v. State, 875 S.W.2d 21, 22* (Tex. App. - Tyler 1994, no pet.) (concluding that it is not reasonable for the State to anticipate needing undisclosed witness to rebut defense testimony that it could not foresee); *Stringer v. State, 845 S.W.2d 400, 403* (Tex. App. - Houston [1st Dist.] 1992, pet. ref'd) (Rule 404(b) notice requirement not applicable to rebuttal evidence); *Yohey v. State, 801 S.W.2d 232, 235* (Tex. App. - San Antonio, 1990, pet. ref'd) ("by its very terms the notice requirements [of Rule 404(b)] are not applicable to rebuttal evidence").

[83] *Jaubert v. State*, 74 S.W.3d 1 (Tex. Cr. App. 2002)(Cochran, J., concurring).

> Any scientist offering views as to his/her expectations for the forensic findings under given case-related circumstances should be able to put forward documented sets of controlled experiments whose relevancy to the case under dispute can be argued. A further question is how many controlled experiments should be conducted and how close should they be to the alleged circumstances. In my view that question should be approached on a case-by-case basis using the adversarial mechanisms available to the parties. The major improvement here is that all parties can access and challenge the body of knowledge available to the expert proffering an opinion.[84]

For this principle to be implemented in circumstances like the case at hand, the State would need to provide advance notice regarding the possibility of introducing testimony accounting for TPPR in rebuttal so the defense would have sufficient time to consider the expert's evaluation *including the data upon which it is built*. Otherwise, anytime the defense asks a series of hypothetical questions at trial in an effort to raise doubt about how the DNA got on the item of evidence, the State could respond in rebuttal with an evaluation of the evidence given activity that the defense hears about for the first time as the expert takes the stand. *Nothing about this scenario is consistent with ISFG or ENFSI guidance,* which clearly requires transparency and "equality of arms," (*i.e.*, the concept of affording both sides the opportunity to understand the opinion reached, the assumptions made, the data upon which the opinion relies, and the limitations associated with the opinion). Also, because the defense is not required to disclose their strategy and Texas does not have reciprocal discovery, the "both sides" component of the "equality of arms" concept is not directly applicable in Texas state court proceedings.

Of course, DNA experts are not attorneys and cannot be expected to know the nuances of Texas criminal procedure or the Constitutional principles underlying Texas criminal jurisprudence. However, what is incumbent upon the expert is to make the attorney offering the expert's testimony aware when something about the process as it unfolds does not align with the

[84] Champod, C. *DNA Transfer: Informed Judgment or Mere Guesswork?* Frontiers in Genetics, Vol. 4, Art. 300, doi: 10.33389/fgene.2013.00300 (Dec. 2013).

very guidance the expert purports to have followed. In other words, while Dr. Kalafut did not have control over the State's desire to call him as rebuttal expert witness, he did have control over whether he agreed to participate in the case and (to a certain extent) under what conditions.

In sum, the expert should do his or her best to communicate to the sponsoring attorney the strong emphasis on transparency and disclosure that exists in applicable international guidance documents with regard to assessments given activity level propositions, especially where (as in this case) those documents are identified as support for the scientific opinion offered. Without this understanding, the attorney may respond to questions regarding whether a report is needed solely focusing on legal procedural rules. Again, DNA experts (especially those in accredited laboratories) would not testify about DNA comparisons without having issued a written report at the sub-source level of the hierarchy of propositions. The same concept should apply at the activity level.

Notwithstanding these admonitions, as with many scenarios where there is a risk of disconnect at the intersection of science and the law, the Commission sees no benefit in laying blame at the feet of the lawyer(s) or the scientist(s) in this case. Rather, the Commission notes that the procedural dynamics on display in this trial are one of the many aspects of U.S. criminal procedure and practice that require thoughtful attention (not just in Texas but throughout the United States) before assessments given activity level propositions can be successfully incorporated by DNA experts or offered at trial in a way that actually comports with the vision set forth by ISFG and ENFSI, both of which point to transparency as a foundational component of good scientific practice.

Issue #3: Lack of Written Report and Its Impact

Dr. Kalafut explained in his response to the complaint that he asked the State whether they "wanted a written report" and they responded that they did not. This is an example of a scenario in which the attorneys were considering the question from the narrow perspective of what is required by governing legal rules, without an awareness of the published guidance on evaluative reporting given activity level propositions. Indeed, the written report is the cornerstone of every international guidance document on the subject: "The expert shall not give opinions on matters that were not addressed in their report(s)."[85] In the United States, DNA experts do not ask the prosecutor if he or she "wants a written report" in the context of DNA comparisons (when considering sub-source level propositions) which often rely on STRmix™ results and likelihood ratios. Rather the report is issued as a matter of course and as a requirement of the FBI's QAS and accreditation. Under international guidance, the approach is no different when an expert reports an evaluation of the results given activity level propositions, regardless of whether that expert is operating within an accredited laboratory setting. As stated by ENFSI, ". . . [w]here there has been good case management, it is rare to give an opinion that is not available in the report."[86]

Dr. Kalafut provided two documents to prosecutors, one titled "evidence reconciliation," and the other titled, "papers of interest," as well as copies of the referenced papers. (**Exhibit F** and **Exhibit G**.) These documents—regardless of how they were intended—were received by prosecutors not as a report but as a "copy of his notes," and the State did not provide these documents to the defense. According to Dr. Kalafut, the written "evidence reconciliation" document did not capture the alternative proposition ultimately discussed at trial, which included new information he received from the State as he was driving to Austin to testify. The new

[85] *ENFSI 2022 Best Practice Manual* at Section 13.
[86] *Id.*

explanation (suggested by the defense in their questioning of Mr. Quartaro) was that DNA may have transferred via a motorcycle helmet that—according to Strickland's recollection—Armstrong last wore a month before the murder. Strickland also recalled having worn the same helmet (twice) and Wilson having worn it (once) on the day of the murder.[87] Of course, because this information was new, it was not included in the "evidence reconciliation" document.[88]

The Commission contrasts the written documentation in this case with, for example, a sample report from UNIL and a sample report published in FSI Genetics in an article by Taylor et al.[89] (**Exhibit H** and **Exhibit I**.) There is a striking difference in the level of complexity and detail in those reports which include a clear delineation of the contested and uncontested case information, as well as the assumptions made during the evaluation.

While the Commission does not assert that Dr. Kalafut necessarily needed to follow these exact report formats, differences between the sample reports and the written evaluation in this case raise questions about the extent of analytical and reporting parameters that would need to be established for U.S. experts to perform this work in a way that comports with international expectations. In other words, were evaluative reporting considering TPPR factors to be widely integrated in the United States criminal justice system, clear guidance regarding what level of reporting is adequate to constitute good scientific practice would be essential.

[87] The helmet was not tested for DNA, which is one indication of the disconnect between the crime laboratory's work and Dr. Kalafut's role in this case. Ideally, there would have been a more holistic case management approach as described in prevailing international guidance and literature.
[88] *See* ENFSI *Guideline for Evaluative Reporting* requiring a clear delineation of the evaluation component in a written report.
[89] *See*, Sample Reports at **Exhibit I**, including: Appendix to Taylor, D., Biedermann A., Hicks T., and C. Champod, *A Template for Constructing Bayesian Networks in Forensic Biology Cases When Considering Activity Level Propositions*, Forensic Science International: Genetics, Vol. 33, 2018, at 136-146, ISSN 1872-4973, https://doi.org/10.1016/j.fsigen.2017.12.006.

Issue #4: Apparent Misunderstanding Regarding What Constitutes a Well-Formulated Activity Level Proposition

One document Dr. Kalafut provided to the prosecutors was titled "papers of interest" and included a brief summary of the ISFG guidelines and highlights of four other studies.[90] A second document titled "reconciliation document" described two hypotheticals including case information provided by the State which, at the time of proposal, involved the motorcycle—not the helmet—and were formulated as:

> H1 = Armstrong removed bike from Wilson's rental home/house/apartment after a high stress encounter.[91]
>
> H2 = Armstrong was passenger on Strickland's motorcycle from time to time. Wilson rode as a passenger a single time and picked up Armstrong's DNA from the motorcycle. Wilson came home, and moved/used her bicycle, that's how Armstrong's DNA got on the bicycle.[92]
>
> Dr. Kalafut also provided the following statement, entitled *Expert Opinion*:
>
> All of this is to say I will not give a "number" as to how much more likely this evidence is given the first proposition than the second. I will only give a qualitative assessment that in my opinion, the DNA profile recovered from the bicycle is much more likely[93] if Armstrong carried the bicycle out of the home of Cash and disposed of it than if Wilson picked up DNA of Armstrong, but not of Strickland (or Cash)

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[90] *See*, Dr. Kalafut Literature Summary at **Exhibit G**.

[91] The term "high stress encounter" included in H1 above is case information that should not be included in a proposition.

[92] *See, e.g., ISFG 2020 Guidelines* Recommendation 6: Results or factors that scientists consider in their evaluation should not be interwoven into the propositions. "The scientist should avoid the use of the term 'transfer' in propositions. Instead, there should be a focus on the alleged activities." *See also*, *ISFG 2020 Guidelines* For an extensive discussion of the proper formulation of propositions, *see*, Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023) at 104-109.

[93] "As words may have different meanings in different contexts, there is always a risk of misinterpretation if that context differs between the sender and receiver of the information. This is especially so with terms that relate to quantities." *See*, Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023) at 367-368. ". . . there are several studies that point to the risks inherent in using verbal equivalents for the likelihood ratio." *Id.* at 368, *citing* Martire K.A., and I. Watkins, *Perception Problems of the Verbal Scale: A Reanalysis and Application of a Membership Function Approach*, Science & Justice: Journal of the Forensic Science Society 55(4) (2015) 264-73; Martire, K.A, Kemp, R.I., Sayle, M. and B.R. Newell, *On the Interpretation of Likelihood Ratios in Forensic Science Evidence: Presentation Formats and the Weak Evidence Effect*, Forensic Science International 240 (2014) 61-68; Garett, B., G. Mitchell and N. Scurich, Comparing Categorical and Probabilistic Fingerprint Evidence, Journal of Forensic Science 63(6) (2018) 1712-1717; van Straalen, E.K., de Poot, C.J., Malsch, M. and H. Elffers, *The Interpretation of Forensic Conclusions by Criminal Justice Professionals: The Same Evidence Interpreted Differently*, Forensic Science International, 313 (2020) 110331.

from a motorcycle that Armstrong had been on a month or so prior and Wilson deposited it on the bicycle.[94]

The activity in question for purposes of this evaluation is the removal of Wilson's bicycle from Cash's home,[95] and neither party contests that the bicycle was removed. Following is a breakdown of Dr. Kalafut's Expert Opinion per his evidence reconciliation document:

Table 2: Activity Level "Propositions" in Reconciliation Document

WORD OR PHRASE	WELL-FORMULATED?	WHY/WHY NOT?
The DNA profile recovered from the bicycle	Yes	Focuses on the DNA evidence
. . . is much more likely	Undecided/lacks consensus	There is a lack of consensus in published literature regarding whether an expert must assign a numerical or qualitative LR (*see* discussion in Issue #8 below) in respect to evaluations given activity level propositions. However, if an expert calculates an LR, the expert may report a verbal equivalent *with* the LR, but not omit the LR in favor of the verbal equivalent alone.
. . . if Armstrong carried the bicycle out of the home of Cash and disposed of it	Yes	Focuses on the alleged activity
. . . than if Wilson picked up DNA of Armstrong, but not of Strickland (or Cash) from a motorcycle that Armstrong had been on a month or so prior and Wilson deposited it on the bicycle	No	This statement lacks clarity and is not concise. From a technical perspective, it is strongly discouraged because it builds the DNA findings into the proposition. In other words, the statement is circular because it conditions on a proposition that includes the evidence itself (the DNA result).

Recommendation 6 of the *ISFG 2020 Guidelines* provides that, "[R]esults or factors that scientists consider in their evaluation should not be interwoven into the propositions."[96] Accordingly, an example of a well-formulated proposition—one that focuses on mutually exclusive *activities* and does not mix explanations and case information—would be:

[94] *See*, Dr. Kalafut Reconciliation Document at **Exhibit F**.
[95] *ISFG 2020 Guidelines* Recommendation 7: "Activity level propositions should focus on the alleged activities."
[96] *Id.* at Recommendation 6.

H1 = Armstrong removed the bicycle from the house.

H2 = An unknown person removed the bicycle from the house.

The DNA results and the factors to be considered in the evaluation (*e.g.,* intermediate transfer events via the motorcycle seat, via the helmet, etc.) would be included as part of the evaluation of background information, information used to form assumptions, or in assigning the probability of the DNA evidence if Armstrong removed the bicycle versus if an unknown person (not Armstrong) did. However, those considerations should not be included in the propositions themselves.[97]

In sum, while Dr. Kalafut makes an earnest attempt at moving toward evaluative reporting given activity level propositions, the expert opinion in the "Evidence Reconciliation" document falls short of stating well-formulated mutually exclusive propositions. Rather, it includes explanations and builds the DNA findings into the alternative proposition in a circular manner, a practice strongly discouraged in the applicable ISFG and ENFSI guidance.[98]

Issue #5: Assessing Suitability and Ensuring Traceability

International guidance requires a robust evaluation and traceability of analysis. The two documents provided via email to the prosecutors are Dr. Kalafut's "case record,"[99] yet they do not adequately detail the connection (*i.e.,* traceability) between the data in the referenced studies and the opinion offered, nor do they justify the assignments of probability.[100]

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[97] For a discussion of this problem, *see* Hicks T., Biedermann A., de Koeijer J.A., Taroni F., Champod C., Evett I.W., *The Importance of Distinguishing Information from Evidence/Observations when Formulating Propositions*, Science & Justice, 55, 520-525 (2015), http://www.sciencedirect.com/science/article/pji/S135503061500091X.

[98] *See ISFG 2020 Guidelines* at Recommendation #6.

[99] *See*, January 26, 2024, quarterly meeting at: https://www.youtube.com/live/7724LkJbntg.

[100] While Dr. Kalafut's expectations regarding "recovery" are mentioned in the reconciliation document, the concept of "recovery" in the literature is about much more than whether DNA is easy to recover but rather requires the expert to consider the methods of recovery used in the case in front of him versus those used in the referenced studies (*e.g.,* swabs; extraction method; amplification kit; cycles; detection methods; interpretation of results (manual interpretation versus probabilistic genotyping).) Additionally, there can be vast differences in the efficiencies of different collection methods, which can impact the value of downstream conditional probabilities.

Dr. Kalafut referenced three DNA transfer studies (Warshauer, et al. (2012), Fonnelop, et al. (2015) and Davies, et al. (2015)), one study regarding how often people touch things around them or themselves (Oorschot et al. (2015)) and the *ISFG 2020 Guidelines*. There are no existing published standards that would help the trier of fact (or another expert) assess whether the quantity or quality of data in these studies are sufficient to support the evaluation given the case circumstances. Other than a general statement that there is "not much in the literature on tertiary studies,"[101] it is difficult for the reader to track why Dr. Kalafut deemed the data from these studies sufficient to support his process for assigning a probability of the evidence given the alternative proposition. It is also difficult to understand Dr. Kalafut's formula for the likelihood ratio, other than the general assertion that he assigned probability of 10% for "low probability," and then added "an order of magnitude" for "each step of the transfer." Dr. Kalafut's justification for moving the decimal place for each intermediate transfer event is unclear, and he expressly declined to offer a numerical LR in the "expert opinion" section of his evidence reconciliation document.

The first step in performing an evaluation must be to specify a case-tailored formula, whether it be hand-derived or utilizing a Bayesian Network. (*See* Chapter 5 of *Forensic DNA Trace Evidence Interpretation* (2023)). It is then easier to understand the manner in which the evaluation behaves and to "avoid illogical construction."[102] The process of developing the formula is more complex than adding a decimal point for each step in the transfer, and only after setting forth the formulaic basis should any numerical calculations be performed.

[101] In *ISFG 2020 Guidelines* under 6.2 titled "Robustness," the authors discuss conducting a sensitivity analysis in the interest of transparency regarding the impact of data (or lack of information). *Citing* Taylor et al., the authors state that "[I]f there is a paucity of data used to assign a probability to which the LR is particularly sensitive, then this may indicate that the opinion of the scientist requires careful investigation of its robustness. This may lead to situations in which the scientist may decide not to report a result, because of concerns about robustness." These matters should be reported before being heard in court.

[102] *See*, Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023) at 124.

In addition, the *ENFSI Guideline for Evaluative Reporting* requires probability expressions to be, first and foremost, in the form of a number (at least an order of magnitude). ". . . . probability assignments shall . . . be expressed by a number between 0 and 1 rather than by an undefined qualifier (such as frequent, rare, etc.) Verbal qualifiers should not be given out of the blue—the number always comes first. This is why, for example, in the *ENFSI Guideline for Evaluative Reporting* table with the verbal equivalents of the LR, the number is in the column on the left, and the table is read from left to right. One should not pick the verbal qualifier first and then discover the numerical value (order of magnitude) in the column on the left.[103]

Table 3: Extracted from ENFSI Guideline for Evaluative Reporting

Values* of likelihood ratio	Verbal equivalent (two options of phrasing are suggested)
1	The forensic findings do not support one proposition over the other. The forensic findings provide no assistance in addressing the issue.
2 - 10	The forensic findings provide weak support** for the first proposition relative to the alternative. The forensic findings are slightly more probable given one proposition relative to the other.
10 - 100	...provide moderate support for the first proposition rather than the alternative ...are more probable given...proposition...than proposition...
100 - 1000	...provide moderately strong suppor tfor the first proposition rather than the alternative ...are appreciably more probable given... proposition...than proposition...
1000 - 10,000	...provide strong support for the first proposition rather than the alternative ...are much more probable given... proposition...than proposition...
10,000 - 1,000,000	...provide very strong support for the first proposition rather than the alternative ...are far more probable given... proposition...than proposition...
1,000,000 and above	...provide extremely strong support for the first proposition rather than the alternative ...are exceedingly more probable given... proposition...than proposition...
* Likelihood ratios corresponding to the inverse (1/X) of these values (X) will express the degree of support for the specified alternative compared to the first proposition. **Forensic practitioners or their reports should avoid conveying the impression that a statement of the kind: "the forensic findings provide weak support for the first proposition compared to the alternative" is meaning that the findings provide (strong) support for the stated alternative. It just means that the findings are up to 10 times more probable if the first proposition is true than if the stated alternative is true. This is also the reason why the alternative should be explicitly stated. In cases where the reader could be mislead as described above, forensic practitioners shall add additional comments.	

[103] *ENFSI Guideline for Evaluative Reporting* at 17.

When the Commission staff asked Dr. Kalafut via email why he was unwilling to "give a number," in the evidence reconciliation document, he explained the following:

> There are two LRs for this case.
>
> > (1) One is the LR I started doing in the report. It was on the order of 10,000 – which I felt was generously low – and has problems.
> >
> > (2) The other LR is the one based on the updated Ha proposition and case information at trial that day. [introduction of helmet as a possible explanation for transfer] This is the LR that I say may as well be approaching infinity. This is also the appropriate LR to present to the jury, and all of my testimony was done with this updated information and proposition in mind. I thought "much more likely" was a reasonable LR to discuss, as we try to present LRs that are favorable to the defense.

The Commission observes numerous problems with Dr. Kalafut's explanation. First, the basis for these very large LR's—both the LR on the order of 10,000 and the LR "approaching infinity" is unclear and difficult to justify.[104] One would need detailed information on the history of the helmet and a considerable amount of data (experimental or published) collected under similar circumstances, to justify either of these LR's, neither of which exists in this case.

As described in the *ENFSI 2022 Best Practice Manual*, "LRs given activity level propositions are typically many orders of magnitude lower than those calculated given sub-source level propositions. It is useful to demonstrate this even if there are limited data available."[105] There seems to be a fundamental misunderstanding regarding the impact of the absence of studies about a phenomenon of interest (the occurrence of DNA traces) on a surface of interest (in this case, a bicycle). Dr. Kalafut indicated (in the same email correspondence) that the lack of studies showing

[104] An LR "approaching infinity" suggests the probability of the alternative proposition is effectively 0. However, in a well-constructed evaluation, as the transfer probabilities become very low then other factors will tend to limit the size of the LR. Examples include the rate of laboratory contamination or—in the case of multiple samples—the chance of background DNA (or DNA from an alternate offender). These factors should be considered during the evaluation—either by building them into the evaluation, or simply considering whether their inclusion would have a meaningful impact on the LR—*even without the defense explicitly stating them as possibilities*.

[105] *See, ENFSI 2022 Best Practice Manual,* at Section 13, item 8. *See also*, Appendix A.1.9, (emphasizing pre-assessment LR's with varying quantities of DNA).

tertiary and quaternary transfer would result in a "huge LR" because the denominator is "tiny," meaning the probability of the evidence given the alternative hypothesis is approaching zero. In other words, the relative lack of studies is interpreted as support for the notion that the *phenomenon itself* (in this case the finding of DNA on the bicycle given the alternative) could not happen. In fact, when there are little relevant data close to the case facts from literature, and no ability to perform case-specific experiments under controlled conditions to study what would be found in simulated cases, a legitimate question would be whether, given the absence of data close to the case facts and absence of studies mimicking the facts, a more appropriate view would be to report that no LR can be assigned, and the findings should be considered uninformative.

A counterargument to the assertion that this case may not have been a good candidate for reporting given activity level propositions is that there are some scenarios in which an expert's refusal to speak about TPPR concepts is itself misleading and could lead to a miscarriage of justice or at least an inappropriate assessment of the probative value of the evidence. If the expert does not insist on explaining that the absence of suitable data implies that the value of the findings in respect to the alleged activities *cannot* be assessed, the danger is that the recipients of the expert information might nevertheless try to draw their own intuitive conclusion.[106] Knowing when to proceed and when to acknowledge a lack of relevant data on key factors is a critical component of education and training in the field. Furthermore, knowing how to alert the trier of fact that the expert cannot—and therefore no one can—use the findings to help distinguish between the alleged activities is critically important to avoid misunderstanding.

[106] Evett I. *The Logical Foundations of Forensic Science: Towards Reliable Knowledge*. Philos Trans R Soc Lond B Biol Sci. (2015) at 15, Aug 5;370(1674):20140263. doi: 10.1098/rstb.2014.0263. PMID: 26101288; PMCID: PMC4581007.

Issue #6: Evaluating the Sufficiency of Published Data on TPPR Generally

As a general matter, the Commission believes additional and systematic review of currently existing published literature on TPPR is needed *if* the path forward in the United States is to implement evaluations of biological results given activity level propositions that consider those factors. The recently published *NIST EWG Report on Human Factors in DNA* makes the following recommendation:

> The [U.S.] federal government should fund collaborative efforts to review and research the foundations and principles of evaluating biological results when considering alleged activities. Based on the findings, additional fiscal support should be available to educate and guide DNA and legal communities on the review, research, selection, and validation of appropriate methods to account for DNA transfer, persistence, prevalence, and recovery when assessing biological results.[107]

The Commission agrees that substantial investment would be needed to help practitioners understand the scientific foundations of evaluations given activity level propositions. As noted in the *NIST EWG Report on Human Factors in DNA*, "Not all research is equal in quality or is appropriate to use in all situations and circumstances. Those applying the research need an in-depth and critical understanding of interpretation, research design principles, limitations, assumptions, and dependencies to ensure that empirical data is used appropriately to guide and inform evaluations given activity level propositions."[108] As also noted in the *NIST DNA Mixture Foundational Review Draft*, "there is a growing body of knowledge about DNA transfer and persistence, *but significant knowledge gaps remain*."[109]

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[107] *NIST EWG Report on Human Factors in DNA at* 182.
[108] *Id.* at 180.
[109] The Commission acknowledges the incorporation of evaluative reporting given activity level propositions in parts of the EU, UK, and Australia is not without criticism; however, for purposes of this report we assume the proper functioning of the various safeguards presented in *Taylor and Kokshoorn*, *Forensic DNA Trace Evidence Interpretation* (2023), *supra* n. 23 at Chapter 11.

Additionally, as stated in the *NIST EWG Report on Human Factors in DNA*, "[f]orensic science methods must be shown to be reliable, reproducible, and accurate, both at a foundational level and within each individual laboratory. Evaluations given activity level propositions are no different. Prior to implementation within an FSSP, internal validation studies must be performed to demonstrate that the established method and the trained analysts are able to produce reliable results."[110]

Per Taylor and Kokshoorn, "[t]here is no specific cut-off or delineation at which a study becomes too different to the case circumstances in order to use."[111] Absent specific guidance, education and training on what type of data and/or how much data are sufficient to allow an expert to assign probabilities during an evaluation given activity level propositions, challenges regarding the data utilized in the case are entirely dependent upon defense counsel's ability to access, review and understand the cited literature, and find an expert who can ask the right questions about the extent to which it should be relied upon given the case circumstances. As noted by Biedermann et al., ". . . the critical issue is disclosure of data and making it available early enough in the process in order to allow for a proper consideration by the defense."[112]

Given the absence of guidance in the United States on what constitutes sufficient data for an evaluation given activity level propositions, the Commission believes the United States (including federal, state and local partners) should work collaboratively with ENFSI and/or ISFG to invest the necessary resources to assess the scientific foundation of published research on TPPR

[110] *See*, *NIST EWG Report on Human Factors in DNA* at 181. It is also essential that FSSPs attempting to implement procedures for evaluations given activity level propositions monitor their competent application.
[111] Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023), *supra* n. 23 at 172, Box 5.1.
[112] *See, e.g.,* A. Biedermann, C. Champod, G. Jackson, P. Gill, D. Taylor, J. Butler, N. Morling, T. Hicks, J. Vuille, F. Taroni, *Evaluation of Forensic DNA Traces When Propositions of Interest Relate to Activities: Analysis and Discussion of Recurrent Concerns*, Front Genet. 2016 Dec 12; 7:215. doi: 10.3389/fgene.2016.00215. PMID: 28018424; PMCID: PMC5149526.

and articulate what a proper method (and related method validation) would look like for evaluations given activity level propositions. As stated in the *NIST EWG Report on Human Factors in DNA*, "[t]argeting research at relevant and realistic scenarios is required, so that FSSPs build a greater body of empirical data both for expanding their knowledge and acquiring data on which to base robust evaluations."[113] Without this information—and without an understanding of how to properly apply the knowledge from the literature to casework—the Commission is concerned that testimony in Texas regarding probabilities of evidence given mutually exclusive activity level propositions lacks a consistent and reliable empirical foundation.

The Texas Code of Professional Responsibility for Forensic Analysts and Crime Laboratory Management requires forensic analysts to "base conclusions on procedures supported by sufficient data, standards and controls,"[114] but at this time in the United States, there is a near complete absence of information or guidance for how to adequately assess published data and then reliably assign probabilities (of evidence) considering TPPR given activity level propositions.

Issue #7: Identifying Data Options in the Absence of Published Literature

Internationally, scientists acknowledge that there are not always sufficient data in published literature applicable to the facts of a given case. They incorporate alternative methods for gathering data, including performing experiments in the laboratory to mimic the case scenario and assigning an LR value based on the expert's experience or knowledge.[115] With respect to laboratory research and incorporation of original experiments, the Commission questions whether current resources in

[113] For example, in Europe, experts have worked toward the establishment of a Trace DNA Transfer Rate Repository & Bayes Net to Calculate LRs (Understanding the Transfer of DNA), https://enfsi.eu/projects/monopoly-programmes-mp/mp2020.
[114] *See*, Tex. Admin. Code at 651.219(b)(8) which may be accessed at the following link: https://texreg.sos.state.tx.us/public/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=37&pt=15&ch=651&rl=219
[115] *See,* Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023), *supra* n. 23 at 169.

U.S. forensic laboratories could even come close to providing an opportunity for laboratories to conduct original experiments, in part because there are few research, development and validation divisions relative to the number of forensic laboratories. The sheer volume of felony cases and existing forensic biology backlogs suggest it would be extremely difficult, though the incorporation of original experiments is advocated by Taylor and Kokshoorn as the "gold standard" for supporting evaluations given activity level propositions, because they can be set up to "mimic the case circumstances as closely as possible within the bounds of ethical science and practicality."[116] In this case, it would not have been possible at a practical level for Dr. Kalafut to perform original experiments because the State first contacted him at the beginning of a twelve-day trial. The literature advocating the incorporation of original experiments as the "gold standard" does not contemplate such a rushed scenario.

In the absence of either original experiments or published data, international experts suggest that analysts trained in evaluations given activity level propositions may use their own "calibrated" experience or knowledge of TPPR as the basis for assigning probabilities.[117] Often, the "information used to assign the probability will fall somewhere between these extremes when some [published] data is available, but an experience-based numerical adjustment must be made for the fact that it does not exactly align with some aspect of the evaluation."[118] Where part of the basis for the LR opinion is professional experience, stated in the form of expectations, it is

[116] *Id.* at 169. The Commission understands based on discussions with international experts that original experiments are often not performed in practice due to resource limitations; however there appears to be a consensus that it is the preferred approach when possible.
[117] *See*, *ISFG 2020 Guidelines*, Section 7.1 at 8.
[118] *See*, Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023)*, supra* n. 23 at 169.

important to clearly articulate what aspect of the assessment is attributable to the cited studies and what is attributable to experience.[119]

The literature is clear that regardless of whether the expert uses published data, laboratory experiments, personal experience, or some combination of these methods for assigning probabilities, *transparency is crucial*. If an expert is unable to provide a detailed justification to substantiate the evaluation, it is a sign that such an evaluation may not be appropriate given the case facts. On the subject of "source of knowledge" and transparency, ISFG states:

> Whenever possible, relevant published data should be used. The source of the knowledge should be disclosed, and the limits of the data discussed. In the absence of published data, calibrated[120] experience, case tailored experiments, or peer consultation can be used. In any case, the use of the data needs to be justified and the expert should be transparent on the limitations of the data.[121]

Similarly, the *ENFSI Guideline for Evaluative Reporting* states:

> The forensic practitioner should not mislead the recipient of expert information as to the basis of the personal assignment, and the extent to which the assignment is supported by scientific research.[122]
>
> Requirement for disclosure: …. experience or knowledge may be used. All bases used should be disclosed.[123]
>
> ...personal probability assignment is not arbitrary or speculative but is based on a body of knowledge that should be available for auditing and disclosure.[124]

[119] Kokshoorn and Luijsterburg reported a retrospective analysis of 74 requests for formal evaluative opinions on the probability of case findings given propositions at the activity level at the NFI. Over half (57%) of the reports included one or more probability assignments that were based on expert opinion only, with relevant data not being available from peer reviewed studies or other sources. Kokshoorn B, Luijsterburg M. *Reporting on Forensic Biology Findings Given Activity Level Issues in the Netherlands.* Forensic Sci Int. 2023 Feb;343:111545. doi: 10.1016/j.forsciint.2022.111545. Epub 2022 Dec 29. PMID: 36634430.
[120] *Id*.
[121] *See, ISFG 2020 Guidelines, supra n. 13* at 7.1 (p. 8).
[122] *See*, *ENFSI Guideline for Evaluative Reporting* at 16.
[123] *Id.* at 22.
[124] *Id.* at 16.

Issue #8: Should Numerical Likelihood Ratios Be Required?

Even among countries in which evaluative reporting given activity level propositions is more common, there is disagreement about whether it is appropriate to assign "notional" probabilities (*i.e.,* a verbal qualifier used to convey the value of results given propositions that addresses the basis for the assignment qualitatively) or whether a numerical LR should always be assigned and reported. Again, the *ISFG 2020 Guidelines* (and the *ENFSI 2022 Best Practice Manual*) state the scientist should report a numerical likelihood ratio.

Some experts believe that regardless of the scenario, when it comes to evaluations of DNA results given activity level propositions there is no excuse *not* to assign an LR (even if derived manually). Others believe a qualitative expression is sufficient.[125] A similar disagreement is observed among end-users (attorneys and judges). While some believe that a numerical LR provides a more robust basis from which to understand and challenge an expert's opinion on the strength of the evidence given activity level propositions, others assert that the basis for assigning the LR is fundamentally subjective (even more so given activity level propositions than with sub-source level propositions) and assigning a numerical value obscures this fact and gives the false appearance that the evaluation is more precise (and less personal) than it truly is. Regardless of the ultimate decision on this subject, there appears to be consensus that "LRs given activity level

[125] *See, e.g.,* Charles E.H. Berger, John Buckleton, Christophe Champod, Ian W. Evett, Graham Jackson, *Evidence Evaluation: A Response to the Court of Appeal Judgment in R v. T*, Science & Justice, Vol. 51, Issue 2 (2011), challenging the implication of the appellate decision in the case "as it implies that a likelihood ratio may not underpin the evaluation of a forensic scientist unless the two key probabilities can be assigned by purely statistical methods," at 43-49. *See also,* "The data provided above cannot be directly converted into precise probabilities, but it is reasonable to support broad probabilistic ranges summarized in tabular form: we can potentially assign subjective probability ranges based on symmetric quantiles, where very low is described by Pr < 5%; low describes Pr = 5-25%; medium describes Pr = 25-75%; high describes Pr = 75-95%; very high describes 95-100%. The wide choice of ranges reflects the uncertainty inherent in the data sets." Gill, Peter, *Misleading DNA Evidence* (2014) at 77.

propositions are typically many orders of magnitude lower than those calculated given sub-source level propositions."[126]

With respect to reporting of DNA comparisons given sub-source level propositions, existing guidance in the United States is clear: an expert may report a verbal equivalent expressing the value of the findings, but the verbal equivalent may not be reported *in lieu of* the likelihood ratio.[127] If the United States ultimately moves forward with integrating evaluations given activity level propositions, the DNA community at the national level will need to consider whether a numerical LR should be required when reporting the evaluation of the findings accounting for the possibility of direct and indirect transfer, as it is with reporting the value of DNA comparisons. The question then becomes which entity (or group of entities) is the appropriate authority to make this determination. The Commission believes that much can be learned from the work of Ian Evett, Duncan Taylor, Bas Kokshoorn, Tacha Hicks, Alex Biedermann, and other experts (this is a non-exhaustive list) but questions regarding numerical likelihood ratios versus qualitative or "notional" probabilities are far from settled in the United States and elsewhere.

Finally, the Commission observes that regardless of the ultimate answer on numerical versus qualitative reporting of likelihood ratios, it is clear that in order for one to truly be an expert in this area, one must have a deep understanding of the factors that must be considered to robustly evaluate the results given activity level propositions. As previously stated, evaluations may be performed manually by deriving LR formulae or by building a Bayesian network. In the *Forensic*

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[126] *ENFSI 2022 Best Practice Manual* at Section 13.

[127] *See*, Recommendations of the *SWGDAM Ad Hoc Working Group on Genotyping Results Reported as Likelihood Ratios* p.2 Recommendations 1.1 and 1.2. https://www.swgdam.org/_files/ugd/4344b0_dd5221694d1448588dcd0937738c9e46.pdf; *ENFSI Guideline for Evaluative Reporting*, *supra* n. 13 at item 3.14, p. 10; *NIST EWG Report on Human Factors in DNA*, *supra* n. 13 at p.155.

DNA Trace Evidence Interpretation (2023), Taylor and Kokshoorn describe the Bayesian network as follows:

> A potential solution to having to manually derive complex LR formulas is the use of a tool known as a Bayesian network (also sometimes called a belief network, or a directed acyclic graph). Bayesian networks are a graphical tool that represent probabilistic relationships and dependencies by the use of symbols and arrows. In this way a Bayesian network is similar to the pathways of transfer that were used in the LR derivations of the previous chapter.[128] Unlike those pathways, BNs have tables of probability that underpin each factor, thereby allowing for a more formal and structured form.[129]

The act of building of a Bayesian network forces a rigor of thinking and transparency in lines of analysis. The Commission maintains that no expert should perform (or testify to) evaluations given activity level propositions without extensive education and additional training beyond what is required to be an expert in DNA analysis and DNA profile comparison. This training must incorporate foundational knowledge and practical exercises consisting of manual derivations of LR formulae and constructing Bayesian networks. Even a cursory review of the University of Lausanne (UNIL) syllabus on Advanced DNA Interpretation shows this is a major component of international training on this topic.[130]

The need for this training is clear *regardless* of whether an expert ultimately chooses to utilize a manually derived LR or Bayesian network in any given criminal case scenario, and *regardless* of whether the DNA community in the United States ultimately supports the use of numerical or qualitative expressions of biological results given activity level propositions.

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[128] The reference to the "previous chapter" is to Chapter 5 of *Forensic DNA Trace Evidence Interpretation* (2023), by Taylor and Kokshoorn.
[129] *See*, *Taylor and Kokshoorn Forensic DNA Trace Evidence Interpretation* (2023)*, supra* n. 23 at 178.
[130] https://www.formation-continue-unil-epfl.ch/en/formation/advanced-dna-interpretation/?utm_source=Brochure&utm_medium=Brochure&utm_campaign=Brochure

Issue #9: What Education and Training Should Be Required?

As previously stated, the education and training required for evaluating DNA comparisons is not the same as the education and training required to perform an appropriate evaluation of DNA results given activity. Currently, the only source for education including university-level credit hours on the subject is an extensive 13-month course (with an estimated average workload of 4 hours per week) offered virtually by UNIL.[131]

In contrast, in the United States, there have been a series of workshops, some of which span a day or two, offered to DNA analysts at conferences or annual meetings. *It is impossible to overstate just how insufficient this level of exposure is,* and faculty who offer these workshops should clearly communicate that attendance at the workshop *is an inadequate basis for performing evaluations given activity level propositions in actual forensic casework.* If NIST (or another federal agency) performs a foundational review of TPPR literature that charts a path forward on method development and validation in this area for U.S. DNA experts, standards developing organizations in the United States (such as the Academy Standards Board (ASB) via the OSAC Human Forensic Biology subcommittee) must directly address the level of education and training that would be needed for DNA analysts in the United States to begin offering evaluations given activity prepared in advance of trial as set forth in international guidance documents on the subject. The Commission recognizes that some DNA analysts may never perform this analysis or testify to the evaluation,[132] but if any ultimately do, the education and training path must be robust and

[131] UNIL Website: https://www.formation-continue-unil-epfl.ch/en/formation/advanced-dna-interpretation/?utm_source=Brochure&utm_medium=Brochure&utm_campaign=Brochure

[132] As discussed earlier in this report, to the extent DNA analysts respond to questions regarding the "possibility of transfer" in a given case, they are in fact testifying about TPPR (perhaps without realizing it, *see, e.g.,* Mr. Quartaro's testimony in this case) just not performing an intentional or formal evaluation. The potential risks of this approach (particularly with respect to "carrying over" sub-source LR's to activity in a way that could be misleading to criminal justice partners) are discussed earlier in this report. *See also, Biedermann et al., Evaluation of Forensic DNA Traces When Propositions of Interest Relate to Activities: Analysis and Discussion of Recurrent Concerns*, Front Genet. 2016 Dec 12;7:215. doi: 10.3389/fgene.2016.00215. PMID: 28018424; PMCID: PMC5149526.

clearly articulated in a consensus standard. For example, in Taylor and Kokshoorn's book,[133] the following "core activities" are articulated:

- Autosomal and YSTR DNA interpretation. This includes both high and low-template samples, single source and mixed DNA profiles.

- Probabilistic genotyping to assess the weight of the evidence. The expert is able to set appropriate propositions and apply a proper statistical model to the data. The expert should be able to defend the decisions made and should be able to explain the workings of the model in general terms. The expert is not expected to be able to have access to, or to have knowledge on the workings of, the source code of the software used. This falls within the domain of the forensic statistician.

- Probabilistic assessment of associations with uncertain cell type evidence and/or non-gender specific markers like saliva or blood that require thorough understanding of Bayesian inference.

- Case assessment. The expert is able to discuss the relevant issue with the mandating authority and is able to structure case information in relevant propositions, assumptions, and undisputed case information. The expert is able to communicate limitations, for example if no reasonable assessment is possible due to lack of information. The expert is able to translate a case assessment based on the case information into an examination strategy.

- Statistical modeling. The expert is able to set up a proper model, *e.g.,* a Bayesian Network, to calculate a likelihood ratio based on probabilities of transfer persistence, prevalence, background, and recovery of biological materials given the relevant propositions and findings in the case. As part of this the expert is able to construct a Bayesian network if needed (*e.g.,* with multiple findings that are conditionally dependent or when cell type is at issue). The expert must be able to express the limitations of modelling decisions.

- Assigning probabilities. The expert is able to assign probabilities to the transfer, persistence, prevalence, background, and recovery of biological material given the propositions, assumptions, and case information. Experts must be able to make the boundaries of their knowledge explicit. The source on which the assignment of probabilities is based should be transparent (*e.g.,* expert elicitation, case file data, published studies, case specific experiments).[134]

[133] *See*, *Taylor and Kokshoorn Forensic DNA Trace Evidence Interpretation* (2023)*, supra* n. 23 at 403-404.

[134] Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023), *supra* n. 23 at 403-404.

In support of these activities, DNA scientists who wish to be listed in the National Registry of Experts (NRGD)[135] in the "activity field" of forensic DNA interpretation must meet the following specific requirements in addition to the various basic requirements of a DNA expert:

- Have interpreted and reported on (the value of DNA comparison given) Source Level (propositions) on at least 25 single source and/or complex and/or mixed DNA profiles divided over a minimum of 5 case requests in the past 5 years that have been subjected to collegial review and/or supervision or be registered as a Source Level or Kinship Analyst expert;

- Have interpreted and reported on at least 5 cases containing propositions on activity level in the past 5 years that have been subjected to collegial review; In case the applicant is also acting as a supervisor, at least 3 cases containing propositions on activity level should be independently interpreted and reported on.[136]

The expert is also required to submit a file containing a number of relevant cases, as well as documentation demonstrating the competencies listed above to an independent panel of scientists and legal professionals.[137] The panel then assesses the competency of the experts based on the file and live questioning if deemed necessary by the competency testing advisory board.[138] Once approved, the expert is listed on a Registry of Experts for a period of five years, at which point they can apply to be re-listed and must undergo the same competency assessment process again.[139]

The Commission observes that while the approach ultimately taken in the United States may look different that the approach currently underway in the Netherlands, the level of training, experience and competency testing required should be commensurate with the solemnity of the task when one considers the potential impact of these evaluations on life and liberty. At the current

[135] https://english.nrgd.nl/fields-of-expertise/dna-analysis-and-interpretation
[136] *Id.* at 404.
[137] *Id.*
[138] *Id.*
[139] *Id.*

time, no organization with authority (regulatory or otherwise) in the United States has articulated the minimum training and education standards needed for evaluations given activity level propositions. There is no Registry of Experts and/or competency testing program similar to what exists in the Netherlands and other countries where this type of assessment and related testimony is regularly offered. At a minimum, standards developing organizations in the United States (such as the ASB via the OSAC Human Forensic Biology Subcommittee, SWGDAM, and accrediting bodies (or some combination thereof)) would need to articulate these requirements for the United States before individuals could proceed down this path. As stated in the *NIST EWG Report on Human Factors in DNA*, "[t]here is a critical and pressing need to educate FSSPs and DNA analysts about DNA-TPPR issues so that all parties recognize when they may be straying outside their lane of expertise—both scientifically and professionally."[140]

Issue #10: What Quality Assurance Measures Should Be Required?

Applicable international guidance includes numerous quality assurance measures that were not in place in this case. For example, competency testing, relevant ongoing proficiency testing, auditing, testimony monitoring, "collegial" (*i.e.,* technical) review, methods for mitigating cognitive bias such as through case management, and the development of standard operating and reporting procedures are all described as vital. Indeed, Taylor and Kokshoorn assert that accreditation will play an important role in the implementation of evaluations given activity level propositions. In particular, they reference the need for FSSPs to have a quality assurance system in place including standard operating procedures that govern the evaluations of findings given

[140] *See*, *NIST EWG Report on Human Factors in DNA* at 179.

activity level propositions. The procedures an expert uses for performing evaluations "need to be documented and will be part of the accreditation of the laboratory."[141]

Even in scenarios where the assessment given activity level propositions by an expert outside of an accredited laboratory setting is deemed admissible by the court, the Commission maintains that certain elements of accreditation should be borrowed by these experts, as discussed in the recommendations below. For example, an expert can adopt a reporting protocol without being accredited. Depending on the circumstances, he or she may also integrate other quality assurance measures such as periodic proficiency testing, technical review, and tools for mitigating cognitive bias.

IV. SUMMARY OF OBSERVATIONS

The complainant alleges that Dr. Kalafut's activity level analysis and testimony departed from "established best practices," including:

- preparing a written report;
- researching relevant literature;
- assigning probabilities based on the literature;
- delineating the specific studies relied upon in formulating an opinion; and
- selecting balanced propositions.

With respect to the first item, this case would have been better served by—and indeed international guidance clearly calls for—a written report. While the prosecutor is responsible for assessing what information needs to be provided to the defense, it is the scientist's obligation to inform the prosecutor that a written report is a cornerstone of all international guidance on the subject of evaluative reporting given activity, especially when it is that very guidance the expert

[141] *See*, Taylor and Kokshoorn, *Forensic DNA Trace Evidence Interpretation* (2023) at 407. While the Commission is currently unaware of activity level reporting being expressly delineated on the scope document of any U.S. laboratory's accreditation, the role of accreditation (and in Texas, licensure) in assessing evaluations at the activity level will need to be addressed if the United States is to move forward with probabilistic activity level evaluation and reporting.

relies on in support of the evaluation. Without this information, the attorney will respond to questions regarding whether a report is needed in reliance on his or her knowledge of legal procedural rules alone.

Second, while Dr. Kalafut cited three studies to inform his evaluation, there is genuine disagreement regarding what quality and quantity of literature would be sufficient to support the testimony offered here. This reflects a gap in the current state of research (and related knowledge) in the United States when it comes to evaluations given activity level propositions. The Commission recognizes that different experts may have different opinions on how much data is "enough." However, none of the studies cited by Dr. Kalafut involved the actual activity at issue in this case—the movement of a bicycle—and at no point did the evidence reconciliation document describe why the three studies cited would be appropriate for extrapolation to the activity in question. To the extent a written evaluation occurred in the form of the document titled, "evidence reconciliation document," it lacked the traceability one would hope to observe in an evaluation of findings given activity level propositions. In other words, it is difficult to trace statements in the "evidence reconciliation document" and related testimony back to the underlying data cited and/or related training and experience.

With respect to assigning probabilities based on the literature and delineating the specific studies relied upon in formulating an opinion, Dr. Kalafut's report did not articulate any underlying formula for how he assigned the probabilities he assigned. As described in ENFSI and ISFG guidance, the Taylor/Kokshoorn book and the UNIL sample report, the development of the formula/model (or alternatively, a Bayesian network) should be done first, and the calculations/qualitative expression of probability second (if they are even able to be done). This process allows a second reviewer and/or defense expert to conduct certain checks of coherence

and plausibility, including the review of conditional independence assumptions (because of the hierarchical/cascaded nature of the events being modeled) and the application of the rules of probability.

Finally, the H2 "proposition" in the evidence reconciliation document was not a proposition but rather a combination of explanation, case information and DNA findings. Dr. Kalafut appears to misunderstand what constitutes a well-formulated proposition. The prosecutor may provide the case information but ideally the scientist works with the prosecution (and defense *if* they choose to participate) to elaborate on this information and formulate the propositions that concisely specify the mutually exclusive *activities*. Instead, Dr. Kalafut's H2 proposition included both explanations and DNA findings in a circular manner, a practice strongly discouraged in the applicable international guidance.

This case also highlights the need for forensic analysts (including defense experts) to understand the hierarchy of propositions framework, what their role is (and is not) under that framework, and the risk that likelihood ratios at the sub-source level will be "carried over" in the minds of the legal end-user to questions regarding activity (*i.e.,* how or when the DNA was deposited). These are all foundational concepts that would need to be understood before forensic scientists in the United States could incorporate evaluative reporting given activity level propositions. Otherwise, there is a serious risk we will replace one less-than-desirable approach (answering hypothetical "is it possible" questions about activity without sufficient basis) with another (ad hoc pseudo evaluations lacking traceability and transparency).

The DNA community is at a crossroads with respect to DNA traces and how to properly assign them value in the context of alleged activities (*e.g.,* questions about how or when the DNA was deposited). The Commission recognizes there may be situations in which the scientist needs

to say something about the results considering TPPR to avoid misunderstanding, but there is currently a lack of established (and validated) methodology, training and quality system infrastructure that would allow analysts to do this properly and consistently. This lack of foundation could lead to overstatements based upon what analysts have seen or think they know ("intuition") as opposed to what can be justified through a rigorous evaluation.

V. RECOMMENDATIONS

Acknowledging the challenging realities of the current environment, the Commission includes recommendations in the following subject areas:

(1) Appropriate responses to hypothetical questions regarding activity in a case (*see* accreditation checklist item below);

(2) Evaluating foundational basis of evaluations given activity level propositions;

(3) Education/training; quality control; reporting/testimony; and

(4) Expectations for experts outside of accredited laboratories testifying in Texas.

The first four recommendations below address foundational questions. The Commission believes this work needs to be done in the order presented below (*i.e.*, attention to foundational questions comes *before* the other items). As referenced throughout this report, NIST has dedicated significant and extensive resources to various aspects of forensic DNA interpretation. However, NIST is not a regulatory body and has no oversight authority with respect to the practitioners and entities performing forensic analysis and testifying on a daily basis. Due to the high throughput nature of operational forensic laboratories in the United States, it is challenging for even the most well-resourced laboratories to implement many of the observations and suggestions contained within NIST's extensive body of work, including the OSAC Registry of Standards.

The Commission observes that while many forensic scientists in Texas follow and understand the basis for the critiques and areas of improvement highlighted by NIST in much of

the agency's work, there is a significant gap between what NIST publishes and the ability of operational laboratories to respond effectively to those publications. In other words, shining light on a problem—even when accompanied by proposed solutions—is not the same as fixing it. Effectively addressing many of the issues discussed in this and other reports will require sustained and collaborative effort and dedicated resources at the federal, state and local level, ideally with input from international bodies such as ISFG, ENFSI or both.

To achieve the greatest possible impact, direct partnership between agencies with subject matter expertise such as NIST, ISFG/ENFSI (if possible), and states with forensic oversight bodies like Texas would be a significant collaborative step forward.[142] Following are recommendations regarding areas the Commission believes represent a logical next step for foundational issues in the area of interpretations and reporting given activity level propositions:

1. With respect to the published literature on TPPR, agencies with research expertise responsibility (such as NIST, ISFG/ENFSI etc.) should conduct a scientific foundational-type review including a public comment phase, to evaluate and report on the state of published literature and offer recommendations.[143]

   However, unlike prior NIST scientific foundational reviews (and more akin to the approach in the human factors series), the author group for this report should include a diverse group of criminal justice partners including legal, statistics and human factors experts, particularly those who have studied the impact of different types of expert testimony on judges and juries. It is essential to understand the interface between criminal proceedings and the scientific evidence proffered.

   The work of this group review should include, at a minimum, the following subject areas:

   - Principles in TPPR and a framework for assessing TPPR literature for purposes of assigning probabilities considering TPPR factors.

[142] A possible resource for state-level coordination would be the newly formed *National Association of Forensic Science Boards*. https://www.nafsb.org/

[143] ENFSI has allocated a substantial amount of funding for labs to collaborate on transfer experiments (*See*, ReACT projects 1 and 2): https://enfsi.eu/projects/monopoly-programmes-mp/mp2020/

- To the extent shortcomings in published data on TPPR exist—and acknowledging there is no such thing as a perfect body of empirical research—guidance on appropriate study design and related issues.

- A survey of the similarities and differences in legal systems where evaluations given activity level propositions are performed including: (a) foundational concepts; (b) roles and responsibilities of parties and experts; and (c) procedural rules, and the potential impact of these issues on the successful communication of evaluations to end-users.

- An evaluation of whether numerical likelihood ratios (derived manually or using Bayesian networks or other similar tools) are essential components of scientific reporting when DNA evaluations given activity level propositions are performed. If qualitative likelihood ratios are permitted (without a numerical LR), an appropriate framework and limitations should be developed.

- Guidance on what would constitute an appropriate method (and adequate internal validation of the method) used to ensure competent application of evaluations given activity level propositions; this guidance should be articulated through clear, specific and robust OSAC Registry standards or other appropriate documents.

Assuming a foundational basis could be established to allow evaluations given activity level propositions *and* reporting and testimony on this topic could be integrated in the work of Texas laboratories, the Commission makes the following recommendations with respect to implementation in the areas of education, training, quality assurance, reporting, and testimony. Clear, specific and robust standards must be articulated by the Commission in collaboration with the work of the OSAC DNA Human Forensic Biology subcommittee (with a near-term goal of publishing at least a technical guidance document) including but not limited to the following areas:

1. Education, training, and experience needed to be qualified as an expert;

2. Specific guidance for effective method validation at operational laboratories;

3. Quality control measures including but not limited to competency and proficiency testing (established in collaboration with the accrediting bodies);

4. Components of an effective report;

5. Guidelines for and limitations of testimony;

6. Education and training needed for lawyers and judges.

The Commission emphasizes again that efforts in this area must include the active participation and engagement of end-users with legal, statistics and human factors expertise (specifically those with expertise on juror understanding of scientific testimony). The interface between end-users and scientists is critically important to prevent misunderstanding and misuse of evidence. Indeed, the fundamental differences in legal systems referenced briefly in this report would require close examination.

Due to the foundational nature of the above recommendations and the extended period expected to implement them, the Commission advises that all Texas FSSP's adopt a policy similar to the one outlined below in the interim. This recommendation observes the principle that while scientists may discuss scientific background knowledge to aid the factfinder, they should not give an opinion on what is the "most likely way of transfer" in a case (direct or indirect) as this amounts to opining on the activities themselves. While the language need not be copied verbatim, a concept similar to this language should be adopted by all FSSP's. **The Commission will request that ANAB and A2LA add this item to the Texas accreditation checklist for assessments of forensic DNA laboratories beginning July 1, 2025:**[144]

> When asked hypothetical questions that require the consideration of transfer, persistence, prevalence, and recovery (TPPR) testifying witnesses should endeavor to communicate that the DNA comparison results (or lack thereof) do not answer the questions of "how" or "when" DNA was deposited or speak to its absence. Such testimony could potentially lead to evidence being misleading, overvalued, or undervalued.
>
> Whenever possible, testifying experts should reiterate that while they may be able to provide limited general information about TPPR, answering questions about how or when the DNA was deposited (or is absent) in the particular case, is outside the

[144] The Commission will consult with the Texas Association of Forensic Quality Managers and Texas Association of Crime Laboratory Directors as well as ANAB and A2LA and may adjust the date as needed to facilitate compliance.

testifying witness' purview. To help address questions about how or when the DNA was deposited in the case, a separate evaluation would be needed.

DNA analysts may consult Table 1 referenced earlier in this report and excerpted from the *NIST EWG Report on Human Factors in DNA* for ideas on how to respond to common questions, and the Commission will continue to meet with Texas DNA technical leaders to discuss the best way to support laboratories on these issues.[145]

Finally, with respect to both licensed DNA analysts *and* experts operating in Texas outside of an accredited laboratory setting—and acknowledging the Court of Criminal Appeals has yet to determine whether evaluations given activity level propositions must be performed in an accredited laboratory setting to be admissible under article 38.35 of the Code of Criminal Procedure—the Commission recommends the following:[146]

(1) To the extent applicable, follow the principles set forth in the Texas Code of Professional Responsibility for Forensic Analysts and Crime Laboratory Management. The Code sets general expectations for sound and professionally responsible scientific practice;

(2) Obtain education and training at the level discussed by Taylor and Kokshoorn in *Forensic DNA Trace Evidence Interpretation* (2023), *before* offering services as an expert in an evaluation of biological results given activity level propositions.

(3) Issue a written report containing balanced, logical, transparent and robust evaluations, being clear about their assumptions and the (statistical) model used to assign probabilities;

(4) Provide traceability of analysis by clearly articulating the source of knowledge for assigning probabilities, including limitations of those sources of knowledge;

[145] The sample policy language was taken in part from the University of North Texas Center for Human Identification Quality Assurance Manual, Policy 031 "Testimony Preparation and Testimony," DOC ID 47332 (September 20, 2023). The Commission intends to continue and expand discussions on this subject during periodic training programs sponsored for Texas DNA technical leaders.

[146] The question of whether activity level assessments must be performed by an accredited laboratory to be admissible under Tex. Code Crim. Proc. art. 38.35 is a question of statutory interpretation falling within the ultimate jurisdiction of the Texas Court of Criminal Appeals ("CCA"). Admissibility decisions are determined at the trial court level on a case-by-case basis pursuant to article 38.35, the Texas Rules of Evidence and related caselaw, and may be appealed (if timely raised). The ultimate arbiter of these questions is (and always will be) the CCA.

(5) Communicate to lawyers that transparency (including a written report and the other items outlined in ISFG and ENFSI documents referenced here) is a cornerstone of international guidance on evaluative reporting given activity level propositions, especially where those documents are cited as the scientific basis for performing the evaluation;

(6) To the extent possible, integrate periodic proficiency testing, technical review, methods for mitigating cognitive bias, and other elements of a quality system found in accredited laboratories;

(7) Decline to offer ad-hoc pseudo evaluations on the stand by following the *ENFSI 2022 Best Practices Manual* on how to respond in circumstances where additional information would be needed to provide a proper evaluation.

Upon adoption of this report, the Commission will consult with NIST (and other state, federal and/or international partners as appropriate) for assistance in implementing the foregoing recommendations and update Texas stakeholders accordingly.

EXHIBIT A

TEXAS FORENSIC
SCIENCE COMMISSION
Justice Through Science
1700 North Congress Ave., Suite 445
Austin, Texas 78701

TEXAS FORENSIC SCIENCE COMMISSION COMPLAINT FORM

Please complete this form and return to:

Texas Forensic Science Commission
1700 North Congress Avenue, Suite 445
Austin, Texas 78701
Email: info@fsc.texas.gov
[P] 1.888.296.4232
[F] 1.888.305.2432

The Texas Forensic Science Commission ("FSC") investigates complaints alleging professional negligence or misconduct that would substantially affect the integrity of the results of a forensic analysis conducted by an accredited crime laboratory. The Commission also has jurisdiction to investigate non-accredited forensic disciplines and non-accredited entities under more limited circumstances, such as to make observations regarding best practices or for educational purposes. (For a comprehensive review of the Commission's jurisdiction, please refer to Tex. Code Crim. Proc. 38.01 as amended by Tex. S.B. 1238, 83rd Leg., R.S. (2013)).

Please be aware that the FSC investigates allegations involving "forensic analysis." This term includes any medical, chemical, toxicological, ballistic, or other expert examination or test performed on physical evidence, including DNA evidence, for the purpose of determining the connection of the evidence to a criminal action.

However, the term "forensic analysis" does not include the portion of an autopsy conducted by a medical examiner or other forensic pathologist who is a licensed physician. **Please be advised that if you submit a complaint regarding the results of an autopsy, it is highly likely your complaint will be dismissed.** (Note: the forensic testing done in connection with an autopsy, such as toxicology, is included within the Commission's jurisdiction even though the autopsy itself is not.)

The FSC will examine the details of your complaint to determine what level of investigation to perform, if any. All complaints are taken seriously. Because of the complex nature and number of complaints received by the FSC, we cannot give you any specific date by which that review may be completed.

If the criteria for an investigation are met, the FSC will send a letter to the laboratory/facility and/or individual(s) named in the complaint indicating that the FSC has received the complaint. The FSC will then request a response from the entity and/or individual who is the subject of the complaint. We may also need to obtain additional information from you.

If the criteria for an investigation are not met or the FSC declines to investigate further, you will receive a letter from the FSC.

The Commission's statute allows it to withhold from disclosure information submitted regarding a complaint until the final investigative report is issued. **However, after a report is issued, all information and complaints are subject to public disclosure under the Texas Public Information Act (Texas Government Code Chapter 552).**

You may submit a complaint without disclosing your identity. However, the FSC cannot guarantee your anonymity. Also, please note that filing a complaint without disclosing your identity may impede the investigation process, especially if our ability to contact you is limited.

Your cooperation, patience and understanding are appreciated.

1. PERSON COMPLETING THIS FORM

Name: Tiffany Roy
Address: [redacted]
City:
State: [redacted] Zip Code: [redacted]
Home Phone: [redacted]
Work Phone:
Email Address *(if any)*: [redacted]

2. SUBJECT OF COMPLAINT

List the full name, address of the laboratory, facility or individual that is the subject of this disclosure:

Individual/Laboratory: Dr. Timothy Kalafut
Address: Department of Forensic Science College of (
City: Huntsville
State: TX Zip Code: 77340
Date of Examination, Analysis, or Report: November 1
Type of forensic analysis: DNA Testimony
Laboratory Case Number *(if known)*: TRIAL COURT C

Is the forensic analysis associated with any law enforcement investigation, prosecution or criminal litigation?
Yes ☒ No ☐

* If you answered "Yes" above, provide the following information *(if possible)*:

* Name of Defendant: Kaitlin Armstrong
* Case Number/Cause Number: TRIAL COURT CAU
(if unknown, leave blank)
* Nature of Case: Murder
(e.g burglary, murder, etc.)
* The county where case was investigated, prosecuted or filed: Travis
* The Court: District Court, Travis County, Circuit 403
* The Outcome of Case:

Defendant convict

* Names of attorneys in case on both sides *(if known)*:

FOR THE STATE:

Your relationship with the defendant:

Self	☐	Family Member	☐
Parent	☐	Friend Attorney	☐
None	☒	Other *(please specify)*:	

If you are not the defendant, please provide us with the following information regarding the defendant:
Name: Kaitlin Armstrong
Address *(if known)*:
Home Phone:
Work Phone:

3. WITNESSES

Provide the following about any person with factual knowledge or expertise regarding the facts of the disclosure. Attach separate sheet(s), if necessary.

First Witness *(if any)*:
Name: Matt Quartaro
Address: [redacted]
Daytime Ph
Evening Phone:
Fax:
Email Address: [redacted]

Second Witness *(if any)*:
Name: Elizabeth Duggan
Address:
Daytime Phone:
Evening Phone:
Fax:
Email Address:

Third Witness *(if any)*:
Name:
Address:
Daytime Phone:
Evening Phone:
Fax:
Email Address:

4. DESCRIPTION OF COMPLAINT

Please write a brief statement of the event(s), acts or omissions that are the subject of the disclosure.

Please review the attached transcript of the testimony of Dr. Timothy Kalafut in the matter of TX v. Armstrong.

Dr. Kalafut provides an opinion in this case on the probability of the evidence given proposed activities. His analysis departs from established field best practice that require him to prepare a written report, research relevant literature, assign probabilities based on the literature, delineate on what specific studies he relied on in formulating his opinion, and select balanced propositions.

Expert for the defense, Matt Quartaro, states he recieved no report in advance of this testimony, no basis for the opinions expressed, and was completely unaware a scientist would be called to rebut his testimony. This precluded any notice which could have resulted in scientific and legal scrutiny of this questionable opinion.

This testimony also violates US guidance in publication at the present for addressing Human Factors in Forensic DNA Interpretation.

5. EXHIBITS AND ATTACHMENT(S)

Whenever possible, disclosures should be accompanied by readable copies **(NO ORIGINALS)** of any laboratory reports, relevant witness testimony, affidavits of experts about the forensic analysis, or other documents related to your disclosure. Please list and attach any documents that might assist the Commission in evaluating the complaint. Documents provided will **NOT** be returned. List of attachments:

Transcript of T. Kalafut testimony in TX v. Armstrong
ISFG Guidance
ENFSI Guidance

6. YOUR SIGNATURE AND VERIFICATION

By signing below, I certify that the statements made by me in this disclosure are true. I also certify that any documents or exhibits attached are true and correct copies, to the best of my knowledge.

Signature: Tiffany Roy

Date Signed: 12/1/23

EXHIBIT B

To the Texas Forensic Science Commission:

This is my defense of my role and testimony in *State of Texas v. Armstrong* that resulted a complaint filed by Ms. Tiffany Roy. My expectation is that a full and fair investigation will include reading the testimony of the other experts as well as my own.

I note that since this complaint was filed by Ms. Roy, she has been engaged by Jessica Freud, the new defense attorney in *State of Texas v. Armstrong* (see Appendix 1, new trial motion in *Armstrong*) as the new defense expert (See Appendix 2 for Ms. Roy's affidavit).

I also note that in *Commonwealth v. Richardson* (See Appendix 3 for the recent court decision on motion for new trial), Ms. Roy alerted her LinkedIn connections that she has filed a similar complaint about testimony in Massachusetts. (See Appendix 4 for this complaint.) By her own admission, Ms. Roy was also hired by the defense during the appeal process.

I would ask that the Texas Forensic Science commission (hereafter, TXFSC) consider any conflict-of-interest considerations related to complaints made by an expert that ends up being hired by the defense for post-conviction activities.

Ms. Roy, and by extension, Mr. Quartaro both admit they are not experts in the area of evaluating DNA evidence given activity level propositions. Mr. Quartaro says so directly, and Ms. Roy implies this by putting forward requirements (based on the Netherlands) that also include the successful completion of a specific course offered by the University of Lausanne. This is indeed a very good course. However, one wonders if they are not qualified themselves, how is it possible for them to evaluate my testimony in *Armstrong*? This is an illogical paradigm.

I would ask the TXFSC to consider the complaint made by Ms. Roy as moot, as Ms. Roy has apparently calculated a likelihood ratio for *Armstrong*. In her role as new defense expert in *Armstrong*, she has apparently advised Ms. Freud, the new attorney of record, that:

> The DNA evidence is approximately 100 to 1000 times more likely if
>
> H1 = the DNA of Armstrong ended up on the bicycle of Wilson due to Armstrong removing the bicycle from the apartment of Wilson in an apparent effort to cover up the murder
>
> rather than if
>
> H2 = Wilson wore the helmet (T1) of Strickland a month after Armstrong last wore the helmet, the DNA survived in the helmet after Wilson went swimming after wearing the helmet the first time, after Wilson wore the helmet a second time to go get dinner, but after the third time Wilson wore the helmet the DNA of Armstrong ended up on the hair/head of Wilson (T2), and then when taking off the helmet the DNA got on the hands

> of Wilson (T3) and finally ended upon the bicycle of Wilson (T4) through some unknown activity, as there is no information that Wilson interacted with the bicycle in any fashion after entering the apartment, all while avoiding getting any DNA of Strickland, the habitual wearer/owner of the helmet (who wore it twice earlier that day on a hot, May, Texas afternoon) and who Wilson was in very close physical contact with as the passenger on Strickland's motorcycle and also hugged him goodbye.

Please see Page 14 of Appendix 1 where the Ms. Freud, defense counsel argues:

> "In the ENFSI 2015 guidelines, a verbal scale was established. This scale equates a LR of up to 1,000 as providing "moderately strong support" for the favored proposition. […] This means that Kalafut's testimony should have, at best, said that the evidence lent "moderately strong support" for the State's theory of how Defendant's DNA ended up on the bicycle."

This "moderately strong support" presented by the defense equates to an LR of up to 1000, as the defense has used the verbal scale provided by ENFSI [1] in their motion. (See Page 64 of [1]) Note that the defense has provided an LR that offers more support than "slight/limited support" and also more than "moderate support".

This means that both Ms. Roy and I agree that the evidence supports H1 more than the alternate H2 proposition. I have no quarrel if Ms. Roy wants to place the magnitude of the LR between 100 and 1000. I chose not to give a numerical LR, which is addressed in the attached copy of my case file, but I would accept this LR offered by the defense. This is no different than one software such as STRmix calculating a different LR than TrueAllele or EuroForMix for sub-source propositions related to "Whose?" DNA might it be.

If Ms. Roy claims that this LR of 1000 somehow is *not* her LR, then I propose an alternative potential solution to this complaint. Now that Ms. Roy is indeed the defense expert in this case, she presumably has access to everything necessary for her to calculate an LR. Since she is now and expert, given her coursework since March, she should be able to perform this calculation.

However, in expectation that the complaint is not dismissed due to the reasons I give above, I will provide my comment below.

If the TXFSC determines that *the framework of* my testimony is problematic, I am unsure of how to move forward[1]. It is patently obvious that that "transfer" testimony is indeed dealing with activity level propositions. This bell has been rung, and I am unsure how to walk back this type of expected testimony. The language most usually used in current testimony about "secondary transfer is possible" is universally condemned by probability experts as offering no value and is incorrect.

[1] I accept that others may have a different opinion about the evidence. If this weren't so, there would be no cross examination.

I urge the TXFSC to consider the position all parties would find themselves in at court should DNA testimony be limited to "All I can say is the defendant cannot be excluded" when asked questions about how the DNA may have ended up on an item of evidence.

There is no middle ground; either DNA testimony should be limited to sub-source issues only, or the community needs to move forward and offer testimony on the probability of the evidence given (at least) two competing propositions, based on actual activities of interest, that have been formulated by an expert based on specific case information. This process of moving forward will take time and effort, and there will be growing pains. But this is the only way to address what is of interest in almost every DNA case – "How did the DNA get there?"

Allegations made by Tiffany Roy:

The complaint by Ms. Roy seems to be sourced from an email she received from the defense expert, Mr. Quartaro based on an unattributed "tweet". (See below.) I point out that neither Ms. Roy nor Mr. Quartaro observed any portion of my testimony.

Ms. Roy makes written claims, both in an email to me and the TxFSC that are demonstrably false. I provided written materials to the prosecution. It is not my duty to inform anyone about any testimony or report.

I point out that there was a total of six (6) defense attorneys in the record, and the defense did *voir dire* me in court record.

Attached you will find a series of threatening emails from Ms. Tiffany Roy to me.

Email #1 (chain of emails; 5 pages) (Appendix 5)

There are numerous false allegations by Ms. Roy in this email. Further, she seems to be focused entirely on my role in the trial. I know of no scrutiny of the testimony of the other experts by Ms. Roy. I was a rebuttal witness, so by definition the issues she was concerned about were raised by the defense.

I was surprised to learn that Ms. Roy apparently used the BCC email option to include an unknown number of additional recipients when making false accusations in writing against me.

The vast majority of her complaints have nothing to do with my role as an expert. Presumably, the entire trial was conducted in a manner that complies with Texas law.

Ms. Roy makes an overwhelming number of *ad hominem* attacks and aggressive statements toward me. I choose to address three of these:

1. "You testified for the prosecutor and you were likely paid to provide this opinion."

This is an outrageous statement. No one paid for my opinion. I was compensated for my time and my expertise. By her own admission in her *Richardson* complaint (Appendix 4) Ms. Roy apparently serves as a paid expert in other cases, and Mr. Quartaro did so in this case. For that matter, I assume other experts who served in this trial (and there were several) were also compensated. I would like to know if Ms. Roy and Mr. Quartaro are strictly pro bono experts. **I would ask the TXFSC to make a specific comment about the implied impropriety of this statement by Ms. Roy**.

2. "What you did in this case is not in line with best practice, and you know it."

Nothing in Ms. Roy's complaint supports this allegation. I invite unreserved feedback from experts in the area of probability and evaluative testimony given activity level propositions. While no testimony is perfect, I submit that, in general, I have met the spirit – and the letter – of all guidance documents.

I have asked Dr. John Buckleton (ESR, Auckland, NZ; STRmix author), Dr. Simone Gittelson (PhD from University of Lausanne; Forensic Statistician and Bayesian network expert, Washington DC Consolidated Forensic Laboratory; Assistant Professor of Statistics, George Washington University) and Dr. Jonathan Whitaker (Principal Forensic Services, expert in evaluation of forensic evidence evaluation given activity level propositions) to provide such analysis as they may feel as valid directly to Lynn Garcia.

3. "I want everyone who supported your document to see how <u>what precious little training you have</u> on evaluations of findings given proposed activities is being exercised. This is unethical." (Emphasis in the original.)

I have given accepted testimony on activity level propositions since at least 2003, and that specific testimony was upheld by an appellate court in *United States vs. Albert Hill*. (See Appendix 6) Admittedly, the testimony in *Hill* is a prime example of the transposed conditional, and I would prefer that I had used other language, but clearly this was accepted testimony given FRE 702. I would argue that in 2003, *very few* people in the United States understood the concept of the transposed conditional; certainly I had not been introduced to it yet at any training event other than a single lecture by the late George Caromody a year or two prior.

In 2017 I helped to arrange training on evaluation of DNA data given activity level propositions at the United States Army Criminal Investigation Laboratory when I was an examiner there. This was the first such training event in this area that I am aware of in the United States. I helped to provide what I believe to be the first-ever training on this topic in the US for the forensic community at large in 2019 at Clayton State University. Since the AAFS meeting of 2021, where I helped to provide a half day workshop on this topic, I have given at least half dozen additional invited lectures due to high interest. These range from a

simple 30 minute presentation to half-day seminars for individual laboratories and various professional organizations in forensics. I am currently scheduled to provide a full-day workshop for the 2024 AAFS meeting on this topic, as well as the 2024 MAAFS conference. Finally, I have led a team at the OSAC subcommittee level on a best practices document on this topic for approximately the last five years.

In all but the invited lectures, I have partnered with experts that are regarded throughout the world as undisputed experts in the areas of probability, Bayesian Networks, Case Assessment and Interpretation, and activity level evaluation of DNA evidence, including Nathalie Hicks-Champod, Jonathan Whitaker, Sue Pope, Gillian Tully, James Curran, Simone Gittleson, Bas Kokschoorn, and Richard Wivell. In addition, I have had in-person or email conversations with Peter Gill, Charles Berger, John Buckleton, Duncan Taylor, Franco Taroni, Alex Beidermann, Christophe Champod, and Ian Evett over probabilistic evaluation of DNA evidence given various levels of the hierarchy of propositions. I estimate this is over 200 hours of direct, personal training and learning from these experts.

I have also attended workshops as a student that have been provided by others when I get the opportunity to do so. Most recently, I attended two different workshops at the ISFG conference in Washington, DC.

I have done everything I possibly can to be prepared to offer this kind of testimony, especially in the past six years. I would argue that my interactions with the undisputed experts in this field have served as extensive education and training.

I am currently performing research in the area of "real world" activity studies in my role at SHSU. I am preparing two papers at this time, and we have completed and publicly presented at least one additional master's capstone project. In addition, my colleague Dr. Patrick Buzzini and I discuss activity level propositions as an ongoing topic, and are working towards hopefully teaching a fully dedicated course at SHSU. I have leaned on Dr. Buzzini's expertise with Bayesian Networks, and he has consulted me on the DNA aspects of activity level evaluation of DNA evidence for students in his courses.

My initial response to Ms. Roy in Email #1 (chain) (Appendix 5):
I responded to Ms. Roy telling her that she was wrong, specifically with regard to her allegations about not providing any written materials and about how I "should have provided the basis for my opinion" as well as her claims that I was unethical. I closed my email by saying I would be willing to have a discussion after she tracks down the transcript that she assured me she would go find.

However, I found out later that Ms. Roy's email made it to a wide array of others, apparently by way of at least one "BCC" recipient, including members of the TXFSC and the elected district attorney of Travis County. I would ask the TXFSC to consider the less-than-transparent email from Ms. Roy, given she copied an unknown number of persons. I was not allowed to respond to

them. Even after being informed by me that she was categorically wrong about several things in her allegations, she has made false claims in her written complaint to the TXFSC.

I can accept that we have a difference of opinion about my testimony. That is common in the trial process; two experts having a difference in opinion about the evidence and the weight it may provide to the given propositions of interest to the court. However, I point out that this goes beyond differences of opinion when she makes, and then repeats, untrue statements in writing to others.

In terms of "ethics" I would ask the TXFSC to evaluate the "ethics" of these specific factually false statements in writing from a person that claims to be an equivalent DNA expert as well as who maintains a law license in the state of Massachusetts. (BBO# 680896).

At this point, when I found out that these statements were made to others, I decided to disengage from Ms. Roy, and I have not responded to her anymore.

Yet Ms. Roy emailed me later that day stating "We can wait on the transcript", but apparently she thinks she should be able to make some sort of evaluation of any written documents I provided. I do not think Texas law, nor any other authority, requires Ms. Roy to have some terminal opinion on what is or isn't appropriate testimony.

Email #2 (single email, 1 page) (See Appendix 7):

Late on the evening of November 16, I received another clearly hostile and threatening email. In this email, Ms. Roy says if my report was "prepared and offered as public record at trial" she "expects to see it" so she can "pinpoint the misconduct." I note she makes no such threat to Mr. Quartaro as far as I know. I am also unaware that Ms. Roy has some authority to decide what is or is not misconduct. I did not respond, as my thinking at the time was that there was no value in doing so. I am unaware of any requirement that an expert witness has an obligation to provide any materials to a member of the general public.

Email #3 (single email, 1 page) (See Appendix 8):

Ms. Roy again demands a written report and appears to bolster her claim to have authority to demand this by providing the transcript of my testimony. I point out that no mention is made of any other transcript by any other expert and that I was a rebuttal witness because of questions asked by the defense and answers provided by other experts.

I feel that such aggressive posturing is a form of harassment and an attempt at intimidation.

Specific allegations by Ms. Roy

In the email Ms. Roy sent to me and others, she claims:

1. “You authored no report in this case.” Later, “You should have authored a written report.
2. “You should have provided the basis for your opinion.”
3. “You were not listed as a witness.”
4. “You were called in rebuttal after the expert assisting the defense had already been released and was in the car on his way back to Dallas.”
5. “You should have given Matt Quartaro the opportunity to review it and challenge it before this case ever went to trial.”

I respond in order:

1. Note that I did indeed provide a written evaluation of my findings to the prosecutors. Please see Appendix 9 for the email I sent eight days prior to my testimony. I will admit that I did not write a formal report on letterhead. I asked the prosecutors if I should prepare a report, but they told me no report was necessary. I did provide the entirety of my personal notes and references I used in coming to my opinion. In essence, I made my complete “case file” available with the expectation that anyone who wished to have it would be given access.

In Appendix 10, for purposes of this response, I have added marginal comments to clarify various things in my written evaluation/case file. Note that this document does not reflect chronological order. Specifically, near the top of Page 1, I list a count of alleles for Wilson and Armstrong and how many are found in the mixture from the seat. This was done *after* I formulated the propositions and recorded my expectations on Page 2. I accept that this layout is not ideal, however my intent was to keep “data” together on page 1, propositions and expectations on page 2, and close with considerations and my actual written opinion.

2. In addition to all my years as a practitioner in a lab (1999 to 2020), training, validations, research as a professor, and studying scientific literature, I started out by identifying around 3 dozen papers I hoped would be useful I then narrowed it down to about 16-20 candidates, and then made notes on about a half dozen or so. These papers were provided to the prosecution, as well as a summary document I prepared as a “cheat sheet” for the prosecutors to refer to. In addition, I discussed three papers during my testimony – at a lay-person, conversational level – and was prepared to answer any questions asked of me about those papers. I also addressed a paper in common with that of Mr. Quartaro, which he brought up on his direct examination.

Appendix 11 is the document I prepared that summarized information from the final papers I decided on.

The papers themselves are provided in a zip file called “Trial References.zip”.

I am unaware of the defense expert providing any written material by him or by others.

3. Listing myself as a witness is outside my role as an expert.

4. Informing someone who left the courthouse prior to my arrival that I will be testifying is beyond my role as an expert witness.

5. I was not going to be an expert witness until or unless Mr. Quartaro testified in a manner that the prosecutors felt needed to be rebutted. I was not told to drive to Austin until after Mr. Quartaro started his testimony - according to my understanding of the timeline. Notifying anyone, let alone before the trial started, is beyond my role as an expert witness.

I point out that in this email, Ms. Roy states: “I don't even know what the evidence was in this case, and I don't think it matters.” I submit that evidence in a trial matters, and the specific evidence given the specific case information must be considered by an expert rather than a blanket statement.

Testimony of Samantha Perkins: (Appendix 12)

Ms. Perkins was called by the prosecution as the author of the DNA reports provided by the state laboratory in this case. On direct examination, Ms. Perkins *only* discussed sub-source level propositions. That is to say, her direct testimony was limited to questions pertaining to possible sources of the DNA recovered in this case.

Notice that the first three questions by the defense were simple introductory questions. The first substantive questions were Questions 4, 5 and 6 (See Perkins testimony, Page 27 Line 22 through Page 28 Line 3):

> Q. Okay. When we look at DNA, it doesn't tell us when it was deposited, right?
>
> **A.** No, it does not.
>
> Q. Doesn't tell us what time?
>
> **A.** No, ma'am.
>
> Q. Doesn't tell us how it got there?
>
> **A.** No, ma'am.

I point out that the first line of questioning from the defense moved the entire inquiry about the DNA evidence from the sub-source level to the activity level of the hierarchy of propositions [2]. The scientific literature is *clear* that “how it got there” is related to transfer, which is a factor to consider while evaluating the DNA findings given questions of activities. This has been a part of the literature for a quarter of a century and is relevant in current guidelines as well. [1-5]

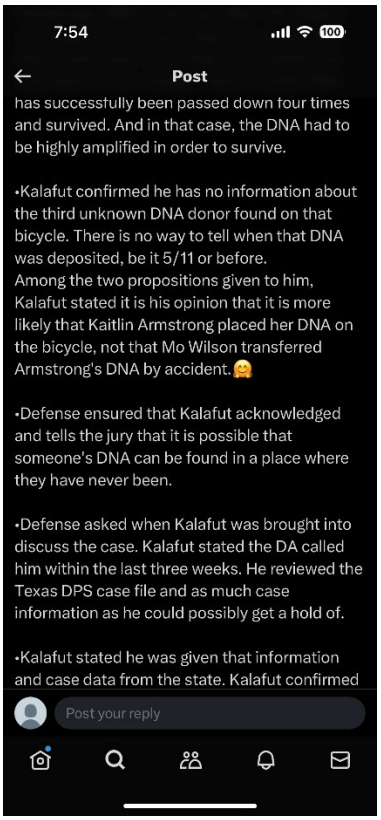
Any discussion about the appropriateness of my testimony in which I evaluated the DNA findings given activity level propositions must acknowledge that the defense brought this issue forward. I was only called as a rebuttal witness in response.

Allegations made by and testimony of Mr. Quartaro:

Allegations by Mr. Quartaro:
Mr. Quartaro states I testified "to which scenario is more likely" in his email to Ms. Roy, which is an absolutely false characterization. I testified about the probability of the evidence IF some things were true, which meets all guidance documents. Mr. Quartaro is claiming that I made a statement about the propositions (activities of interest to the court), which is inherently false as shown by the court transcript. A statement about the propositions ("scenario" in Mr. Quartaro's language) would be considered the "Transposed Conditional" or the "Prosecutor's Fallacy" and this is improper according to guidance documents.

> See Kalafut testimony, Page 18 Lines 13-15 where I specifically state that I don't know if something happened.
>
> See Kalafut testimony, Page 23 Lines 2-7 where I specifically tell the court that I do not comment on what happened but give my opinion about the evidence given propositions provided to me by others.

Mr. Quartaro provided a screenshot of an unattributed "Tweet" that is an example of the "Transposed Conditional" – *if said by an expert*. Presumably, this tweet was made by some member of the media who observed the proceedings. Reporters, jury members, observers, and even attorneys *do not* have to avoid speaking about the propositions. Those lay persons provide their posterior beliefs after hearing my testimonial opinion when they comment, and there is nothing improper if anyone who hears the expert's opinion re-states the information in the form of a Bayesian posterior belief. This is how it is supposed to work. The "tweet" was not a direct quote of my testimony.



Testimony of Mr. Quartaro. (Appendix 13)
I comment on the testimony of Mr. Quartaro simply to compare and contrast my testimony. I am not making any allegation that Mr. Quartaro's testimony was improper. It is similar to what happens in almost every case, as most times the court's interest moves beyond the sub-source level.

It is clear from the transcript that the purpose of the direct examination of Mr. Quartaro was to address activity level propositions as part of the defense case in chief. However, contrary to all guidelines, the testimony was not presented in terms of probability, and was focused on the propositions, usually phrased as "transfer" in an unbalanced manner. Mr. Quartaro never presented a probability statement conditioned on two mutually exclusive propositions that were formed around actual activities of interest in the case. I am unaware of any written report or materials prepared by Mr. Quartaro who also testified in the case.

Mr. Quartaro, by his own admission, is not familiar with the Hierarchy of Propositions and isn't sure of which terms to use when discussing levels of propositions. Furthermore, he states that activity level propositions are "trying to figure out what may be more likely in a case." This is an example of the Prosecutor's Fallacy, as he is addressing the propositions.

See Recommendation 3 of ISFG Guidelines [3] related to the prosecutor's fallacy.

> See Cook et al [2] and Evett et al [4] for information about the Hierarchy of Propositions.

Mr. Quartaro tenders himself as an expert in “transfer DNA”. See Quartaro testimony Page 8 Line 78 through Page 9 Line 2. All guidelines (ISFG, ENFSI, UK Forensic Science Regulator) [1, 3, 5]and the literature make it clear that transfer, persistence, prevalence, and recovery (TPPR) are factors that require expert knowledge to consider during the evaluation of DNA findings given actual, real activities related to the case. Claiming to be an “expert in DNA transfer” would seem to be contrary to all published guidelines on activity level evaluation of DNA. I am unsure why Ms. Roy did not bring up this issue as well.

> See Recommendation 7 and 8 of ISFG Guidelines for considering activity level propositions. [3]

It is important to note that Mr. Quartaro represented himself as an expert in “transfer DNA” at trial, yet also provided a post-conviction affidavit (See Appendix 14) where he says:

> “The scope of my expertise includes… the background knowledge of how DNA can be transferred between people or objects.”
>
> “This background allows me to answer questions about… whether a certain phenomenon [transfer] could be possible.”
>
> “I am not an expert in activity-level propositions…”
>
> “Understanding that limitation of my expertise, had I known the State was planning on offering testimony on activity-level propositions… I would have recommended that we engage a separate expert on activity-level propositions.”

“DNA transfer” is the result of the activities that occurred. This is clear in the scientific literature and has been addressed in a formal fashion for over a quarter of a century. In addition, “had I known the state was planning on offering testimony…” is rewriting what happened in this case. The state apparently had no intention of offering testimony “…on activity propositions” until Mr. Quartaro offered his opinion on “transfer” that is based on implied activities. To suggest anything else is a failure of logical thinking.

Mr. Quartaro seems to be unaware of the Case Assessment and Interpretation (CAI) model first published by Cook et al near the end of the previous century [6]. During the Case Assessment phase, the expert should record their expected results given the propositions in the case. CAI is a common framework to use when evaluating, for example, DNA evidence given activity level propositions.

> “In this phase, it is desirable that the scientist should document his expectations in statements of the kind "if such and such a proposition were true, then I would expect to

> find appreciable quantities of transferred fibres". Such expectations not only pave the way for sound decision making during the service delivery phase, but also form the basis of the interpretation which is later made when the statement is written." (Page 153 of [6])

Evett [7] also discusses this exact process of determining the probability of the evidence if the prosecution and defense propositions were true.

The ENFSI guidelines also address the need for pre-assessment [1]. See Section 3.3

Mr. Quartaro says he doesn't "have any expectations of what DNA is going to be present on any item that I test." See Quartaro testimony Page 16 Line 24 through Page 17 Line 6. However, this is what is expected in order to evaluate DNA evidence given activity level propositions.

> See Cook et al "A model for case assessment and interpretation." [6]
>
> See ISFG Recommendation 3, which states, "The scientists' role is to assess the value of the results if each proposition is true ..." [3]
>
> See ENFSI 3.3 – 3.8. [1]

Mr. Quartaro testifies that "It's possible…" related to finding different persons of interest in the case at hand "somewhere." See Quartaro testimony Page 26 Line 25 through Page 27 Line 3. This is another example of the Prosecutor's Fallacy, is not based on probability, and an alternative proposition is never mentioned. The Principles of Evidence Interpretation require an alternative proposition [7, 8].

> See ISFG Recommendations 7 and 8 relating to alleged activities and basing the assessment on the probability of DNA recovery conditioned on case relevant activities. [3]
>
> See ENFSI Guidance Note 2 (Pages 11-15). [1]

Mr. Quartaro appears to make an "identification statement," which violates the sub-source level of DNA testimony. See Quartaro testimony Page 27 Line 10. Mr. Quartaro said, "Tells us who is there."

The FBI has specifically banned such testimony for their experts in their Uniform Language for Testimony and Reports. This view has been widely adopted in the forensic DNA community, although this type of testimony is allowed by FRE 702. While identity statements were used somewhat in the past when Random Match Probability statistics were calculated, such statements are inconsistent with and wholly inappropriate related to a likelihood ratio, as the LR is a statement of how much weight and in what direction rather than any type of frequency of occurrence. This is a fundamental misunderstanding of the LR.

When answering questions related to the motorcycle helmet and the bicycle Mr. Quartaro made numerous statements about things that "could" have happened or are "possible." Please refer to ISFG and ENFSI guidelines, in addition to numerous writings by Evett, Taroni, Biedermann, Champod, Lindley, de Finetti and others. He also introduces additional explanations for which there is no direct support from any other evidence presented nor by the case information. (Coughing, sneezing, etc.) Mr. Quartaro never puts his opinion about the results in context by using two competing, mutually exclusive propositions.

See Quartaro testimony Page 27 Line 11 through Page 30 Line 16

See ISFG Recommendation 1 relating to a list of possible explanations being irrelevant at court, as it does not allow for an assessment of the value of the evidence. [3]

See ISFG Recommendation 2 stating that a likelihood ratio should be used that is specific to the activity level propositions. [3]

See ISFG Recommendation 5 about formulating propositions (this means two mutually exclusive propositions) in order to assess the *probability* of the results conditioned on those probabilities. [3]

See Evett and Weir [8], page 30-31, for the first three principles of evidence interpretation:

> To evaluate the uncertainty of any given proposition, it is necessary to consider at least one alternative proposition.
>
> Scientific interpretation is based on questions of the kind, "What is the probability of the evidence given the proposition?"
>
> Scientific interpretation is conditioned not only by competing propositions, but also by the framework of circumstances within which they are to be evaluated.

See Evett [7] for the fourth principle:

> The ratio of the two probabilities determines the weight of evidence to be assigned.

These four principles provide the role of the balanced scientist, which are summed up in the ENFSI guidelines [1] as balanced, logical, robustness, and transparency, all of which are encapsulated in the likelihood ratio. (Section 4.0 of ENFSI)

See ENFSI Guidance Notes 3 and 4 (Pages 15-18). [1]

Mr. Quartaro admits that “possibilities have different probabilities” (Page 30 line 25 through Page 31 Line 5).

Berger et al [9] address such “could” or “possible” testimony: “In most situations ‘could have’ is no more than a statement of the blindingly obvious…”

Biedermann [10] addresses this in a section titled “The eternal ‘could have/be’” (4.2), saying “The expression ‘could have/be’ is particularly unsuitable for use by forensic scientists for a number of reasons…” and then provides more than one full dedicated page of discussion. As part of this, Biedermann says such could/would/possible language at trial “lead[s] to a fairly easy life: no real interpretation is required…” and quotes Bruno de Finetti saying experts “…say and unsay in the one breath…”

Biedermann reminds that de Finetti said “if the questions are asked in such a way as to obtain a probability value as an answer, the ambiguity disappears.” Forensic scientists on the witness stand cannot ensure the questions are asked in this manner, but they can answer using probabilities, which has the effect that de Finetti discusses.

A strict interpretation of FRE 403 might claim Mr. Quartaro’s testimony is *irrelevant* as the definition of relevant evidence “has a tendency to make a fact more or less probable than it would be without the evidence.” A probability statement, as expressed in a likelihood ratio, has both direction and magnitude, supporting one proposition more than the other by some large amount or some small amount. “Could” or “possible” has neither. Of course, sometimes the evidence offers an equal amount of support to both propositions (uninformative where LR=1), or sometimes it may not be possible to make a probability statement at all.

Mr. Quartaro was engaged in several pages of transcript by the defense (see above) and then again by the prosecution about the motorcycle helmet. See Quartaro testimony, Page 32 Line 14 through Page 40 Line 14. This matters, as part of Ms. Roy’s complaint against me is captured in a marginal comment in the transcript she provided to the TxFSC. She says this about the alternative proposition: “[this] is not an activity. what is being proposed is so far fetched and I'm not even sure this was the defense hypothesis. So how is this relevant?” [sic] The implication is that I made up the alternative proposition. Clearly, this proposition was of interest to the court in a manner that had nothing to do with me. In fact, I was unaware of the interest in the helmet until I arrived at court shortly before I was called to the witness stand. (However, as will be explained below, this information only had the effect of driving the likelihood ratio to be even more in favor of the prosecution’s proposition.)

Mr. Quartaro then was asked a series of re-direct questions by the defense (Page 41 Line 5 through Page 42 Line 19) again relating to sweaty helmets. Of importance, the defense mixed in questions about “body fluids” and “moisture”. Mr. Quartaro discussed blood, semen, and saliva. The net effect of this line of questions and answers is that “touch” DNA where sweat may be involved “could” yield DNA amounts along the lines of blood, semen, and saliva. This was

offered with zero support, and I would suggest that the literature makes it clear that blood, semen, and saliva have much more DNA than "sweat" or "touch DNA involving sweat," but then again, two experts can disagree. (See below for my testimony about moisture and DNA and DNA from body fluids.)

Mr. Quartaro ends his examination by the defense (See Quartaro testimony Page 42 Line 22 through Line 23) by doubling down on what could be considered an identity statement, saying DNA "Tells you potentially whose DNA it is." While this statement with the word "potentially" allows for some wiggle room in avoiding an identity statement, when coupled with his earlier statement, "Tells us who is there" the jury may be left thinking there is no uncertainty about who the source(s) of DNA is in this case. Contrast this to my testimony below where I explicitly state "I don't know…" at least three times related to sub-source level propositions and who is the actual donor.

Mr. Quartaro ends his testimony with questions by the prosecutor related to the helmet and the effects of swimming by replying "possibility" twice, "could" twice, and "could potentially" once. All of these are, again, statements about the proposition, and, as such, are examples of the Prosecutor's Fallacy. In addition to the problem of not addressing the probability of the evidence in the case given conditional probability, Mr. Quartaro stayed consistent throughout the entirety of his testimony by never considering the evidence under two competing hypotheses conditioned on the specific case information. This is a violation of ISFG and ENFSI guidelines, as well as using a basic Bayesian framework.

> See ISFG recommendations 1, 2, 5, 6, 7, 8, and 9. [3]
>
> See EFNSI Guidance Notes 2-4. [1]

Testimony of Tim Kalafut: (Appendix 15)

My testimony was limited to rebutting testimony solicited by defense.

I will let others[2] – assuming they do so – make comments on the technical merits of my testimony and how it does or doesn't conform to published guidelines and scientific literature. By this, I mean did I avoid the transposed conditional, did I use the laws of probability rather than "possible" or "could", and did I present balanced, transparent, robust, and logical testimony following the Principles of Evidence Interpretation. [7, 8, 11] However, I wish to reserve the ability to amend this response document and address it later if no other experts speak to this. There is a long list of persons qualified to comment, and many that are not.

[2] Dr. John Buckleton, Dr. Simone Gittelson, and Dr. Jonathan Whitaker have been asked by me to review my transcript and case notes and send any comment directly to Lynn Garcia.

I will point out differences in testimony that aren't necessarily arguments about wording, transposed conditional, or the use of probability. I will point out where I mentioned refereed papers, how I handled similar questions differently, and where I gave hard limits as to where my ability to give an opinion stops according to the guidelines. I note that I specifically avoided testimony that is allowed by FRE 702[3] (opinions on whose DNA or what happened).

Page 6 Line 16 through Page 7 Line 3

> Defense asked me only two questions in a brief *voir dire*. (No objections were raised during my testimony.)

Page 7 Line 16 through Line 23

> I make clear that I agree with the findings of both experts, although I use the term "persons who might be considered possible sources" for the inclusionary interpretations rather than make an identification statement.

Page 7 Line 24 through Page 9 Line 5

> I provide background information to the jury on the Hierarchy of Propositions to try and set up a clear understanding of the various levels of interest. This is so the jury can both understand the differences between sub-source and activity levels, and to help them make their decisions about this issue that are before the court. At this point in the trial, it is clear that the court is interested in both sub-source and activity level propositions.

Page 9 Line 6 through Page 10 Line 22

> The prosecution asked me about the same study that the defense asked Mr. Quartaro about. I pointed out some things about the experimental design that differ from the allegations in this case. We clearly have a difference of opinion about how the experimental design and results may inform probabilities related to the evidence in this case. It is expected that experts may have differences in opinions about any given study.

Page 11 Line 1 through Page 13 Line 7

> This is the discussion that sets the two competing propositions that I considered as I gave my opinion testimony about the evidence. I wish to point out that I made it clear I was not the source of either proposition; they were both provided by the prosecution. The first

[3] It should be noted that since I was accepted by the court as an expert, the law would have allowed me to overtly give my opinion about "how" the DNA got on the bicycle. I could have told the jury my personal beliefs about which of the two propositions was actually more likely in my opinion. This is expressly allowed by FRE 702, which seems to be ubiquitous. I *did not* do this. I "stayed in my lane" and made sure I only spoke about my opinion on the probability of the evidence IF these are the two scenarios the court is interested in.

is what the prosecution is alleging as actions by Armstrong. The second seems to be inferred by the prosecution based on the testimony elicited by the defense while questioning Ms. Perkins and Mr. Quartaro.

Page 12 Line 7 through 23

I try to address the concepts of transfer, prevalence, persistence, and recovery as factors that are considered during the evaluation of DNA evidence given activities of interest. I try to set up that the propositions involve actual activities.

Page 13 Line 20 through Page 15 Line 4

Rather than focus on "transfer" only, this section discusses the issue of persistence related to an actual undisputed activity in this specific case.

At Page 14 Line 25 I am transparent about factors (persistence and prevalence) that affected the assigned probability of the evidence given the alternative proposition, which among other things includes swimming; there was no opportunity for the DNA of Armstrong to have been replenished on the helmet (or any item), and it is not in dispute that Strickland wore the helmet and rode the motorcycle twice, and Wilson once since the last opportunity for Armstrong's DNA to have been deposited.

Page 15 Line 5 through Page 16 Line 22

There is room for improvement in my testimony here. "Transfer" is not to be part of the proposition; however, this term was used extensively prior to my testimony. In this section of testimony, I was asked a direct question about "tertiary transfer", which is not an activity, but is implied by a series of three activities. Tertiary transfer means the DNA moved a total of 3 times involving four different persons, locations, or items. I tried to relate each step to an activity that is part of the alternate proposition, but I found this challenging.

The literature is universal in that after each transfer event, there is less DNA available for the next event as no transfer process proceeds with 100% efficiency. In addition, most studies involve heroic efforts to remove any and all background DNA, and are often done with the "primary transfer" by someone who is known to leave high amounts of DNA behind and subsequent steps are performed by persons wearing gloves and in what is essentially clean room environment. In contrast, this case involves persons in the real world with no known information about cleaning procedures, and with no removal of background DNA, as there is an unknown male donor on the bicycle, and a bicycle is used in the real world by a sweaty rider.

I was asked about an additional "transfer" – referred to as quaternary transfer – as well. It is important to note that this now involves DNA starting at Position #1 and ending up at Position #5.

I am transparent that although I am unfamiliar with any studies on "quaternary transfer", there may be such studies, and I allow that it is not impossible for DNA to be detected after five transfers.

During this discussion, I refer to two specific studies. This is perhaps another opportunity for improvement of my testimony, as I addressed them very conversationally, and I did not give any specific reference such as author/article title or journal name and volume. I was prepared to do so, should either party ask for more information.

At Page 16 Line 8-11 I am referring to Warshauer et al [12], where they had to increase the number of PCR cycles from 28 to 34 to detect the tertiary transfer. Even when doing so, 87.5% of the study samples returned less than 50% of the expected alleles of the tertiary transfer event.

At Page 16 Lines 13-17 I am referring to Davies [13], where they conducted a tightly controlled experiment under tightly controlled conditions with an immediate sequence of actions. While the sub-source likelihood ratio provided by Ms. Perkins (224 billion for the seat) *cannot* be used as an activity level likelihood ratio, such an LR suggests that we would only expect an LR of this magnitude or larger in a population of 224 billion persons. Yet in this study, the authors apparently had difficulty deciding if the known tertiary contributors were detected or not. They concluded:

> "Unambiguous tertiary transfer was difficult to establish due to the complexity of the final mixtures. [ ] As such, in most datasets it was not possible to establish if there was a partial DNA profile from a tertiary donor or interference from a low level of non-donor DNA."

Page 18 Line 8 through 24

I was asked about "if the person coughed inside the helmet." I had no case information that anyone had coughed while wearing the helmet, so I asked for clarification about who would have coughed. I am trying to help the jury keep actual activities in the case separate from hypothetical situations. I immediately try to focus back on an alleged specific activity – the defendant wore the helmet – along with a reminder that I have no personal knowledge about this and I am only considering information provided to me.

Contrast this with the testimony of Mr. Quartaro at Page 28 Line 6 where Mr. Quartaro discusses "coughing, sneezing" unprompted with no case information to support those

activities. See ISFG Recommendation #1 about offering "explanations" as it does not allow an assessment of the value of evidence. [3]

Page 20 Line 18 through Page 21 Line 1

This was an opportunity for me to present my evaluation of the evidence given the propositions in the form of a likelihood ratio. The value of the LR I assigned was "more likely".

Side note: In Appendix 1, motion for new testimony, Ms. Freud discusses that LRs greater than 1000 are not expected "when performing activity propositions." We will ignore the incorrect characterization of the issue. (Experts don't perform activity propositions.) There are times that the LR that describes the support the evidence gives for one proposition over the alternate can be much larger than this. A recent case study paper by Murphy and Ryan presents an LR of 450,000. [14]

Please see Appendix 10[4], which is the case file/work product I prepared. I explain why I chose not to give a numerical LR in my testimony. By my estimation, the LR in *Armstrong* is approaching the magnitude of the LR published by Murphy and Ryan. However, unlike the case study paper, which found readily available published data, I was unable to find published data involving three (and then four) chained-together-activities involving sweaty motorcycle helmets worn multiple times by two persons after the person of interest last wore it a month prior. Hence my "verbal" or "qualitative" LR. See below for a discussion on quantitative and qualitative LRs.

There is an opportunity for improvement here, in that I only said "direct interaction" rather than "Armstrong removed the bicycle from the apartment by carrying it using the seat and handlebars" for the first proposition. I had just discussed "grabbing ahold of the bike" on Page 17 Line 6, so I was trying not to repeat myself using the same words, but I should have done better than "direct interaction" here.

Likewise, when I stated the alternate proposition as "this series of indirect activities", I used shortcut language, as we had already discussed four separate activities[5] (implying

[4] This copy has been altered in two ways from the original work product that I previously provided to Lynn Garcia. I have made extensive margin notes so TXFSC members can better understand my process and I added additional spacing so the margin notes are legible.

[5] Ms. Roy provided a copy of my transcript with her notes and highlights when she filed her complaint with the TXFSC. This copy was provided to me. I point out that at this point in the testimony, Ms. Roy makes the following comment:

"this is not an activity. what is being proposed is so far fetched and I'm not even sure this was the defense hypothesis. So how is this relevant?" [sic]

quaternary transfer). I purposely avoided restating all of the elements of the alternate proposition, as that would have been about a half a page worth of testimony, and by reading the faces of the jurors, I felt they understood this. Therefore, I went for simple and succinct rather than a full restatement of the entire proposition. Perhaps there is a better course.

Page 21 Line 2 through Page 22 Line 24

I was asked a question that allowed me to discuss intervening activities between the activities that imply a transfer of someone else's DNA. Specifically, about reaching into a bag, implying the process that Armstrong would have gone through after being dropped off back at her apartment. Additional questions in this line of inquiry were asked about additional activities related to the interactions Armstrong had during her time with Strickland. While I have no case information about the specific activities asked by the prosecution, it is not in dispute that Armstrong and Strickland were on a date, and the activities proposed are commonly encountered on a date. Presumably the jury has heard from other witnesses about these things, or they should be able to sort through these things based on their own experience. Likewise with activities involved in entering an apartment.

In any case, I used this as an opportunity to discuss "intervening" activities that affect the persistence and prevalence of DNA results. Unlike the two peer reviewed articles I mention above, in real life there are often numerous intervening activities between the specific activities that make up activities that imply transfer as part of one or both of the propositions in a real case.

I refer to another paper at this point. van Oorschot, et al [15] recorded videos of everyday activities as "any contact can influence the gain and/or loss of DNA," not just the activities related to the movement of a specific person's DNA to a specific item of interest. They sum up their study by saying:

> "The findings indicate that several items are touched over a relatively short period of time. Appreciation and consideration of general activities that may have

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I admit that I used short cut language at this point in my testimony. However, while this alternate activity proposition may indeed be "far fetched", it was indeed the alternate proposition given to me at trial. Therefore, I have an obligation to evaluate the evidence given this proposition, no matter how "far fetched" it may appear to be. This is consistent with both forensic science guidelines and the law. Expert Testimony Instruction 7-9-1 from the U.S. Trial Judiciary Electronic Military Judges' Benchbook, reads:

> "When an expert witness answers a hypothetical question, the expert assumes as true every asserted fact stated in the question."

Altogether, this means that an expert witness is should not "adjust" a proposition just because it may be "far fetched." Note that a copy of this instruction is provided as Appendix 16 and is available at https://www.jagcnet.army.mil/Sites/trialjudiciary.nsf/homeContent.xsp?open&documentId=900756AC675854ED8525804400729CBB

occurred between key focus activities are necessary to assess any impact these may have on what is deposited at the final collection site. The information this provides is imperative when weighting alternative transfer scenario propositions."

I specifically discussed this, as unlike laboratory-controlled studies, it is patently obvious that Wilson would have interacted with many items, including the items expected to have DNA from Strickland (wearing his habitual helmet, holding onto him while riding on the motorcycle) and also would have interacted with things throughout the day, including going into the apartment at the end of the date.

Even IF the DNA of Armstrong had been in the helmet of Strickland at the beginning of day of interest, there were at least four wearings of the helmet – that are NOT in dispute – prior to the final time Wilson wore the helmet. Between each wearing, both Strickland and Wilson interacted with untold numbers of items – and one another – throughout the day, including going swimming after the third use of the helmet. I have an exceedingly low expectation that the DNA of Armstrong would persist (yet an expectation of background DNA from Strickland) in that helmet until the fifth and final wearing that day, and even then, the helmet was habitually worn – and worn that very day – by Strickland, whose DNA is NOT found on the motorcycle.

Page 22 Line 25 through Page 23 Line 7.

I was asked a question for my direct opinion on the propositions. My answer was explicitly clear that I do not address which proposition is more likely. This is the source of the complaint against me per Mr. Quartaro's email to Ms. Roy. Instead, I answered with my likelihood ratio of "much more likely" describing the support given to the proposition of "the defendant grabbing the bicycle" than the alternative proposition of "this other chain of events happened."

In this instance, I did a better job of stating the first proposition than I did previously (Page 20/21), but I still relied on the extensive discussion given throughout my testimony relating to all the different activities that make up the alternative proposition rather than try to restate everything all at once.

Page 24 Line 1 -20

Defense asked me a series of questions related to sweat and direct/indirect transfer along with DNA being on an item that someone has not touched. The three questions asked of me in Lines 5 – 12 caused me to be concerned that the jury was getting confused about "touch" DNA, "sweat" DNA and direct/indirect as I watched the faces of the jury members. I tried to give an explicitly clear answer that dripping sweat directly on an item is a direct DNA deposition rather than "Doesn't have to be something somebody touched" as implied by the question.

Page 27 Line 11 – 22

> Defense asked me questions about "moisture" and "moist DNA". They asked similar questions of Mr. Quartaro (Page 41/42). However, I felt that they were conflating the issues of "moist" (as in water or humidity) with "body fluids" such as blood or semen. I tried to make the jury aware that "moist" DNA isn't the same as a body fluid and I gave a clear answer about moisture affecting DNA compared to DNA recovered from body fluids.

Page 28 Line 1 – 6

> I made it explicitly clear that I was NOT giving testimony about how the DNA got on the bicycle. This is the very allegation that both Mr. Quartaro and Ms. Roy are accusing me of.

Page 28 Line 25 through Page 29 Line 13

> This was a challenging exchange for me, as experts are not to use "transfer" as part of the proposition, and the defense directly asked for me to give my opinion on "direct transfer" and the unknown male donor on the bicycle. While I am sure there was a better way to handle this, I tried to be clear that without any knowledge of who the unknown male may be, there is no possible way to evaluate the probability of the evidence (presence of this unknown male) give level activity propositions, as we have no activities to consider. I tried to communicate this by answering "…that's an empty question. I can't offer anything to answer that."

Page 30 Line 7 through Line 21

> This question kind of blurred the line between the sub-source and the activity levels. I addressed each in turn, and made clear that "I don't know whose DNA…" is on the bicycle. However, in order for the court to have any interest in the activity level, there is an implicit, and sometimes overt, acknowledgment that the sub-source level is not in question. This is the only way to progress to activity level. I did my best to explain the differences and define the differences.

Qualitative vs. Quantitative LRs

Ms. Roy points out in her email (Appendix 5) that she "oppose(s) notional assignments of probabilities." This term "notional" is not defined by Ms. Roy. However, by reading her email, affidavit, and the motion for new trial, by context "notional" seems to be any probability that is not based on a hard number from a peer reviewed study or *ad hoc* experiment. To be fair, many other people feel similarly, and this is often expressed as a disagreement between qualitative and

quantitative probability. The former is considered “vague” and “personal” and “subjective” and the latter is “objective” and “data driven” and “reliable.” However, this is not the case, as all probability is personal.

In the “R v T” paper [9], this is directly addressed. This paper has a good discussion of aleatory and epistemic uncertainty on page 45. In addition, the authors specifically say that it is “clear to us that probability is *personal*.” Each and every forensic DNA case is a one-time event with different evidence and fact patterns. The data we have that can inform our probabilities is imperfect. “…the essential point to recognise here is that whenever we are making an inference from a sample the data are always an incomplete representation of the full picture…” Therefore, “the probability that is quoted then will inevitably be a personal [epistemic] probability and the extent to which the data influence that probability will depend on expert judgement.”—p. 45

In the R v T case, the court had issues with the imperfect data and the personal probabilities. Essentially, the court did not allow epistemic uncertainty. However, the authors of this response paper say “…the likelihood ratio is the ratio of two probabilities and there is nothing in the logical framework that we have described that demands those two probabilities to be aleatory. Indeed, the foundation of the Bayesian paradigm (from which the forensic “Bayesian approach” derives) is that the logic works equally well with purely epistemic probabilities as it does with aleatory probabilities…” —p. 46.

With regard to the LR and not having “hard data” the authors say, “The principles lead inevitably to the two key probabilities and *we entirely accept that the expert will not be able to assign precise values to them*. Nevertheless, *it is essential for the expert to address qualitatively their relative magnitudes*. Under which of the two propositions is the evidence more probable? That is the proposition which is better supported by the scientific observations. The *likelihood ratio is still central, even if the probabilities can only be qualitatively assessed* though it is worth reiterating that the expert needs to be able to state the basis for such an assessment.” —p. 46 (emphasis added)

“However, the solution for all those cases where the likelihood ratio is qualitative is the notion of using some kind of verbal qualifier to convey the strength of the support that the observations bring.” —p. 47

The authors do not think very highly of the type testimony involving “possible” or “could have” that is not in the LR framework. “On the contrary, our view is that “could have made” is valueless for expressing evidential weight and this view is shared by others. […] In most situations “could have” is no more than a statement of the blindingly obvious such as:

> The DNA in the crime sample has the same profile as that of the suspect, therefore it could have come from him.

The latter part of this sentence does not warrant the status of an expert opinion; whereas the jury will understand it, it does not convey any appreciation of the weight of evidence that the observations provide to assist them in their task.” —p. 47

The use of a qualitative (non-numerical) LR is sometimes the only option. "'Moderate support' is an attempt, however imperfect, to convey some impression of weight of evidence." —p. 47

It is obvious that Ms. Roy, Mr. Quartaro, and Ms. Freud disagree with Berger, Buckleton, Champod, Evett, and Jackson about "notional" probability. However, published along with R v T is a position statement [16] signed by over 30 imminent scientists, statisticians, law professors, and probability experts. (Of interest, three signatories are faculty members at the University of Lausanne, where Ms. Roy is taking her course.) This position paper provides further amplification that is directly relevant to a case like *Armstrong* where there is epistemic uncertainty:

> 5) A verbal scale based on the notion of the likelihood ratio is the most appropriate basis for communication of an evaluative expert opinion to the court. It can be phrased in terms of support for one of a pair of clearly stated propositions.
>
> 7) Probabilities should be informed by data, knowledge and experience. *All data collections are imperfect and incomplete* and it necessarily follows that different experts might legitimately assign different probabilities to the same set of observations. (emphasis added)

Ms. Roy claims that my testimony violates ENFSI [1] guidelines. She has said the same about the ISFG guidelines [3], but has given no concrete examples of any violations other than lack of a report and her concerns about "notional probabilities." The transcript shows that all other guidelines were met. If she is referring to a "written report", I provided my entire case file, and offered to write a report but was told it was unnecessary. However, in light of Ms. Roy's strong feelings about "notional probabilities" I wish to point out that on page 15 of the ENFSI [1] guidelines it says:

> If appropriate published data are not available then data from unpublished sources may be used. Regardless of the existence of sources (published or not) of numerical data, *personal data* such as experience in similar cases and peer consultations *may be used*, provided that the forensic practitioner can justify the use of such data.

In this case, I made all efforts to find relevant studies. I came up with a handful that I used to inform the probabilities I assigned in a qualitative fashion. This is in line with best practice. Biedermann [10] warns about "Misconceived subjective probabilism and spurious objectivism" in section 2.4. The ENFSI guidelines [1] say, "…personal probability assignment is not arbitrary or speculative, but is based on a body of knowledge…" and move onto a discussion that the practitioner should be transparent about where this knowledge comes from. But in no way do

these guidelines speak against a personal or subjective probability. Taroni et al devote an entire article dedicated to the topic [17]. This article starts by stating:

> "There is a continuous flow of articles published in legal and scientific journals that recite outworn direct or subtle attacks on Bayesian reasoning and/or the use of the subjective or personalistic interpretation of probability."

Taroni quotes de Fenetti who says, "Probability does not exist' (in things). Probability is not something that can be known or not known: probabilities are states of mind, not states of nature."

Perhaps Ms. Roy's definition of "notional" probability is really a question of numerical vs. verbal (words) probability. This has also been addressed in the literature. Biedermann [10] addresses the practical issues with a fully numerical approach with a practical level of detail that can pose "operational difficulties." They directly address numerical vs. worded probability by saying:

> "What we are saying is that probabilistic expressions can take the form of both numbers and words. The most important evidential test in law, that of relevance, depends on the tendency of an evidence item to make a proposition more or less probable. Probabilistic judgments by participants of the legal process, whether on relevance, degree of persuasion or aspects of forensic expertise, and whether numerical or verbal, have a quantitative connotation."

Notice the parallels between this comment and FRE 401 which addresses the definition of relevant evidence. The probability literature allows for both numerical and verbal expression, since both have a "quantitative connotation."

Berger et al [9] address potential definitions of "notional" by calling them "aleatory" where the uncertainty in the probability comes from randomness (such as a coin flip) and "epistemic" where the uncertainty is based on limitations of knowledge. Unfortunately, the former has become thought of as "objective" and the latter as "subjective". They go on to say that "…there is an essential contribution to be made by personal judgement" and that "even with DNA the 'element of judgment' might be wider than the Court appreciated."

With regard to the question of verbal or numerical probabilities, Berger et al. says:

> "To deny scientists the contemplation of the likelihood ratio – whether quantitative or qualitative – is to deny the central element of this logical structure."

Ms. Roy attributes much to Drs. Taylor and Kokshoorn, and I agree that they are leaders in this field. However, on page 54 of their book *Forensic DNA Trace Evidence Interpretation* [18], even these two experts agree that at times, "soft" probabilities must be used:

> "Even when 'hard' data is not available to the scientist (i.e., data based on controlled scientific studies) then 'soft' probability assignments can be used. These assignments are when the scientist assigns a probability based on their understanding of the aspects of the event being considered and their experience in the dynamics of transfer and persistence in the discipline in which they work (for example, see the use of expert elicitation in [71]). This may make the reader uncomfortable, as it seems highly subjective; however, subjectivity itself should not be shied away from (all evaluations are subjective in some way, in the data chosen, the models used and the assumptions made, or the prior probabilities set)."

The literature disagrees with Ms. Roy's opinion about "notional probability."

Demonstrably false claims

Ms. Roy and Mr. Quartaro (by way of affidavits in support of a motion for a new trial) and Ms. Freud[6] (by way of a new trial motion) make statements that are false. I point out a few below.

From Appendix 1, Motion for a new trial by Ms. Freud

> Page 4; "Kalafut represented to Roy that he prepared a report in this case."
>
> > – I never said any such thing. I said I provided "the basis for my opinion along with citations in writing" in response to Ms. Roy's patently false accusation where she claims "You should have provided the basis for your opinion." I provided my case file to the prosecution. I have provided the email proof of doing so. In any case, Ms. Roy had no standing, and I am under no obligation to provide anything to her just because she sent an email based on a tweet. I provided the basis for my opinion in my oral testimony as well.
>
> Page 8; "Kalafut represented himself to be a qualified expert pursuant to Texas Rule of Evidence 702 in the technique of ALP, which was false: he is not a qualified expert in such a technique."
>
> > – Ms. Freud invented this out of whole cloth. The prosecution offered me "as an expert in DNA." The defense asked two questions: 1) "Have you produced any sort of publications on DNA?" and 2) "Do you do any sort of continuing

[6] As a side note, Ms. Freud claims as *new evidence* the email of Ms. Roy. Since when does an email written by a person who did not observe the testimony, did not read the transcript, has no knowledge of the evidence in the case, and doesn't care what the evidence is count as "exculpatory evidence?" I expect the answer may be beyond the purview of the TXFSC, but this is the foundation of this complaint.

education regarding DNA studies?" No one questioned me about "ALP". Had they done so, I would have started by saying "ALP" is NOT a term of the art. Furthermore, I would have explained that being an expert in "activity level propositions" is a total mischaracterization of the entire Hierarchy of Propositions.

"ALP" implies a comment on the propositions. This is the Transposed Conditional, or "the prosecutor's fallacy." I would have explained that as an expert, I comment on the probability of the evidence given activities of interest to the court. I would have said that deciding which (if any) of the activities was responsible for the DNA ending up where it was found is up to the jury. The voir dire could have continued at length, as my connection with "ALP" (to use the incorrect term the defense has coined) goes back decades and I have provide such evidence numerous times.

Page 8; This is a complete mischaracterization of "qualifications" discussed by Drs. Taylor and Kokshoorn in their book.

Ms. Freud has left out that on page 404 of *Forensic DNA Trace Evidence Interpretation* [18], in that "five cases in five years…" is the formal standard as set forth in the Netherlands Register for Court Experts (NRGD). I am aware of this, as I was contacted about four years ago by the Netherlands Forensic Institute to see if my experience met the specific requirements set forth in the "Experts in Criminal Cases Act" that governs Dutch experts.

Perhaps Ms. Freud would be willing to adopt other aspects of the Dutch system, such as the inquisitorial nature of the proceedings rather than the adversarial system in the US. In conversations I've had with Dr. Kokshoorn, I'm told that his role in the Dutch system involves a meeting with the judges, the attorneys on both sides, and the expert. The parties are expected to *each* put forward their respective hypotheses, and after all agree on the issues to be considered, the expert then goes about preparing their opinion. The concept of cross-examination does not exist in the Netherlands. In addition, the judge will decide which expert is appointed. This is after a discussion with the parties, but nevertheless there is no guarantee whatsoever that the defense gets to have their preferred expert.

Finally, in the Netherlands, all expert witness testimony is admissible, unless it was illegally obtained. One suspects that Ms. Freud is simply suggesting requirements for "qualified experts" that she feels are to her benefit rather than adopting the entire system that feels those are the appropriate qualifications. In any case, I have given direct activity testimony, along with my former colleagues, for many years in US courts.

Page 9; “What is clear, as this is believed to be the first identified criminal case in the United States in which ALP has been offered and admitted…”

> – Ms. Freud needs to read more case law. There are numerous cases where activity level propositions have been of interest to the court. In United States v. Brooks [19] the lab expert testified that “it was “very highly unlikely” that his DNA wound up on the zip tie as a result of a secondary transfer from this bank teller.” The defense expert “indicated it was “quite possible” that a secondary transfer had occurred…” Clearly, in this case, one proposition is the activity if securing a bank teller by way of using zip ties. The alternate proposition argued by defense was some vague “secondary transfer.” In rejecting the appellant’s argument, the court notes the defense expert’s report “addresses the possibility of determining whether a secondary transfer inf act occurred, not its likelihood, it does not render [the lab expert’s] opinion unreliable.”
>
> Mr. Quartaro gave vague testimony about “possible” and “transfer” while I gave my opinion about the probability of the evidence given two specific activity propositions of interest to the court. There are strong parallels between *Brooks* and the case at the center of this complaint. To be sure, I am not arguing that my testimony is “validated” by the *Brooks* decision; I simply point out that this case dates from 2013 and clearly involves “ALP.”
>
> What may be more important is that recent convictions have been overturned because the prosecution *did not* elicit testimony related to activity level propositions. While the language in the appellate decisions is unfortunate, as the judges focus on “transfer” and “primary” or “secondary” or “indirect” rather than actual activities, the fact is there were either alternate activities that may have explained the DNA, no activity proposition was offered by the state, or there was no connection between the quality/quantity of the DNA profile and the activity proposition. I provide these cases in the references attached to this document. [20-22].

Page 11; “Under Kelly, ‘reliability should be evaluated by reference to the standards applicable to the particular professional field in question.’”

> Ms. Freud invokes *Kelly* to claim my testimony was reliable. *Kelly* says essentially says that the testimony must meet the standards applicable to the field in question. It is ironic that the forensic DNA literature has said for over a quarter century in literally hundreds of papers that testimony on “the possibility of transfer” is unsuitable for court. The IFSG and ENFSI guidelines make these statements throughout. This is how Mr. Quartaro testified, and Ms. Roy has pointed out that she has been studying how to evaluate DNA evidence given activity propositions using probabilities since March. Surely Ms. Roy recognizes

that probability based testimony using an LR framework meets the *Kelly* standard. How else did Ms. Freud make the claim that the LR I presented was too high other than having Ms. Roy do some type of LR calculation of her own?

Page 13; "If the Court finds that Kalafut was qualified and ALP is reliable under Kelly, Kalafut still gave false testimony regarding his degree of confidence in his opinions; specifically, he overstated his degree of confidence."

By definition, probability is the belief of the observer. All probabilities are personal, and based on the knowledge and information the observer has. This is not in dispute in the scientific community. This form of probability is not always recognized, as most people only consider aleatory uncertainty – an issue with uncertainty in the data, such as not enough observations. In this case, the uncertainty is better described as epistemic uncertainty – where there is uncertainty in information. In other words, there is no data for the likelihood that the DNA of the defendant would hide out inside that helmet until the fifth time it was worn by the Victim, and then only the DNA of the defendant – and none of the helmet's owner – made it to the bicycle eventually.

Essentially, claiming that someone overstated their own qualitative opinion is akin to telling your friend who says they really love vanilla ice cream – "No, you only like it. You don't love it."

From Appendix 2, Roy Affidavit

Page 5; "Tim Kalafut's 31 page testimony is not based in science. Modern DNA testing does not allow for conclusions about how the DNA transferred or how long it may have persisted on an item…"

I gave no "conclusion about how the DNA transferred" in this case. Ms. Roy is accusing me of "the transposed conditional" or giving my comment directly on the propositions. This did not happen, and the transcript shows this. Such language does not exist in my testimony.

Ms. Roy claims that she is taking the only class she knows of that teaches the tools required for such evaluation. Yet she claims that evaluating evidence given activity level propositions "is not based in science." One wonders why she is spending 13 months taking this course that is "not based in science."

Ms. Roy claims, "There is still significant debate among the forensic community regarding whether these evaluations have foundation and can be applied consistently and accurately." Yet she also claims to be learning from the world's leading experts. Duncan and Bas are indeed experts in this field, and I have

learned much from them directly, but they are not the only ones. They both offer such testimony in their own expert roles that Ms. Roy has concerns about "foundation and application." Ms. Roy may want to reconsider the value of this course, if it's being taught by two instructors who testify in a manner that "is not based in science." One wonders what her instructors – and the faculty at the University of Lausanne – would think of her characterization of the subject matter of this course.

There are ways to learn frameworks besides the class she is taking. For instance, I have spent 5 years working with two people from the very university that Ms. Roy is attending. I have access to another PhD graduate of that university as a colleague.

No page exists; no comment on the testimony of Mr. Quartaro.

Ms. Roy offers critiques of Ms. Perkins testimony and mine. The testimony of Mr. Quartaro is not supported by any guidelines or by the course Ms. Roy is taking. She makes no comment on it.

From Appendices 4 and 5, Roy-authored documents

In Appendix 5 (Email chain 1) Ms. Roy claims in this email she sent to me that she "opposed your [the one I authored] OSAC document." This document is a proposed Best Practices Document (BPR) that I have chaired for the past five years. A group of international experts is attempting to offer guidance on how to address activity (manifested as "possible transfer") questions at court. In this email, Ms. Roy implies that this document is problematic.

However, in Appendix 4, where Ms. Roy authors a letter to the Massachusetts equivalent of the TXFSC, she uses this very document as the foundational basis for her complaints about testimony given by Dr. Carll Ladd and Dr. Frederick Bieber, and by extension, the two forensic scientists from the crime lab. In this letter, Ms. Roy describes this document as "being proposed to address problematic testimony of the type offered in this case (*Richarson*)."

Ms. Roy seems to have large swings in her opinion about this document.

From Appendix 14, Quartaro Affidavit

Page 4; "The only expert that resides within the United States who might be qualified on this topic that I am aware of is Tiffany Roy."

Ms. Roy and Ms. Freud seem to define "qualified" as having your name listed in the book that Duncan and Bas have written. Ms. Roy's name is not listed.

Page 6; "There was no supporting studies cited in testimony…"

I discussed three specific papers that directly impacted my evaluation.

– Tim Kalafut, PhD

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EXHIBIT C

(Sidebar Concluded)

MR. JONES: Permission to publish, Your Honor?

THE COURT: Yes.

MR. JONES: Your Honor, are they admitted?

THE COURT: Yeah. I just said those were admitted.

(State's Exhibits 482 - 483 admitted)

Q. (By Mr. Jones) Ms. Perkins, I want to direct your attention to State's 482. Can you tell me how many submitted items you have?

A. As far as the submitted number of items, I am not able to see just from that report based on the outer packaging that is there because there could be inner additional evidence within the package.

Q. Let's talk about the first submission, 01.

A. Okay.

Q. Can you go on your report and tell us what that was?

A. Yes, sir. 01-01 is the swabs from the handlebars of decedent's bicycle, Item 2935470-4. The DNA profile obtained is interpreted as a mixture of three individuals with Anna Wilson as an assumed contributor.

Q. Tell us why Anna Wilson is an assumed contributor.

A. The information that I received is that this was her bicycle, so I assumed her as a contributor to the profile.

Q. Okay.

A. The probability of obtaining this profile if the DNA came from Anna Wilson, Kaitlin Armstrong, and one unrelated, unknown individual is 49,400 times greater than the probability of obtaining the profile if the DNA came from Anna Wilson and two unrelated, unknown individuals. This likelihood ratio indicates support for the proposition that Kaitlin Armstrong is a possible contributor to the profile. Refer to the appendix.

Q. And that's on the handlebars of the bike; is that correct?

A. Yes, sir.

Q. And did you compare 01-01 to anyone else?

A. No, sir.

Q. Tell us about that.

A. I had also received samples from Colin Strickland and Caitlin Cash.

Q. And tell us about those results.

A. The probability of obtaining this profile if the DNA came from Anna Wilson and two unrelated, unknown individuals is 20 times greater than the probability of obtaining the profile that the DNA came from Anna Wilson,

Colin Strickland, and one unrelated, unknown individual. This likelihood ratio indicates support for the proposition that Colin Strickland is excluded as a possible contributor to the profile. Internal validation has shown that a likelihood ratio of this value may also indicate support for exclusion of a true donor from the profile. Refer to appendix.

Q. And who else did you compare these swabs from the handlebars to?

A. Caitlin Cash.

Q. Tell us about those results.

A. Based on the likelihood ratio result, Caitlin Cash is excluded as a contributor to this profile. Refer to appendix.

Q. Okay. And what is the next item?

A. 02-01, swabs from seat of decedent's bicycle, Item 2935470-5.

Q. Just one question before you go on. This 49,400 times more likely, where would this particular profile fall on the chart, the likelihood ratio?

A. Would you be able to show me the chart?

So for 49,400 would fall under strong support, which is 10,000 to 999,999.

Q. Where does very strong start?

A. At above or equal to a million.

Q. And higher, correct?

A. Yes, sir.

Q. Okay. Now, Ms. Perkins, let's talk about 02-01.

A. The DNA profile obtained is interpreted as a mixture of three individuals with Anna Wilson as an assumed contributor. The probability of obtaining this profile if the DNA came from Anna Wilson, Kaitlin Armstrong, and one unrelated, unknown individual is 224 billion times greater than the probability of obtaining the profile if the DNA came from Anna Wilson and two unrelated, unknown individuals. This likelihood ratio indicates support for the proposition that Kaitlin Armstrong is a possible contributor to the profile. Refer to appendix.

Q. And where does this fall on that chart?

A. It would be over a million and so very strong support.

Q. And there's not a higher category for you to report this on, is there?

A. No, sir.

Q. Okay. And did you compare the 02-01, the swabs on the seat, to Colin Strickland and Caitlin Cash as well?

A. Yes, sir.

Q. Tell us, the jury, what the results of that was.

A. Based on the likelihood ratio results, Caitlin Cash and Colin Strickland are excluded as contributors to this profile. Refer to appendix.

Q. Okay. And let's talk about -- we're still at State's Exhibit 482. Let's talk about item 03-01. Tell the jury first of all what the swab is from.

A. 03-01, swabs from firearm grip, trigger, trigger guard, safety, magazine release, and slide serrations, Item 2935585-14.

Q. Okay.

A. The DNA profile obtained is interpreted as a mixture of three individuals. The probability of obtaining this profile if the DNA came from Kaitlin Armstrong and two unrelated, unknown individuals is 3.87 septillion times greater than the probability of obtaining this profile if the DNA came from three unrelated, unknown individuals. This likelihood ratio indicates support for the proposition that Kaitlin Armstrong is a possible contributor to the profile. Refer to appendix.

Q. And did you also report -- compare this to Colin Strickland?

A. Yes, sir. The probability of obtaining this profile if the DNA came from Colin Strickland and two unrelated, unknown individuals is 2.69 million times

greater than the probability of obtaining this profile if the DNA came from three unrelated, unknown individuals. This likelihood ratio indicates support for the proposition that Colin Strickland is a possible contributor to the profile. Refer to appendix.

Q. Now, is this data basically saying that it appears that both Colin Strickland and Kaitlin Armstrong have maybe had contact with this weapon?

A. The evidence just shows that they --

Q. Their DNA is on it?

A. That if the DNA profile obtained, the probability if the DNA came from Colin Strickland and Kaitlin Armstrong is greater than if it did not.

Q. Came from someone else, correct. Okay. Now, those numbers 2.69 million times and 3.87 septillion times, do those numbers mean anything?

A. Do they mean anything? Can you rephrase your question?

Q. Well, when Kaitlin Armstrong's probability is 3.87 septillion times greater and Colin Strickland is 2.69 million times greater, do those difference in those numbers tell us any -- give us any additional information?

A. The difference in the likelihood ratio would indicate that there's more information that would -- more

information that would be consistent with the alleles of Kaitlin Armstrong than Colin Strickland.

Q. Okay. Did you compare anyone else to 03-01?

A. Yes.

Q. And who was that?

A. Caitlin Cash and Anna Wilson.

Q. What were those results?

A. Based on the likelihood ratio results, Caitlin Cash and Anna Wilson are excluded as contributors to this profile. Refer to appendix.

Q. This is the firearm grip; is that correct?

A. Yes, along with other locations on the gun.

Q. Okay. And let's talk about item 04-01. What is that?

A. 04-01, swabs for magazine base and loading port, Item 2935585-18. No interpretable DNA profile was obtained from this item, insufficient data is present for interpretation.

Q. And what is 05-01?

A. The known saliva standard from Kaitlin Armstrong.

Q. And that was just used for comparison purposes; is that correct?

A. Yes, sir.

Q. Would it be the same thing for 06-01?

A. Yes, sir, for Anna Wilson.

Q. Let's talk about Item 11-01. What is that from?

A. 11-01, swabs from underside of bicycle seat, Item 2949399-1.

Q. Now, I want to go back to compare that to swab 02-01. Now, 02-01 is from the seat of the bicycle; is that correct?

A. Yes, sir.

Q. And then 11-01 is from the underside?

A. Yes, sir.

Q. Okay. What were you results from 11-01?

A. No interpretable DNA profile was obtained from this item. Insufficient is data is present for interpretation.

Q. And let's talk about Item 12-01. What was that item?

A. 12-01, swabs from exterior of gum wrapper, Item 2949587-1. No DNA profile was obtained from this item.

Q. And what is the purpose of 13-01?

A. That was the known saliva standard from Colin Strickland.

Q. And that's used for comparison purposes; is that correct?

A. Yes, sir.

Q. What about 14-01?

A. That was the known saliva standard from Caitlin Cash.

Q. Okay. And that was also used for comparison purposes, correct?

A. Yes, sir.

Q. Let's talk about Item 16-01. Tell the jury what that was.

A. 16-01 were swabs of stain on floor, Item 2935470-10. The DNA profile obtained is interpreted as originating from a single individual. The probability of obtaining this profile if the DNA came from Anna Wilson is 3.98 octillion times greater than the probability of obtaining the profile if the DNA came from an unrelated, unknown individual.

Q. So these are the swabs of the blood stain on the floor at the scene; is that correct?

A. All the information I have is that it was from a stain on the floor.

Q. Stain on the floor, correct.

Now, do you exclude anybody as a contributor?

A. Yes, sir.

Q. Who are those people?

A. Kaitlin Armstrong, Caitlin Cash, and Colin Strickland.

Q. Okay. Now, I want to turn your attention to State's 483. Did you also test additional items?

A. Yes, sir.

Q. And let's talk about the first item that you checked, 05-01.

A. The known saliva standard from Kaitlin Armstrong.

Q. What was the purpose of that?

A. That was used to be able to compare the evidentiary profile to Armstrong's profile.

Q. Okay. And 06-01?

A. That was the known blood standard from Anna Wilson.

Q. And what was the purpose of that?

A. To be able to compare any evidentiary profiles to her DNA profile.

Q. The next one?

A. The known saliva standard from Colin Strickland.

Q. What was the purpose of that?

A. To be able to compare his profile to any evidentiary profiles obtained.

Q. And, finally, 20-01. What was 20-01?

A. 20-01 was the swabs of stain on left thigh from Anna Wilson, Item 2935470-11.

Q. Okay. What was the results of that stain on her

left thigh?

A. The DNA profile obtained is interpreted as originating from a single individual. Anna Wilson is an assumed contributor to this profile.

Q. And, Ms. Perkins, did you perform any other analysis?

A. I made comparisons to that profile to Caitlin Cash, Kaitlin Armstrong, and Colin Strickland.

Q. And what were the results?

A. They were excluded as contributors to the profile.

Q. Okay. And did you do anything else with regards to this particular case?

A. No, sir.

MR. JONES: Your Honor, pass the witness.

CROSS-EXAMINATION

BY MS. DUGGAN:

Q. Good morning, Samantha. How are you?

A. Pretty well, thank you.

Q. You're the one that analyzed all the DNA in this case, right?

A. I interpreted the DNA in the case.

Q. Sorry. Lay terms. Yes. Interpreted. Thank you. You're the scientist behind it, right?

A. Yes.

Q. Okay. When we look at DNA, it doesn't tell us when it was deposited, right?

A. No, it does not.

Q. Doesn't tell us what time?

A. No, ma'am.

Q. Doesn't tell us how it got there?

A. No, ma'am.

Q. Let's talk about the firearm. In the submission form, it refers to the DNA swab of that as a SIG Sauer, right?

A. I do not have the submission form. Would you be able to -- that was the one thing I did not print out in my case file.

MS. DUGGAN: Judge, may I approach the witness?

THE COURT: You may.

A. Yes, it is swabs from SIG Sauer firearm.

Q. (By Ms. Duggan) Did you have any swabs from the Springfield firearm?

A. I did not. If there are -- that was the only item that was listed.

Q. Okay. You're not the one that collects all the swabs, right?

A. No, ma'am.

Q. And you are not the one that decides which swabs

to test, right?

A. If evidence is submitted, then it would be determined on what items are tested, but it would have to be submitted to be tested.

Q. The DNA profile on SIG Sauer is a mixture of three individuals, right?

A. Yes, ma'am.

Q. You compared these to the known profiles that you were provided from APD, right?

A. Yes.

Q. Ms. Armstrong can't be excluded as one of these individuals on the SIG Sauer, right?

A. Right.

Q. And Colin can't be excluded from these?

A. Yes, that's correct.

Q. You excluded Caitlin Cash and Mo Wilson from this though, right?

A. Yes, ma'am.

Q. Is there a third unknown individual on this firearm?

A. Yes, the profile was consistent with three contributors.

Q. Are you able to tell if this third individual is a male or a female?

A. I am not based on there being three contributors

and a Y chromosome was detected, but that doesn't -- I'm not able to use that to determine how many males would contribute to the profile, just that a male is a contributor to the profile.

Q. And you might expect the owner of an item, for example, the SIG Sauer, to have their DNA on that item, right? That would make sense?

A. Yes. Based on what I was saying earlier about an indigenous sample, if someone was an owner of that item and was known to use it regularly, they would be an assumed contributor to that item.

Q. Mr. Jones -- this might not be word for word -- but kind of asked you if -- can you tell if they touched that item, right?

A. I don't know if those were the words that he used.

Q. He suggested that they had contact with the item?

A. There -- if an indigenous sample was known to come in contact that you are known to use regularly, then that would be an expectation, but as far as how DNA is placed on an item or is transferred to an item, we wouldn't really be able to speak to that transfer.

Q. What is transfer DNA?

A. Transfer DNA, it can be -- a direct transfer

would be touching an item and directly depositing your DNA onto that item of evidence. There could also be secondary transfer or tertiary transfer where maybe I touch this item and somebody grabs the item and the DNA from -- that I have left behind could be deposited onto the hands of whoever grabbed it next, and so they can have my DNA on their hands. There's -- it can go tertiary transfer where someone then may shake that person's hand and get my DNA onto their hands.

Q. So DNA can be transferred more than once, right?

A. It can, yes.

Q. DNA can transfer from a person to an object?

A. It can.

Q. And from a person to another person?

A. Yes.

Q. I have a hypothetical for you. If a person drools when they are sleeping on a pillow case and DNA transfers from the inside of their mouth onto the pillow case, is that transfer DNA?

A. If the DNA is transferred from the person's mouth to a pillow case, yes, that would be a direct transfer of DNA evidence.

Q. What if that pillow case is then flipped over?

A. Are you asking --

Q. Does it get on the other sheets?

A. There are a lot of factors that impact the transfer of DNA. So is the biological material wet when it comes into contact with another surface. If it was dry, there may be less likely chance of transfer but -- so there's a lot of factors that are involved with whether something could be transferred or not.

Q. If DNA ended up on the sheets, that would be kind of an example of secondary transfer?

A. Possibly. The other aspect is if somebody is already in contact with those sheets, the person who is using the pillow then, they could have transferred their DNA directly to the sheets and not from transfer DNA. So could be -- you wouldn't be able to know what was transferred directly or transferred as a secondary transfer if they were known to have contact with those sheets as well.

Q. Okay. And remind me what tertiary transfer is again.

A. So tertiary transfer would be a third transfer event where if I touch this item, that would be a direct transfer; somebody else comes in contact with that item, that's a secondary transfer; if they were to shake hands with somebody else and that third person who I had no contact with, he didn't have contact with the item that I touched, he would have my DNA, that would be a tertiary

event.

Q. Is that widely recognized in your field?

A. It is a very, I would say, hot topic in our community now. There's a lot of studies that have been carried out. Of course the limitations to the studies is that you're not able to create the exact same thing of, you know, a scenario in a case. So there's a lot of conflicting studies, you know, a lot of -- a lot of papers show that tertiary transfer can happen but there has to be, you know, certain factors involved. There's other papers that talk about tertiary transfer depending on the biological material. Just a lot of different factors impacting that.

Q. But it can happen, right?

A. It can happen, yes.

Q. So we talked about kind of saliva on a pillow case, but other forms of DNA can transfer in the same way, right?

A. Yes.

Q. For example, if somebody was cut, blood could transfer from their arm to a floor?

A. Yes.

Q. That blood would contain DNA, right?

A. Yes, it would.

Q. And then someone wearing shoes could step into

that blood and that DNA goes on their shoes?

A. Yes, that can happen.

Q. And if they walked into another room, they could transfer that blood and, therefore, DNA would be in a different room?

A. Yes.

Q. Does DNA transfer apply to skin cells?

A. It does apply to skin cells. Again, there is a lot of factors impacting skin cells based on, like I said earlier, the biological material that is deposited and the amount of skin cells that are there to begin with, which are impacted by a lot of other factors. The -- you know, what's happened to that surface or that item since the contact, the original contact with that item.

Q. I think you kind of touched on this but if you and I shake hands, your DNA could end up on my hand, right?

A. Yes, it could.

Q. So then if I went and touched a pen with that hand and then it's swabbed, it could have your DNA on it, right?

A. Possibly, depending on how much DNA I deposited onto your hand, whether I was a good shedder or bad shedder. If I had a skin condition where maybe I have dry hands and I have a lot of skin sloughing off or had I

just washed my hands and maybe I didn't leave behind too much DNA on your hand because she also has DNA on her hands and she has a lot of it, so if she grabbed a pen, then you may be able to see my DNA profile interspersed with hers as a mixture. Or depending on how much DNA, I could have deposited enough to be able to be either a major contributor or even a pretty strong contributor to the profile. It just depends, again, on a lot of different factors.

Q. You touched on shedding. Do people shed at different rates?

A. They do. So there's the term we use "good shedders" and "bad shedders," and even a good shedder may not shed as well as on a -- during a certain time frame. So it is very variable. And there's, you know, a lot of studies done on the shedding status of an individual, but it's just honestly very variable during certain time frames.

Q. Silly question, but it's not just hands that would shed DNA, right? It can be all parts of our bodies?

A. Yes. The spacious locations such as your palms and your feet would tend to shed more, but you can shed DNA through other body parts.

Q. It's possible if we hugged, we would transfer

DNA, right?

A. Yes, it is possible.

Q. Okay. Going back to the firearm. The swab that you tested was from the firearm grip, trigger, trigger guard, safety, magazine release, and the slide serrations, right?

A. Yes, ma'am.

Q. Basically anywhere that someone handling that firearm could have touched?

A. Yes, ma'am, I would assume so.

Q. Because all these areas were collected in one swab, we can't tell exactly where it came from?

A. That's correct.

Q. For example, you can't really say there was DNA on the trigger, right?

A. That's right. Because it was all swabbed together, there would be no way to determine that.

Q. And we can't tell if one's DNA was on one part of the gun and another person's DNA was on a different part of the gun?

A. No, ma'am.

Q. Because it was all one swab, right?

A. Right.

Q. Do you know where the swab was taken on the handlebars?

A. I do not.

Q. It was a mixture of three individuals, right?

A. Yes.

Q. And Ms. Wilson and Kaitlin cannot be excluded?

A. Yes, ma'am.

Q. Is there an unknown?

A. Yes. There was a third contributor that provided very little information.

Q. Can you tell if that one was male or female?

A. Would you -- may I refer to my notes?

Q. Yes, you can. Thank you.

A. What I'm looking for in determining that information is to see if there is any Y chromosome that was detected on the DNA profile, and on the handlebar of the bike, there is a Y that was detected.

Q. That's a male indicator?

A. Yes, it is.

Q. Thank you. Sorry. Not a scientist. And unknown means you weren't able to match it to a known sample, right?

A. That's right. From the reference samples that were submitted, there was no reference sample that was included in that.

Q. Going back to that. You were given four reference samples, right?

A. Yes.

Q. Who are those individuals?

A. Caitlin Cash, Colin Strickland, Kaitlin Armstrong, and Anna Wilson.

Q. Those were the only four?

A. Yes, ma'am.

Q. And you can only compare DNA samples to known DNA samples?

A. That's right, yes.

Q. You can't compare it to anybody else that we don't have a sample from?

A. Yes, ma'am.

Q. Do you know if APD collected any other known samples?

A. I do not know that information.

Q. But you can only do that if somebody provides you a known sample?

A. Yes, ma'am.

Q. So referring back to the handlebars, you had a sample of Colin to compare it to?

A. Yes, I did.

Q. But it wasn't Colin?

A. He was excluded as a contributor, and the likelihood ratio that was provided, that was calculated was in a range where our validation has shown that

likelihood ratios of that value may indicate support for exclusion of a true donor, but that's -- he was reported as being excluded.

Q. Moving on to the seat. Do we know where the swab was taken from on the seat?

A. I do not know.

Q. And this was a mixture of three individuals?

A. Yes, ma'am.

Q. Was there an unknown on this one?

A. There's third contributor. There's no Y in the profile but also very little information from the third contributor.

Q. So that's three unknowns so far, right?

A. We -- so we don't make comparisons to see if it's the same unknown person or if it's a different, you know, three unknown individuals. So that comparison isn't performed.

Q. So it's at least three unknowns, right, could be more?

A. Well, as far as -- again, we didn't compare to see if it's the same person or three different people, and we're not able to make those kind of comparisons either.

Q. Now moving on to the underside of the seat. There's -- in your report, there is no interpretable

profile was obtained from this one, right?

A. Yes, ma'am.

Q. This was because there was an insufficient amount of data present to interpret it or why would that be?

A. So if we have a profile that doesn't have -- there may just be not a lot of alleles present to be able to provide us information that we need to make comparisons.

Q. But you have some low level data from that sample, right?

A. We do.

Q. What's the name of a sex typing marker that tells you if the sample originated from a male or a female?

A. We have amelogenin and DYS391.

Q. And do you see the X and Y chromosome on the underside of the seat?

A. So it was not an interpretable profile. So we wouldn't be able to make comparisons to the sample. So there's data that's available that somebody could -- you could see information that's on the profile but, again, we determined it uninterpretable due to the insufficient amount of data.

Q. But if you only see an X chromosome there, that

would indicate a female?

MR. JONES: Objection, Your Honor. Asked and answered twice. She said she is not able to interpret it. She doesn't have enough data. She is trying to get her to say something she is not comfortable saying that does not fall within her area of expertise and does not fall within the guidelines that she used to report that item.

THE COURT: Any response as to the objection as far as asked and answered already?

MS. DUGGAN: I don't believe I asked that specific question, Judge. I will rephrase it.

THE COURT: Okay.

Q. (By Ms. Duggan) Are you comfortable reviewing that data and determining whether there's an X or Y chromosome in that?

A. I think due to it being uninterpretable, I would not make the assumption.

Q. I appreciate that. Thank you. Did you analyze any DNA from the Jeep?

A. I do not believe so.

Q. So you weren't provided any samples collected from the Jeep Grand Cherokee?

A. No, ma'am.

Q. Do you know if any was collected?

A. I do not know that information.

Q. Just generally speaking, there could be all sorts of DNA inside a vehicle, right?

A. Yes, there could be.

Q. You analyzed swabs from other vehicles before, right?

A. Yes, I have.

Q. Those can contain blood DNA?

A. They could contain blood, yes.

Q. Could contain skin cells?

A. Yes.

Q. DNA from sweat?

A. Yes.

Q. Any of those we discussed on your PowerPoint earlier, right?

A. Right.

Q. Are you familiar with the phrase "wear DNA"?

A. Yes, I am.

Q. Will you explain what that is?

A. So that's an indigenous sample. So somebody who has known contact with an item. So they say "wear" because it's typically when you have a T-shirt and you are wearing that T-shirt where you would expect to find DNA from the person wearing the T-shirt.

Q. Just could mean DNA found on clothes that

someone is just wearing, right? Simple terms.

A. Well, I think the key point is that it's the DNA of the person who is wearing that item.

Q. Got you. Thank you for clarifying that. For example, my jacket might have my wear DNA on it, right?

A. Yes.

Q. And you would, in fact, expect to find DNA on clothes someone is wearing, right?

A. Expect to find DNA from that person?

Q. Correct. Like you would expect to find my DNA on my jacket?

A. Right, yes.

Q. Also on socks and underwear?

A. Yes.

Q. Any type of clothes really?

A. Yes, ma'am.

Q. Do some items of clothing capture more DNA than others?

A. Possibly depending on the biological material that may come into contact with that item. So I guess it depends on the item of evidence and where it is on your body.

Q. Could a hat capture DNA from someone's head?

A. It could, yes.

Q. A motorcycle helmet could too, right?

A. That's right.

Q. And a full face helmet probably would too?

A. Right. It would depend on how often that item was worn by the individual. So if it was worn once, now maybe the expectation would not be that they would be considered a true indigenous item of evidence. Indigenous or wear DNA would really imply that that person wore or used that helmet regularly.

Q. A full face helmet may capture more because it could have DNA from someone breathing?

A. Yes, it could.

Q. But also the wear DNA from just touching my skin, right?

A. Right, that's true.

Q. Is saliva a rich source of DNA?

A. It is. It is used as a reference sample. Buccal swabs are collected to be used as a reference sample.

Q. So that full face helmet, especially one covering the mouth, could have a lot of DNA that's been transferred?

A. It could potentially. I mean, depending on if the item was cleaned, the face shield was cleaned after use. It may have not have what was originally deposited on it, but also it really depends on, you know, with the

item not coming into direct contact with your mouth. There would be a lot of factors that would involve whether you could get a rich DNA source from that item, if that would be a rich source of DNA.

Q. I kind of jumped around a little bit but kind of making sense of it. DNA can be transferred?

A. Yes, ma'am.

Q. DNA can be on clothes somebody is wearing?

A. DNA can be from the person who is wearing those items of clothing, yes. The DNA from that person would be expected to be on the item. However, depending on if you are talking about somebody else transferring DNA from them to you, to your clothes, is that what you're talking about?

Q. Yes.

A. So, again, depends on a lot of factors, whether the person is a good shedder, bad shedder, what kind of touching was performed.

Q. So given all this, someone's DNA can be present in a location they have never even been?

A. Yes, that is true.

MS. DUGGAN: Pass the witness, Judge.

REDIRECT EXAMINATION

BY MR. JONES:

Q. Ms. Perkins, can a person's DNA also be present

in somewhere that they have been?

A. Yes, that is true.

Q. Okay. Now, let's talk about these environmental factors that tell us about transfer DNA. Defense gave an example of if she shook your hand, could your DNA transfer to her hand.

A. Right. There would be a lot of factors involved in that.

Q. Assume it did transfer and she shook my hand 30 days later. Tell me something about some of the factors you might consider for your DNA to be on my hand when you shook her hand a month ago.

A. So as a broad scope of DNA and the persistence of DNA, there are a lot of factors. So one is what is the biological material that was originally transferred. Was it a wet biological material when it was transferred? If it -- depending on the length of time, what activities has happened in those 30 days or whatever time frame has happened to where you may not detect that DNA. So washing hands or washing an item might remove a little bit of DNA. Friction removes DNA. So any time somebody comes -- so an originally deposited sample. Any time somebody else comes in contact with that item, there's a removal of DNA and also a transfer of DNA from the other person to that item. So you -- Locard's Exchange

Principle, that's really the important part of forensics, right, you are able to transfer an item and take an item any time you interact with an item. So friction can remove evidence, DNA from an item. Also in terms of storage conditions, where is an item stored or what environmental factors impact the evidence or the DNA. Because if DNA is stored in a hot, humid environment, there could be a degradation of DNA over time to where at a certain time frame you wouldn't be able to detect that DNA possibly due to that humidity and heat that kind of introduces bacteria. So that is the factor. And also UV light could also impact DNA and is known to rapidly degrade DNA.

Q. Ms. Perkins, do you live here in Austin?

A. I do.

Q. Is it generally pretty hot here in May?

A. I would need to look at the Farmers' Almanac.

Q. Is it generally hot in May?

A. It's normally warm.

Q. Okay. Do -- inside of a garage closed up, is it generally warmer than it is inside the house where you have air-conditioning?

A. It might. It would be warm.

Q. Okay. Would that affect the degradation, something being in a hot environment like that for 20, 30

days?

A. It would really determine on the quality of DNA that was originally deposited. So if it was a high-quality amount of DNA, it might not be impacted as much.

Q. What if we talk about DNA from the skin, dry touch DNA as opposed to blood or saliva, would that make it degrade? Would that affect the degradation process?

A. I do not know that answer.

Q. Okay. Now, the defense asked you a lot of questions about things you didn't test. Let's talk once again about the things you did test. You tested a bike, is that correct, items from a seat of a bike and handlebars from the bike, right?

A. Yes, sir.

Q. Do you know who the owner of that bike was?

A. I was provided the information that it belonged to Anna Wilson.

Q. Would you expect Anna Wilson to be a contributor to the DNA?

A. Yes, I would.

Q. Now, would you expect the DNA profile of the defendant to be on Anna Wilson's bike?

A. I don't have any information on whether she had previously touched the bike or whether she had come in

contact previously.

Q. But you wouldn't expect it to automatically to be on that bike because she is the owner; is that correct?

A. The only assumption I would be able to make is that Anna Wilson is a contributor to the bike based on it being her bike that she uses regularly.

Q. Okay. Now, is it safe for us to say that the defendant's DNA profile was on Anna Wilson's handlebars on her bike?

A. She cannot be excluded as a contributor.

Q. And that was a strong likelihood; is that correct?

A. If you are referring to the verbal qualifier, there was strong support for the likelihood ratio.

Q. Now, the sample taken from Anna Wilson's bike seat, was the defendant's -- tell me about the defendant's DNA on that seat, the profile.

A. The DNA profile obtained, the probability of obtaining that profile if the DNA came from Anna Wilson, Kaitlin Armstrong and one unrelated, unknown individual is 224 billion times greater than the probability of obtaining the profile if the DNA came from Anna Wilson and two unrelated, unknown individuals.

Q. Where did that fall on your chart?

A. Would you mind putting the chart back up?

Q. I think you testified earlier anything over a million was the top category?

A. Yes. Very strong support.

Q. So very strong starts at a million, right?

A. Yes, sir.

Q. And what was your number in this?

A. It was 224 billion.

MR. JONES: Pass the witness.

RECROSS-EXAMINATION

BY MS. DUGGAN:

Q. You can't distinguish transfer DNA from other types of -- or how DNA ended up on something, right?

A. No, you cannot.

Q. And the prosecutor kept asking you about the defendant's DNA on the seat, right?

A. Yes, ma'am.

Q. And you can't say that Kaitlin Armstrong's DNA was for sure on the seat site, right?

A. Right. The likelihood ratio, it's a comparison of two hypotheses, which is the -- is Kaitlin a contributor or is she not. And so it's -- it's the likelihood that she -- the likelihood obtained is indicating that she is a possible contributor to that profile.

Q. Nobody asked you to test swabs taken from the Jeep, right?

A. No, ma'am.

Q. And there were plenty of unknowns that couldn't be identified?

A. I would say that there's no way to know how many unknowns just because we're not able to make that comparison.

Q. If someone is wearing a hat, their DNA may get on their hat, right?

A. Yes, that is true.

Q. It's a great source of DNA, sweat, skill cells, things like that, right?

A. Right.

Q. And if somebody takes off the hat, right -- how would you take off a bicycle helmet, do you know?

A. I would assume you would take it off -- I don't ride bicycles. Probably never worn a helmet before. But I would assume you would take it off from the outside.

Q. So then DNA from someone's head or DNA on someone's hand could end up on the helmet, right?

A. It could end up on the helmet, yes.

Q. And vice versa. The DNA on the hand can end up on the helmet, right?

A. Right. But there, again, are a lot of factors

that involve that transfer and then detection of the DNA based on how many other people may have used the helmet and how much DNA they may have also deposited onto that helmet.

Q. So if I'm wearing someone else's helmet and I take it off, I can potentially be wearing their DNA, right?

A. DNA could be transferred and it's -- but transfer DNA is -- there's also detection of that DNA. So would the DNA be detected, it would depend on a lot of factors like prevalent DNA that's already located on an item. So like I said, if I was to shake your hand and she has really sweaty hands and maybe I just cleaned my hands, maybe there would be a transfer of DNA, but there might not be a detection of my DNA based on how much DNA she has overwhelming my DNA.

Q. But it could be transferred that way, right?

A. It could be transferred that way, yes.

MS. DUGGAN: Pass the witness, Judge.

FURTHER REDIRECT EXAMINATION

BY MR. JONES:

Q. Just one question. Same one she asked. If she put on your helmet -- you talked about a lot of factors. First of all, for your DNA to be transferred to the helmet, right?

A. Right.

Q. And are there other factors that will cause that DNA from the helmet to be transferred to her hands?

A. Would there be factors involving that transfer DNA, yes. Yes.

Q. So if you put your helmet on, your DNA could be on the inside of her face, is that correct, or somewhere in her face?

A. It might be transferred.

Q. Okay.

A. But the other part of it is -- I can talk about transfer DNA and persistence of DNA, but as far as activity level, which is what is the more likely scenario, I am not trained to do that, so it's a very gray area as to what you could testify to whether something is more likely or not.

Q. Let me ask you this. You testified that the defendant is not excluded from the seat or the handlebars; is that correct?

A. That's right. Could not be excluded as a potential contributor.

Q. Is one way for her DNA to get on that bike is for her to touch it? Is that a possible way for her DNA to get on that bike?

A. If someone were to touch an item, there could be

transfer of DNA; and the other aspect is whether that would be detectable because there are a lot of factors that would factor into whether the DNA would be actually detected.

Q. And in this case, this particular case, you tested the seat and the handlebars; is that correct?

A. Yes, sir.

Q. And you did not exclude the defendant, did you?

A. She could not be excluded as a contributor.

MR. JONES: No further questions.

MS. DUGGAN: No questions, Judge.

THE COURT: Thank you. You may step down.

Ladies and gentlemen of the jury, you have indicated that 30 minutes is sufficient for your lunch. You may very gotten hungrier now and want more time. But if that is case, we are going to take a lunch break for 30 minutes and so that will put us at 1:40. So you are in recess until 1:40.

(Luncheon Recess)

(Open Court, Defendant and Jury Present).

THE COURT: State, next witness.

MR. JONES: State calls Pam Mazak.

THE COURT: All right.

EXHIBIT D

right?

A. Correct.

Q. Travel out of the state of Texas, right?

A. At the time we dropped her off, yes.

Q. And lawfully travel outside of the United States, right?

A. As far as I know.

Q. Thank you, sir.

MR. COFER: Nothing further.

MR. JONES: No further questions, Your Honor.

THE COURT: You may step down.

Next witness.

MR. COFER: One second, Judge.

MS. DUGGAN: Defense calls Matthew Quartaro.

MATTHEW QUARTARO,

Having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MS. DUGGAN:

Q. Good morning, Matt.

A. Good morning.

Q. Will you introduce yourself to the jury?

A. Sure. My name is Matt Quartaro. Last name is spelled Q-u-a-r-t-a-r-o.

Q. What do you do?

A. Currently I am a forensic DNA consultant. So since 2015, I've had my own consulting firm that helps attorneys and sometimes jury members like you make sense of some of the DNA analysis that is performed in cases.

Q. Before this, what did you do?

A. Starting in 2002, I worked for a lab in Dallas. It was called Cellmark Forensics. There I held a variety of roles over the 14 years I was there from DNA analyst, training coordinator, quality control of our proficiency testing unit, acting section leader for a bit, DNA supervisor, and for the last few years, I was an associate laboratory director.

Q. What are the job duties of all of that?

A. My prior role or my current role?

Q. Let's start with your prior role.

A. Sure. So it was a private laboratory. We contracted with different labs, different police agencies all over the country to perform DNA testing for them. You know, everything that -- we actually did cases for Texas DPS. So a lot of the information that you heard from Ms. Perkins yesterday is just as pertinent as well. We would do the same type of testing and then come testify if needed to explain our results.

Q. Okay. What are your job duties now?

A. Now it's reviewing work that other people have done, so other labs around the country, and help attorneys when they are preparing for trial to help them understand the DNA results; make sure that the laboratory has done everything according to their own standards and according to, you know, national guidelines; and then really make sense of what those DNA results mean.

Q. You mentioned reviewing their work. Do you take some of the same steps that you did when you were an analyst?

A. Sure. One of the steps that I performed as an analyst was a technical review. That's looking at all the documentation, all the paperwork, the data, making sure that, you know, all the I's are dotted, T's are crossed; all the procedures were performed correctly; all of the controls in the laboratory are working correctly; if there's no indications of contamination, looking at the data, making sure I agree with the interpretation of the data; and that's statistical calculations as well.

Q. What is your education background?

A. I have a bachelor's of science degree from Texas A&M University and cell and molecular biology and a master's of science degree in molecular biology from the University of Texas of Dallas.

Q. How many times have you testified?

A. Just north of 90 times.

Q. And for the defense only?

A. Majority of those are for the prosecution when I was still working in the lab. Currently I mostly work for the defense because the prosecution typically has a lab that performs the DNA testing and comes and explains those results to you.

Q. Have you been recognized by any other courts as an expert?

A. I have been recognized in 18 different states and three different countries and federal courts in both state, federal, civil courts all over the country.

Q. And those -- are you saying you have testified as an expert witness in those?

A. Yes.

Q. And what were those other countries?

A. I have been to Guam, South Korea, and United Kingdom.

Q. How did you get in the capacity to testify there?

A. Some of the work I do is for the military. So there are courts-martialed all over the world, so I am called on at times to go assist in those courts-martialed in different parts of world.

Q. Back in your prior experience when you worked at

the lab, did you have to take continuing education courses?

A. I did, yes.

Q. And what do you do now to kind of keep up with the knowledge?

A. Sure. I still read journal articles that come out recently or that are more recent and try to attend symposiums, seminars that talk about the latest technology in DNA. So I do stay up-to-date.

Q. You consider yourself a lifelong learner?

A. Yes, I do.

MS. DUGGAN: Judge, we ask this Court to recognize Mr. Quartaro as an expert in DNA testing procedures and DNA and serology.

MR. JONES: Your Honor, may I take the witness on voir dire?

THE COURT: You may.

VOIR DIRE EXAMINATION

BY MR. JONES:

Q. Mr. Quartaro, what is sub-source level DNA?

A. Sub-source level?

Q. Yes.

A. I'm not familiar with that term.

Q. How about activity level?

A. Activity level propositions?

Q. Tell us what that is.

A. Are you -- is that the correct term you're asking?

Q. Yes.

A. Activity level propositions are sometimes trying to add mathematical calculations to figure out what may be more likely in a case.

Q. Okay. And have you studied transfer DNA?

A. Yes.

Q. And are you here as -- holding yourself as an expert in transfer DNA?

A. Transfer DNA is part of DNA analysis.

Q. My question is: Are you here as an expert in transfer DNA?

A. Yes.

Q. Okay.

MR. JONES: No further questions, Your Honor.

THE COURT: Any objection?

MR. JONES: No objection.

THE COURT: All right. You may proceed.

MS. DUGGAN: Thank you, Judge.

DIRECT EXAMINATION CONTINUED

BY MS. DUGGAN:

Q. What is the first step when an analyst receives

DNA?

A. Typically it's to -- when it's received to the lab is to look at the packaging, verify all the case numbers are correct; that everything that was supposed to be submitted to the lab, whichever agency sends it in, is present; that doesn't appear to be any tampering; that all the evidence seals are in proper condition; and it is logged into an evidence room or some secure location to prevent, you know, easy access to that evidence.

Q. What happens next?

A. Typically is assigned to an analyst. An analyst may communicate with the law enforcement agency to get an understanding of the case, what was submitted, to try and identify, you know, what items may be pertinent to test, what exactly we're looking for.

Q. And when evidence is received, can the analyst attest to the integrity of the evidence?

A. They can attest to the integrity as they received it. So if it is received in a sealed condition, I can say I received this envelope, it was in a sealed condition, I know the label was a certain way. That's all I can really attest to.

Q. Can they attest to how it was collected?

A. No.

Q. Can they attest to if somehow it was

contaminated before they received it?

A. No.

Q. When looking at DNA, can we tell when and how it got somewhere?

A. No, we can't. I mean, DNA is great for telling us whose DNA is present on that sample when it was collected, but it's not great at telling us how it got there or when it got there or why it is there.

Q. What's the process of getting what I would call the raw data that the analysts look at? How does that happen?

A. Ms. Perkins went through the whole process yesterday starting with the extraction which is, you know, isolating the DNA from whatever sample is sent. Next would be quantitation, which would measure how much DNA you were able to extract from that sample. The next step would be amplification, which she described as a Xerox machine, you know, making millions and millions of copies of those particular regions that we're looking at. And then the final step is detection, where we are able to visualize the DNA that we just amplified. And then finally you interpret that data, compare it to the evidence samples, to the known reference samples that you have. If there is an inclusion or you're not able to exclude someone, then the statistical calculations are

performed at that time.

Q. What evidence did you look at in this case?

A. I looked at, you know, the case file from Texas DPS, which includes chain of custody, submission of documents, all of the vast paperwork from every step of the process. We're talking about extraction through detection. And the data itself, what the DNA profiles looked like. And, again, all of the reports as well.

Q. When you say what the DNA profiles look like, give us a rough visual of what you're looking at.

A. I think you saw one yesterday that Ms. Perkins put up, and it's basically, you know, you think of it like an EKG you may think of like at the hospital where there may be a couple of peaks and then flatline and a couple of peaks, and that's just indicative of the different sizes of DNA that we amplified that are separated by different color dyes that we add to them in the amplification process.

Q. And you were able to look at those in this case?

A. Yes.

Q. Do you know if there were any swab samples from a Jeep?

A. I don't recall seeing any swab samples from a Jeep on the submission forms. I know I didn't see any of them that were tested or were the results of any DNA

report.

Q. Do you know how many samples were from firearms?

A. I believe there was one swab from a SIG Sauer, from several locations on a SIG Sauer firearm.

Q. And then which known samples were the DNA then compared to?

A. There were four reference samples that were submitted. It was Ms. Cash, Mr. Strickland, Ms. Armstrong, and Ms. Wilson.

Q. So four individuals?

A. Correct.

Q. Did you recognize any serious flaws in the testing procedures?

A. No. I thought everything went pretty well.

Q. That's what we want to see, right?

A. Exactly.

Q. Okay. What type of DNA was analyzed in this case?

A. Well, going back to like the steps of DNA. One of the things that we look at first is can we identify any biological fluids. So blood, semen are the two most common fluids that we can test for. In this case, there was a couple of samples. There was a swab on the leg of Ms. Wilson, a stain from the floor that were tested for the presence of blood, which was negative. So really

when you're looking at skin cells, epithelial cells, basically cells that are not blood or semen.

Q. Let's kind of point our direction to you reviewed the evidence or the information related to the SIG Sauer testing, correct?

A. Correct.

Q. Okay. What were the results of that one?

A. So that was a mixture of three individuals. As Ms. Perkins told you, Ms. Armstrong and Mr. Strickland could not be excluded as potential contributors to that sample. You know, there was three individuals present. So there was still one -- some amount of DNA there that was unaccounted for.

Q. Do you make your own separate conclusions when you look at it or are you just referencing what the analyst said?

A. I do look at the data and evaluate from the number of contributors. I do make comparisons between the reference samples and the known samples, and I also verify the results as well. So I look at the report and see do I agree or not.

Q. Did you have any major disagreements between the reports?

A. No, I did not.

Q. You agreed with most of it, right?

A. Yes.

Q. Okay. So going back to that SIG Sauer. Who did you say couldn't be excluded?

A. Ms. Armstrong and Mr. Strickland.

Q. Do you know if that SIG Sauer belonged to Ms. Armstrong?

A. That was my understanding based on the documentation I received.

Q. Okay. Do you know where the swab was taken from on that firearm?

A. It was taken from several locations. There was -- I think all collected together there was the trigger, the trigger guard, the slide serrations, the grip, and the safety, I believe.

Q. So from what you reviewed, it was one swab that tested all the parts of the firearm?

A. It might have been two swabs together, but all of those samples were swabbed together and collected as one sample.

Q. So can you point to a specific DNA on the trigger versus another DNA that was on another part of the firearm?

A. No. When they're all collected together, all we're looking for, all we're able to say is this DNA was found somewhere on this firearm. And one of those

locations. It could be one location and not the other. It could be on all of those locations. Can't really say there's -- can't do any further resolution to this DNA was found on this particular part of the gun and this person's DNA was on a different part of the gun. All we have is DNA that's found in the sample that contained all those different areas of the pistol.

Q. Okay. Remind me again who you said was excluded from that?

A. It was Ms. Wilson and Ms. Cash.

Q. Okay. And then did you say there was an unknown individual's DNA on that firearm?

A. Again, it was a mixture of three people. We were able to not exclude Ms. Armstrong and Mr. Strickland, and there is additional genetic DNA there that's not consistent with any of the reference samples that we have.

Q. Can you tell us if it was male or female DNA?

A. No. If there is a male present, we will see a Y chromosome, but we are not able to say if there was more than one male there. So knowing that Mr. Strickland would not be excluded, he could be the source of that Y chromosome. Could the third person be a male? It's possible, but I can't really say with any sort of resolution because that Y chromosome can be present just

because Mr. Strickland cannot be excluded.

Q. That's kind of what the analyst testified to yesterday, right?

A. Correct.

Q. Let's move on to the bicycle handlebars. Do you recall the results of the DNA on the handlebars?

A. Yeah. Again, that was the mixture of three individuals. Ms. Wilson could not be excluded and Ms. Armstrong could not be excluded.

Q. Who could be excluded?

A. Mr. Strickland and Ms. Cash.

Q. Is it possible that Ms. Armstrong's DNA could be present even though Mr. Strickland's wasn't?

A. I really don't have any expectations of what DNA is going to be present on any item that I test. That's the reason that we test it. If we knew before we tested it whose DNA would be present -- again, we don't know how any of the DNA really ended up on that sample. So it could be anyone's DNA.

Q. Okay. What do you know about the unknown profile on the handlebars?

A. On the handlebars, I really can't say a whole lot. There was a Y chromosome present. So there is a little bit of male DNA present there. But there wasn't enough, you know, DNA there to generate a complete DNA

profile that, you know, we can say this is the third person. There's just additional genetic data there present.

Q. And it led you to believe it was male DNA?

A. Correct. There is a Y chromosome present there.

Q. Okay. Have you seen anything like that happen before or studied anything about it?

A. About which part? I'm sorry.

Q. Just having the male DNA, like what do you look for when you're making that determination?

A. One of the markers that we look at is called analogin and that, you know, tests for the presence of the X chromosome, which is present in both males and females, and the Y chromosome, which is only present in males. So if we see that Y chromosome present, it's an indication that a male was present or male DNA was present.

Q. Let's move on to the bicycle seat. Do you recall what the results of the DNA was on the seat?

A. Again, that was a mixture of three individuals, and, again, Ms. Wilson and Ms. Armstrong could not be excluded and same results with Ms. Cash and Mr. Strickland were excluded.

Q. And that third individual, the unknown, do you know anything about that one?

A. I don't. Again, there was not a lot of additional genetic data present. In this particular sample, there was no Y chromosome present. So it doesn't appear that a male was present, but it could also be a very low level male that just wasn't detected.

Q. And moving on to the underside of the bicycle seat, what were the results of this one?

A. The report listed this as an uninterpretable DNA profile. They weren't able to make comparisons to -- couldn't make comparisons to any of the reference samples because there wasn't a lot of genetic data present there.

Q. Okay. And you were here yesterday when the DNA analyst testified, right?

A. I was, yes.

Q. Okay. And she was a little bit uncomfortable sharing about that profile?

A. Yes. She determined it was uninterpretable, basically meaning that she wasn't able to compare it to any of the known reference samples. That can happen for a variety of reasons. Could be that there's not a lot of DNA there, which is the reason why this one was uninterpretable. Sometimes you can have too much DNA present, and because there's so many people contributing DNA to a sample, you can't get a determination as to, you know, this particular person is included.

Q. Okay. And you've reviewed this data, right?

A. I have, yes.

Q. Okay. Are you -- what did you -- what conclusion did you look at and look into?

A. Again, there's not enough there to compare to any of these reference samples. I totally agree with that. There is some data present and it is present above the analytical threshold that the laboratory says for, you know, this -- when it's above an analytical threshold, that means there's enough DNA there to have some certainty about the results. One of those markers was analogin and there was an X and a Y present there.

Q. So there was some sort of indication that there was male DNA, right?

A. Correct.

Q. But we couldn't have -- we don't know if this was Colin's known DNA or an unknown. We just detect that chromosome?

A. Right. If there's not enough data points to compare to, we can't really say whose DNA is there.

Q. We kind of mentioned a couple of unknown profiles. Can we be sure how many unknown profiles there are?

A. No. We don't -- there wasn't a sample there that had like a complete single-source unknown profile

from, you know, someone that wasn't compared. We just have some additional genetic data in several of the samples. So we know that, you know, there's a number of samples with additional genetic data that wasn't consistent with any of the reference samples, but I can't say if it is the same person or who that may be.

Q. Okay. So it could have been one individual or it could have been multiple unknowns?

A. Correct. I have no idea. There wasn't enough data there to make that comparison.

Q. And just by profiles, we mean people, right?

A. Correct.

Q. And we can be confident that on the handlebars, seat, and underside of the seat, there is some sort of male DNA?

A. There is an indication of male's presence, yes.

Q. Could have been Colin's?

A. For, let's see, the handlebars, he was excluded by the laboratory. And the other for the -- I'm sorry, which samples again?

Q. The handlebars, seat, and the underside. I know that was a confusing question.

A. That's okay. On the seat, there was no Y chromosome detected. The underside of the seat, there was not enough genetic data to make a comparison to the

reference samples.

Q. Got you. Could they have compared these unknown profiles to other known profiles if they wanted to?

A. Yes. If there was additional known reference samples submitted to the lab, just like they compared to the four reference samples they did, they can compare it to additional reference samples if they were submitted.

Q. Okay. And we talked a lot yesterday about transfer DNA with the analyst. Give us a rundown of transfer DNA again.

A. Sure. Can I add one last caveat to my last statement?

Q. Yes. Sorry.

A. Okay. So the underside of the seat, again, there wasn't enough genetic data. So even if they sent a million reference samples, you couldn't compare it just because there's not enough data there. I just want to make sure I clarify that.

Q. Got you. Yes. Thank you for doing that.

A. Sure.

Q. Hopping back to transfer DNA.

A. Sure.

Q. Give us the rundown on what that is.

A. Sure. So DNA, you know, can transfer in many different ways. You know, one way is direct contact. If

you come into contact with, you know, my water bottle here that I carry around all the time, it wouldn't be unexpected that my DNA is on that water bottle because I touch it and I handle it, leaving skin cells behind, maybe saliva when I drink out of it. It could have other people's DNA on it who may have touched it. It could have -- you know, if I have DNA on my hands from someone else and I grab my water bottle, it could leave some of that DNA behind there.

So DNA can transfer through contact. Again, it doesn't have to be direct contact. Can be DNA present on this water bottle from someone who's never touched the water bottle because I acted as the intermediary to transfer the DNA to the water bottle.

Q. Got you. And it can be transferred in multiple different ways, right?

A. Yes.

Q. So like we discussed yesterday, the four different types of DNA, blood, saliva, skin, semen, like those can all transfer in different ways, right?

A. Correct, yeah. All those are sources of DNA. Some of them like body fluid, like blood, saliva, semen, are very rich sources of DNA. Skin cells, we don't really know. Like me touching something could leave a whole spectrum of amounts of DNA. But as Ms. Perkins

said, there's a lot of factors that come into play when you're trying to determine -- you know, I'm not able to say how much DNA would transfer through a single touch or an extended touch just because there's so many variables.

Q. The idea of shedding, how does that relate to this?

A. You know, people shed DNA at different rates. Some people -- like right now I'm up here a little bit nervous. A lot of people out there. My hands are a sweaty. I may be shedding a little more DNA when I touch this counter or my water bottle. If I just washed my hands and I clean all the DNA off and all those dry skin cells off, I may transfer less DNA when I touch something. I mean, I have a bad sunburn and I'm peeling so, you know, larger pieces of skin are falling off. I could have bad dandruff and dandruff is coming off at a higher rate than a normal person. So people, you know, may shed skin cells at different rates.

Q. Do you know of any real life case studies that demonstrate the potential for transfer DNA specifically?

A. There's lots of, you know, lab created like papers and there are also different cases that sort of demonstrate at the same time. Talking about a paper first, there was a 2016 study from the University of Indianapolis that was published in the Journal of

Forensic Sciences, and they were looking at, you know, the possibility of DNA transfer, both direct and, you know, secondary transfer. So the idea was they had two individuals kind of paired up, several of these, you know, pairs, and they have 12 smooth handled knives and they had 12 rougher handled knives, and the idea was to have a rigorous handshaking with one person, and then the person who they just shook hands with would turn around and handle the knife for a certain amount of time, and then they would collect any DNA that was present on that knife and see whose DNA was present.

So in total, there were 24 samples that were 24 knives, 24 samples. Of those 24 knives, 20 of them gave interpretable DNA profiles. So even like direct contact on four of those didn't give, you know, interpretable DNA profiles.

On 17 of them, they saw DNA from both individuals. So the person who actually touched the knife and the person who didn't touch the knife, and on five of those 17, the person who didn't touch the knife was either the major contributor of DNA or the only contributor of DNA.

So you can see that there's a spectrum of you can touch something and not leave detectible amounts of DNA behind to you can not even touch something

right?

A. Correct.

Q. Travel out of the state of Texas, right?

A. At the time we dropped her off, yes.

Q. And lawfully travel outside of the United States, right?

A. As far as I know.

Q. Thank you, sir.

MR. COFER: Nothing further.

MR. JONES: No further questions, Your Honor.

THE COURT: You may step down.

Next witness.

MR. COFER: One second, Judge.

MS. DUGGAN: Defense calls Matthew Quartaro.

MATTHEW QUARTARO,

Having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MS. DUGGAN:

Q. Good morning, Matt.

A. Good morning.

Q. Will you introduce yourself to the jury?

A. Sure. My name is Matt Quartaro. Last name is spelled Q-u-a-r-t-a-r-o.

Q. What do you do?

A. Currently I am a forensic DNA consultant. So since 2015, I've had my own consulting firm that helps attorneys and sometimes jury members like you make sense of some of the DNA analysis that is performed in cases.

Q. Before this, what did you do?

A. Starting in 2002, I worked for a lab in Dallas. It was called Cellmark Forensics. There I held a variety of roles over the 14 years I was there from DNA analyst, training coordinator, quality control of our proficiency testing unit, acting section leader for a bit, DNA supervisor, and for the last few years, I was an associate laboratory director.

Q. What are the job duties of all of that?

A. My prior role or my current role?

Q. Let's start with your prior role.

A. Sure. So it was a private laboratory. We contracted with different labs, different police agencies all over the country to perform DNA testing for them. You know, everything that -- we actually did cases for Texas DPS. So a lot of the information that you heard from Ms. Perkins yesterday is just as pertinent as well. We would do the same type of testing and then come testify if needed to explain our results.

Q. Okay. What are your job duties now?

A. Now it's reviewing work that other people have done, so other labs around the country, and help attorneys when they are preparing for trial to help them understand the DNA results; make sure that the laboratory has done everything according to their own standards and according to, you know, national guidelines; and then really make sense of what those DNA results mean.

Q. You mentioned reviewing their work. Do you take some of the same steps that you did when you were an analyst?

A. Sure. One of the steps that I performed as an analyst was a technical review. That's looking at all the documentation, all the paperwork, the data, making sure that, you know, all the I's are dotted, T's are crossed; all the procedures were performed correctly; all of the controls in the laboratory are working correctly; if there's no indications of contamination, looking at the data, making sure I agree with the interpretation of the data; and that's statistical calculations as well.

Q. What is your education background?

A. I have a bachelor's of science degree from Texas A&M University and cell and molecular biology and a master's of science degree in molecular biology from the University of Texas of Dallas.

Q. How many times have you testified?

A. Just north of 90 times.

Q. And for the defense only?

A. Majority of those are for the prosecution when I was still working in the lab. Currently I mostly work for the defense because the prosecution typically has a lab that performs the DNA testing and comes and explains those results to you.

Q. Have you been recognized by any other courts as an expert?

A. I have been recognized in 18 different states and three different countries and federal courts in both state, federal, civil courts all over the country.

Q. And those -- are you saying you have testified as an expert witness in those?

A. Yes.

Q. And what were those other countries?

A. I have been to Guam, South Korea, and United Kingdom.

Q. How did you get in the capacity to testify there?

A. Some of the work I do is for the military. So there are courts-martialed all over the world, so I am called on at times to go assist in those courts-martialed in different parts of world.

Q. Back in your prior experience when you worked at

the lab, did you have to take continuing education courses?

A. I did, yes.

Q. And what do you do now to kind of keep up with the knowledge?

A. Sure. I still read journal articles that come out recently or that are more recent and try to attend symposiums, seminars that talk about the latest technology in DNA. So I do stay up-to-date.

Q. You consider yourself a lifelong learner?

A. Yes, I do.

MS. DUGGAN: Judge, we ask this Court to recognize Mr. Quartaro as an expert in DNA testing procedures and DNA and serology.

MR. JONES: Your Honor, may I take the witness on voir dire?

THE COURT: You may.

VOIR DIRE EXAMINATION

BY MR. JONES:

Q. Mr. Quartaro, what is sub-source level DNA?

A. Sub-source level?

Q. Yes.

A. I'm not familiar with that term.

Q. How about activity level?

A. Activity level propositions?

Q. Tell us what that is.

A. Are you -- is that the correct term you're asking?

Q. Yes.

A. Activity level propositions are sometimes trying to add mathematical calculations to figure out what may be more likely in a case.

Q. Okay. And have you studied transfer DNA?

A. Yes.

Q. And are you here as -- holding yourself as an expert in transfer DNA?

A. Transfer DNA is part of DNA analysis.

Q. My question is: Are you here as an expert in transfer DNA?

A. Yes.

Q. Okay.

MR. JONES: No further questions, Your Honor.

THE COURT: Any objection?

MR. JONES: No objection.

THE COURT: All right. You may proceed.

MS. DUGGAN: Thank you, Judge.

DIRECT EXAMINATION CONTINUED

BY MS. DUGGAN:

Q. What is the first step when an analyst receives

DNA?

A. Typically it's to -- when it's received to the lab is to look at the packaging, verify all the case numbers are correct; that everything that was supposed to be submitted to the lab, whichever agency sends it in, is present; that doesn't appear to be any tampering; that all the evidence seals are in proper condition; and it is logged into an evidence room or some secure location to prevent, you know, easy access to that evidence.

Q. What happens next?

A. Typically is assigned to an analyst. An analyst may communicate with the law enforcement agency to get an understanding of the case, what was submitted, to try and identify, you know, what items may be pertinent to test, what exactly we're looking for.

Q. And when evidence is received, can the analyst attest to the integrity of the evidence?

A. They can attest to the integrity as they received it. So if it is received in a sealed condition, I can say I received this envelope, it was in a sealed condition, I know the label was a certain way. That's all I can really attest to.

Q. Can they attest to how it was collected?

A. No.

Q. Can they attest to if somehow it was

contaminated before they received it?

A. No.

Q. When looking at DNA, can we tell when and how it got somewhere?

A. No, we can't. I mean, DNA is great for telling us whose DNA is present on that sample when it was collected, but it's not great at telling us how it got there or when it got there or why it is there.

Q. What's the process of getting what I would call the raw data that the analysts look at? How does that happen?

A. Ms. Perkins went through the whole process yesterday starting with the extraction which is, you know, isolating the DNA from whatever sample is sent. Next would be quantitation, which would measure how much DNA you were able to extract from that sample. The next step would be amplification, which she described as a Xerox machine, you know, making millions and millions of copies of those particular regions that we're looking at. And then the final step is detection, where we are able to visualize the DNA that we just amplified. And then finally you interpret that data, compare it to the evidence samples, to the known reference samples that you have. If there is an inclusion or you're not able to exclude someone, then the statistical calculations are

performed at that time.

Q. What evidence did you look at in this case?

A. I looked at, you know, the case file from Texas DPS, which includes chain of custody, submission of documents, all of the vast paperwork from every step of the process. We're talking about extraction through detection. And the data itself, what the DNA profiles looked like. And, again, all of the reports as well.

Q. When you say what the DNA profiles look like, give us a rough visual of what you're looking at.

A. I think you saw one yesterday that Ms. Perkins put up, and it's basically, you know, you think of it like an EKG you may think of like at the hospital where there may be a couple of peaks and then flatline and a couple of peaks, and that's just indicative of the different sizes of DNA that we amplified that are separated by different color dyes that we add to them in the amplification process.

Q. And you were able to look at those in this case?

A. Yes.

Q. Do you know if there were any swab samples from a Jeep?

A. I don't recall seeing any swab samples from a Jeep on the submission forms. I know I didn't see any of them that were tested or were the results of any DNA

report.

Q. Do you know how many samples were from firearms?

A. I believe there was one swab from a SIG Sauer, from several locations on a SIG Sauer firearm.

Q. And then which known samples were the DNA then compared to?

A. There were four reference samples that were submitted. It was Ms. Cash, Mr. Strickland, Ms. Armstrong, and Ms. Wilson.

Q. So four individuals?

A. Correct.

Q. Did you recognize any serious flaws in the testing procedures?

A. No. I thought everything went pretty well.

Q. That's what we want to see, right?

A. Exactly.

Q. Okay. What type of DNA was analyzed in this case?

A. Well, going back to like the steps of DNA. One of the things that we look at first is can we identify any biological fluids. So blood, semen are the two most common fluids that we can test for. In this case, there was a couple of samples. There was a swab on the leg of Ms. Wilson, a stain from the floor that were tested for the presence of blood, which was negative. So really

when you're looking at skin cells, epithelial cells, basically cells that are not blood or semen.

Q. Let's kind of point our direction to you reviewed the evidence or the information related to the SIG Sauer testing, correct?

A. Correct.

Q. Okay. What were the results of that one?

A. So that was a mixture of three individuals. As Ms. Perkins told you, Ms. Armstrong and Mr. Strickland could not be excluded as potential contributors to that sample. You know, there was three individuals present. So there was still one -- some amount of DNA there that was unaccounted for.

Q. Do you make your own separate conclusions when you look at it or are you just referencing what the analyst said?

A. I do look at the data and evaluate from the number of contributors. I do make comparisons between the reference samples and the known samples, and I also verify the results as well. So I look at the report and see do I agree or not.

Q. Did you have any major disagreements between the reports?

A. No, I did not.

Q. You agreed with most of it, right?

A. Yes.

Q. Okay. So going back to that SIG Sauer. Who did you say couldn't be excluded?

A. Ms. Armstrong and Mr. Strickland.

Q. Do you know if that SIG Sauer belonged to Ms. Armstrong?

A. That was my understanding based on the documentation I received.

Q. Okay. Do you know where the swab was taken from on that firearm?

A. It was taken from several locations. There was -- I think all collected together there was the trigger, the trigger guard, the slide serrations, the grip, and the safety, I believe.

Q. So from what you reviewed, it was one swab that tested all the parts of the firearm?

A. It might have been two swabs together, but all of those samples were swabbed together and collected as one sample.

Q. So can you point to a specific DNA on the trigger versus another DNA that was on another part of the firearm?

A. No. When they're all collected together, all we're looking for, all we're able to say is this DNA was found somewhere on this firearm. And one of those

locations. It could be one location and not the other. It could be on all of those locations. Can't really say there's -- can't do any further resolution to this DNA was found on this particular part of the gun and this person's DNA was on a different part of the gun. All we have is DNA that's found in the sample that contained all those different areas of the pistol.

Q. Okay. Remind me again who you said was excluded from that?

A. It was Ms. Wilson and Ms. Cash.

Q. Okay. And then did you say there was an unknown individual's DNA on that firearm?

A. Again, it was a mixture of three people. We were able to not exclude Ms. Armstrong and Mr. Strickland, and there is additional genetic DNA there that's not consistent with any of the reference samples that we have.

Q. Can you tell us if it was male or female DNA?

A. No. If there is a male present, we will see a Y chromosome, but we are not able to say if there was more than one male there. So knowing that Mr. Strickland would not be excluded, he could be the source of that Y chromosome. Could the third person be a male? It's possible, but I can't really say with any sort of resolution because that Y chromosome can be present just

because Mr. Strickland cannot be excluded.

Q. That's kind of what the analyst testified to yesterday, right?

A. Correct.

Q. Let's move on to the bicycle handlebars. Do you recall the results of the DNA on the handlebars?

A. Yeah. Again, that was the mixture of three individuals. Ms. Wilson could not be excluded and Ms. Armstrong could not be excluded.

Q. Who could be excluded?

A. Mr. Strickland and Ms. Cash.

Q. Is it possible that Ms. Armstrong's DNA could be present even though Mr. Strickland's wasn't?

A. I really don't have any expectations of what DNA is going to be present on any item that I test. That's the reason that we test it. If we knew before we tested it whose DNA would be present -- again, we don't know how any of the DNA really ended up on that sample. So it could be anyone's DNA.

Q. Okay. What do you know about the unknown profile on the handlebars?

A. On the handlebars, I really can't say a whole lot. There was a Y chromosome present. So there is a little bit of male DNA present there. But there wasn't enough, you know, DNA there to generate a complete DNA

profile that, you know, we can say this is the third person. There's just additional genetic data there present.

Q. And it led you to believe it was male DNA?

A. Correct. There is a Y chromosome present there.

Q. Okay. Have you seen anything like that happen before or studied anything about it?

A. About which part? I'm sorry.

Q. Just having the male DNA, like what do you look for when you're making that determination?

A. One of the markers that we look at is called analogin and that, you know, tests for the presence of the X chromosome, which is present in both males and females, and the Y chromosome, which is only present in males. So if we see that Y chromosome present, it's an indication that a male was present or male DNA was present.

Q. Let's move on to the bicycle seat. Do you recall what the results of the DNA was on the seat?

A. Again, that was a mixture of three individuals, and, again, Ms. Wilson and Ms. Armstrong could not be excluded and same results with Ms. Cash and Mr. Strickland were excluded.

Q. And that third individual, the unknown, do you know anything about that one?

A. I don't. Again, there was not a lot of additional genetic data present. In this particular sample, there was no Y chromosome present. So it doesn't appear that a male was present, but it could also be a very low level male that just wasn't detected.

Q. And moving on to the underside of the bicycle seat, what were the results of this one?

A. The report listed this as an uninterpretable DNA profile. They weren't able to make comparisons to -- couldn't make comparisons to any of the reference samples because there wasn't a lot of genetic data present there.

Q. Okay. And you were here yesterday when the DNA analyst testified, right?

A. I was, yes.

Q. Okay. And she was a little bit uncomfortable sharing about that profile?

A. Yes. She determined it was uninterpretable, basically meaning that she wasn't able to compare it to any of the known reference samples. That can happen for a variety of reasons. Could be that there's not a lot of DNA there, which is the reason why this one was uninterpretable. Sometimes you can have too much DNA present, and because there's so many people contributing DNA to a sample, you can't get a determination as to, you know, this particular person is included.

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Q. So there was some sort of indication that there was male DNA, right?

A. Correct.

Q. But we couldn't have -- we don't know if this was Colin's known DNA or an unknown. We just detect that chromosome?

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Q. We kind of mentioned a couple of unknown profiles. Can we be sure how many unknown profiles there are?

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from, you know, someone that wasn't compared. We just have some additional genetic data in several of the samples. So we know that, you know, there's a number of samples with additional genetic data that wasn't consistent with any of the reference samples, but I can't say if it is the same person or who that may be.

Q. Okay. So it could have been one individual or it could have been multiple unknowns?

A. Correct. I have no idea. There wasn't enough data there to make that comparison.

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A. For, let's see, the handlebars, he was excluded by the laboratory. And the other for the -- I'm sorry, which samples again?

Q. The handlebars, seat, and the underside. I know that was a confusing question.

A. That's okay. On the seat, there was no Y chromosome detected. The underside of the seat, there was not enough genetic data to make a comparison to the

reference samples.

Q. Got you. Could they have compared these unknown profiles to other known profiles if they wanted to?

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Q. Okay. And we talked a lot yesterday about transfer DNA with the analyst. Give us a rundown of transfer DNA again.

A. Sure. Can I add one last caveat to my last statement?

Q. Yes. Sorry.

A. Okay. So the underside of the seat, again, there wasn't enough genetic data. So even if they sent a million reference samples, you couldn't compare it just because there's not enough data there. I just want to make sure I clarify that.

Q. Got you. Yes. Thank you for doing that.

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you come into contact with, you know, my water bottle here that I carry around all the time, it wouldn't be unexpected that my DNA is on that water bottle because I touch it and I handle it, leaving skin cells behind, maybe saliva when I drink out of it. It could have other people's DNA on it who may have touched it. It could have -- you know, if I have DNA on my hands from someone else and I grab my water bottle, it could leave some of that DNA behind there.

So DNA can transfer through contact. Again, it doesn't have to be direct contact. Can be DNA present on this water bottle from someone who's never touched the water bottle because I acted as the intermediary to transfer the DNA to the water bottle.

Q. Got you. And it can be transferred in multiple different ways, right?

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Q. So like we discussed yesterday, the four different types of DNA, blood, saliva, skin, semen, like those can all transfer in different ways, right?

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So you can see that there's a spectrum of you can touch something and not leave detectible amounts of DNA behind to you can not even touch something

and you can leave the only DNA profile behind. So that sort of demonstrates that DNA transfer is possible.

One case that was in the news or several articles written about it and in presentations given at different seminars, the case out of New York, and it was a home invasion case that turned into a homicide. Left behind there at the house, there was duct tape over the decedent's mouth and there were some gloves left by the perpetrators. They performed DNA testing on the gloves, they performed DNA testing on the duct tape and they did DNA testing underneath the fingernails of the deceased, and they found three different profiles, which was great from an investigative standpoint. The DNA profile from the tape and the DNA profile from the gloves, through different investigative means they found these two individuals were in that location at the time. So that, you know, was probable cause for them.

The DNA under the fingernails came from a man whose name was Lukis Anderson, and he was a homeless man who apparently couldn't find any real link to him and the crime scene other than the DNA under the fingernails. Come to find out, pretty earlier that day Mr. Anderson was found very inebriated when the ambulance was called and he was driven to the hospital in this ambulance. He was in the hospital at the time that this crime was

committed, and people were checking on him every 15 minutes because of his state, so he couldn't have performed this -- you know, this crime. After further digging and digging, they realized that the ambulance that had picked up Mr. Anderson was the same ambulance and ambulance team that picked up the deceased. And the idea is that possibly the pulse oximeter that's put on the finger of both of these individuals was the mechanism of transfer of that DNA.

Q. So we're trying to compare that this is how transfer works in real life, right?

A. Right. That's an example of it.

Q. Got you. And through the idea of transfer DNA, it's possible that Ms. Armstrong's DNA could be found somewhere but not Colin Strickland's, right?

A. Yes, that's possible.

Q. Is it possible to say whether Ms. Armstrong's DNA is there via touch or transfer DNA?

A. No. Just the presence of DNA somewhere doesn't give any indication of how that DNA got there.

Q. DNA doesn't tell us how it got there. It just tells us it's there.

A. Tells us who is there.

Q. Got you. I think I asked this question wrong yesterday, but what is wear DNA?

A. So wear DNA is DNA you would expect on someone that is wearing an item of clothing. Like my shirt I am wearing right now, you might expect to find my DNA kind of around the neck of the collar where it's rubbing against my neck. So me wearing this, you may see on the cuffs of my sleeves, around my neck, you may expect my DNA just because I am the one wearing this shirt and owns this shirt.

Q. And I've shown you a picture that's -- or a screenshot of a video that's been entered into evidence of Mr. Strickland and Ms. Wilson riding on a motorcycle.

A. Yes. You showed me that, yes.

Q. And there was a helmet. Can you tell us would that helmet be a good source of DNA?

A. Possibly. A helmet, especially a full face helmet that's covering the mouth, it could capture DNA. If you can imagine riding on a motorcycle and talking really loud to the person in front of you or talking to anyone, maybe coughing, sneezing, it may get caught in that mouthpiece or the piece that covers the mouth. Additionally, any time you're putting the helmet on and off, you know, it's going to be rubbing against your ears, rubbing against your skin, going to capture hair in there. The chin strap around your chin, if you tighten it really tight, opening and closing it, DNA from your

fingers could be on the buckle or the clasp that you tighten it or let it loose, and also around the chin strap, you know, where it's rubbing against your chin. So there are several places that could be good places where DNA could be left behind.

Q. It looked like that helmet kind of covered the mouth, right?

A. It appeared so.

Q. Okay. So that -- potential for lots of DNA in that helmet?

A. Yeah. Could be, yes.

Q. Okay. So if someone -- say somebody is wearing a hat and they take their hat off with one hand, right?

A. That's one way to take it off, yes.

Q. Yes. Thank you. And then touches something else with the same hand, is it possible any DNA from that hat can get onto that other item?

A. So their own DNA? They are wearing their own hat?

Q. Say it's somebody else's.

A. So if they are wearing someone else's hat, I mean, if there's DNA, a sufficient amount of DNA present in the location that they're touching, it could transfer to their hand, and if there's enough there, it could transfer to the next thing that they touch, yes.

Q. Yeah. I gave you a bad example, didn't I?

A. That's okay.

Q. So if it was somebody else's hat -- say it was my hat, had my DNA on it, you were wearing it, you took it off with your hand and then you came and touched one of those computers?

A. It's possible. Like if I touched a location that had a sufficient amount of DNA to transfer to my hand and there's DNA on my hand, that's step one, and then there's enough DNA for me to touch something else and transfer it there, then you have to have enough DNA to still be detectable. So it is a possibility.

Q. Thank you for clarifying that.

A. Sure.

Q. What's your opinion of whether or not Ms. Armstrong's DNA could have been located on the bicycle without her even touching it?

A. That's a possibility. Again, the DNA is there. It lets us know who is there. It doesn't tell us how it got there.

Q. That's kind of what the analyst said yesterday, right?

A. Correct.

Q. Possibility. You agree that a person's DNA can be present in a place they have never even been?

A. That's correct, yes.

Q. And can be on an item that they've never even seen, yet alone touched?

A. Correct, yes.

MS. DUGGAN: I pass the witness, Judge.

CROSS-EXAMINATION

BY MR. JONES:

Q. Good morning, Mr. Quartaro.

A. Good morning, sir. How are you?

Q. How are you doing, sir?

A. Doing good. How are you?

Q. Good. Just a few questions.

I want to talk about this. Is possibility and probability the same thing?

A. I mean, possibilities have different probabilities.

Q. Yes. Correct, right?

A. Correct, yes.

Q. You play the lottery?

A. Not that much. When it gets really high, I may buy a ticket just in the hopes something turns up, but I'm not a usual lottery player.

Q. I played the lottery when it was a billion dollars. Did you play when it was a billion dollars?

A. I do tend to buy a ticket or two when it gets

that high.

Q. Was it not a possibility that you would win?

A. There is a possibility I would win.

Q. But it wasn't likely, was it?

A. Not likely.

Q. Okay. Now, we talked about this touch DNA. She asked you is it possible for Ms. Armstrong's DNA to be on that bicycle without Ms. Armstrong having ever touched that bicycle, correct?

A. She did, yes.

Q. Is it possible?

A. It is possible.

Q. It is also possible that Ms. Armstrong's DNA is on that bicycle because Ms. Armstrong touched that bicycle?

A. That is a possibility as well, yes.

Q. Now, you talked about the fact that transfer DNA is possible, correct?

A. Yes.

Q. Does degradation play a part in whether there's DNA left to be able to be transferred?

A. Degradation will affect the amount of DNA that's present in the sample. So if we start with a large deposit of DNA and over time or through different factors it gets degraded, there will be less DNA there to

potentially transfer to something else.

Q. Okay. Now, did you receive any information at all that Ms. Armstrong ever had that helmet on that we're talking about?

A. I was given information that it was her helmet.

Q. It was her helmet?

A. Or the one that she wears.

Q. Oh, is that the information you were given?

A. Yes.

Q. Who gave you that information?

A. From the defense, yes.

Q. Oh, they didn't tell you it was Colin Strickland's helmet, correct?

A. They told me it was the helmet that she wore when she road the bike with him.

Q. Oh, okay. Did they tell you that she hadn't been on that bike for over a month?

A. No.

Q. Would that affect degradation?

A. I mean, there could possibly be degradation. Degradation doesn't happen overnight. There has to be -- you know, different factors can cause degradation to occur at different rates.

Q. Okay. How about other environmental factors, heat?

A. Heat can. It can promote some degradation.

Q. How about Mr. Strickland putting the helmet on and off several times before Mo Wilson puts it on?

A. I wouldn't call that degradation, but that may add some of his DNA to it as he puts the helmet on and takes it off, and it may remove some of Ms. Armstrong's DNA that was there after he puts it on and off.

Q. That's if Ms. Armstrong had any DNA on the helmet in the first place, correct?

A. Correct. There was no testing done of the helmet, so I don't know.

Q. You didn't receive any information that she had that helmet on, did you?

A. Again, the information I was given is that was the helmet she wears when she rides the motorcycle with Mr. Strickland.

Q. Did she give you that information?

A. Who?

Q. Ms. Armstrong, the defendant.

A. No. I haven't talked to her.

Q. Okay. I just want to be sure.

How about if -- assuming there were DNA in that helmet, what if Ms. Wilson or Colin Strickland put the helmet on and took the helmet off and the DNA became on their person and they went swimming, would that affect

the DNA they had on?

A. That could remove some of the DNA that's there, yes, if it did transfer.

Q. If it transferred, the swimming may wipe it off?

A. Correct.

Q. Now, you also talked about skin cells, epithelial DNA, correct, when you handshake or something like that?

A. Yes.

Q. And you talked about the level of some people are more -- shed more?

A. They can, yes. And they can change based on environmental factors too, yes. Some persons -- some people in one -- one instance maybe leave a lot of DNA behind. Like if your hands are a little bit sweaty, a little nervous, I may leave a little bit more DNA behind, you know. When I'm sitting on my couch all relaxed, you know, I may not shed as much DNA because my hands aren't sweaty or my hands are clean.

Q. You're saying if you're nervous, you might shed a little bit more?

A. That is one possibility.

Q. Okay. Let me ask you a hypothetical. You don't have a weapon, do you?

A. No, sir.

Q. Okay. But if you had one and you were getting ready to shoot me in about 15 minutes, might you be a little nervous and heightened if you've never done it before?

A. Possibly, yes.

Q. And if you got nervous because of that, would it potentially cause your DNA to shed a little more?

A. I wouldn't know if I would call it nerves make you shed more DNA, but potentially sweaty hands. You know, again, friction is another way that DNA can transfer. So I wouldn't say that nervousness itself causes you to shed more DNA, but some of those physical reactions to nerves may.

Q. You testified that because you're nervous, your hands were sweaty and that may cause more DNA?

A. Correct. Correct.

Q. Would the hypothetical I just described to you, do you think that might make you nervous and sweaty?

A. Potentially, yes.

Q. Okay. Now, also, you talked about that -- those -- an Indianapolis study, correct?

A. Yes.

Q. Was that study in pristine lab conditions?

A. They try to control it as best as possible. So in the beginning, they'd sort of rinse their hands off.

One person would -- wore rubber gloves to prevent any contamination from any outside sources. Again, an extended handshake, extended handling of the knife, that was in controlled conditions.

Q. Right. But in that hypothetical, nobody went on vacation for 30 days before they came back and touched that knife, did they?

A. No, sir. It was an immediate shake hands, touch the knife.

Q. Nobody went swimming and came back and touched that knife, did they?

A. No, sir. It was immediately after.

Q. So those factors might affect the DNA to get transferred to that knife?

A. The immediacy of the touch.

Q. How long, whether they went swimming before they touched the knife?

A. Sure. Anything that happens between when DNA is deposited on one thing and comes into contact with someone else could affect how much DNA is present to transfer.

Q. Now, what is tertiary transfer?

A. Primary DNA transfer is where I touch something and leave skin cells behind. Secondary transfer is where someone else comes by and touches it and the DNA

transfers to their hand. And then tertiary would be them moving that DNA to a different object or person.

Q. Is there another level where you go a fourth time?

A. Quaternary.

Q. Quaternary?

A. Yes.

Q. I wanted you to say it so I wouldn't screw it up.

A. I don't know if I said it right.

Q. I don't know if you said it right either. So would all those levels affect the amount of DNA that might be available to transfer, assuming you had some in the first place?

A. Sure. So any DNA transfer that occurs typically doesn't take all of the DNA from that initial transfer. So if I touch this counter here and I leave DNA behind, someone else may come by, touch it, and just take a portion of that DNA. And then whatever is on their hands when they touch something else, they could just leave a portion of that DNA. It's not going to take all the DNA off their hands and transfer it. So it's not like -- you think of it as like an in-tact unit. It's not like passing along from one transfer to the next. It's just a portion of that DNA that's getting transferred to the

next step.

Q. So does that mean that with every transfer, the possibility of the existence of DNA may be diminished?

A. If you are talking about the same sample, right. So if you're talking about a particular pool of DNA, for lack of a better word, but then someone or something touches and transfers and transfers, yes, I would expect there to be less DNA in subsequent transfers.

Q. What about if I shook your hand just briefly and then I came back, grabbed my water bottle, if you transfer DNA, might I deposit some on my water bottle?

A. That's a possibility, yes.

Q. And I would possibly have less on my hand?

A. Correct.

Q. And I left this building and turned the doorknob, could I then deposit some more on the doorknob?

A. Yes, you could.

Q. If I picked up my phone to use my phone, assuming there's any left, could I also transfer it to my phone?

A. Yes.

Q. So then me going and touching a fourth item, wouldn't a possibility of me having DNA left on my hand, if you, indeed, did transfer it to me, would be diminished significantly?

A. The amount of DNA there would be much less, yes.

Q. Now, if Mr. Colin Strickland was the primary wearer of his helmet, would you expect his DNA to be on his helmet?

A. Yes.

Q. Would you expect his DNA to be the primary source on his helmet?

A. I can't say yes because I don't know. There's a lot of factors that come into play there.

Q. Tell me those factors.

A. If he wears it all the time and someone else wears it one time and has a cold, they sneeze a lot, you can expect more DNA there. So while someone who wears it often may leave their DNA behind there, again, people shed at different rates. There's different factors that can affect how much DNA someone wearing that helmet subsequent or in the middle could leave behind on an item.

Q. Okay. So once again, you're not here today to tell us how the defendant's DNA got on Ms. Wilson's bike, are you?

A. No, sir. Again, DNA doesn't tell us how DNA ended up somewhere.

Q. And you don't have any personal knowledge or you haven't been given any information to refute the fact

that her DNA may have been there because she touched the bike, do you?

A. That is a possibility.

MR. JONES: Just one second, Your Honor.

Q. (By Mr. Jones) Do you know a scientist by the name of Bruce Budowle?

A. Yes.

Q. Would you consider him respected in this field?

A. Absolutely.

Q. How about Peter Gill?

A. Yes.

Q. Would you consider him a respected opinion?

A. I do, yes.

MR. JONES: No further questions. I pass the witness, Your Honor.

REDIRECT EXAMINATION

BY MS. DUGGAN:

Q. Body fluid is a rich source of DNA, right?

A. It is, yes.

Q. Would you say more rich than skin cells?

A. Again, it's hard. You're comparing apples to oranges, right. So blood, saliva, semen are very rich sources of DNA. If I were to compare that to one light touch of an item of this counter top, I would expect, you know, a visible amount of blood or saliva or semen to

contain more DNA there. So it's hard to like pound for pound like say which one. I would expect saliva, semen, and bodily fluids to contain higher concentrations of DNA potentially. I mean, again, depends on the touch and a lot of different factors.

Q. When we were talking about the helmet, we weren't just referencing skin cell DNA but maybe also sweat, right?

A. Correct.

Q. You wear a helmet, it could be hot outside?

A. Yes.

Q. Do you live in Texas?

A. I do, yes.

Q. What is May like in Texas?

A. Mostly I'm inside. It's hot.

Q. Especially this year, right?

A. Yes.

Q. And we were just kind of using the helmet as one way, but there could have been other ways that DNA was transferred, right?

A. Right. Again, I can't tell you how the DNA got there. There could be many different possibilities for how the DNA ended up there.

Q. Does the presence of moisture affect transferability of DNA?

A. It can aid in, you know, providing a mechanism to make it more likely or transfer more DNA if there's moisture available to remove any skin cells or saliva or bodily fluids to a different item.

Q. If somebody was swimming, that could help. Or what other -- what other form of moisture would that be?

A. I was thinking sweat.

Q. Got you. DNA doesn't tell you how long it's been sitting there?

A. Correct.

Q. Just tells you there's some form of DNA there?

A. Right. Tells you potentially whose DNA it is.

MS. DUGGAN: Pass the witness, Judge.

RECROSS-EXAMINATION

BY MR. JONES:

Q. You said that May in Texas is hot, correct?

A. Yes, sir.

Q. Now, just to be clear: You were given some information that that was not Colin Strickland's helmet. Is that what you testified to?

A. I may have -- what I was told was this was the helmet that she wore when she was riding the motorcycle with Colin Strickland.

Q. But you didn't tell she hadn't been on the motorcycle in over a month. You weren't told that, were

you?

A. I have no information as to how often, when, the last time, any of that.

Q. What if I told you that on the day of this murder that Mr. Colin Strickland had that helmet on and he road from South Austin to North Austin to a dentist appointment, is it possible he was sweating in the Texas heat?

A. That's a possibility, yes.

Q. And what if I told you that later on that day, he road that motorcycle back in the May Texas heat from North Austin to East Central Austin, is it possible he was sweating with that helmet on?

A. I would imagine that's a possibility, yes.

Q. With those facts and if I also told you if Ms. Wilson had the helmet -- or Ms. Armstrong had the helmet on, it was more than 30 days ago, what would you expect from all that sweat from Mr. Strickland to be inside the helmet?

A. Again, I don't know what is inside the helmet, right. There was no DNA testing that was performed inside of the helmet. Could there be a lot of Mr. Strickland's DNA there because it's his helmet, absolutely. Could there be DNA from other people who also wore the helmet, absolutely. That's about as much

information as I can say seeing how the helmet wasn't tested.

Q. You also testified that if the DNA was to get on someone, them going swimming could potentially wash it off?

A. It could, yes.

MR. JONES: Okay. Pass the witness, Your Honor.

MS. DUGGAN: No questions, Judge.

THE COURT: Thank you. You may step down.

Ladies and gentlemen of the jury, we'll take a 15-minute break.

(Recess)

(Open Court, Defendant and Jury Present)

THE COURT: Defense.

MR. PURYEAR: Judge, defense calls Bill Tobin. This was the witness the Court previously allowed virtual testimony for, Your Honor. We're just getting that logistically worked out.

THE COURT: You're getting it worked out or has it been worked out?

MR. PURYEAR: It has been worked out. We are trying to -- in light of cross-examination, Your Honor, and I think some documents it sounds like that may be shown to the expert, we are trying to get that

and you can leave the only DNA profile behind. So that sort of demonstrates that DNA transfer is possible.

One case that was in the news or several articles written about it and in presentations given at different seminars, the case out of New York, and it was a home invasion case that turned into a homicide. Left behind there at the house, there was duct tape over the decedent's mouth and there were some gloves left by the perpetrators. They performed DNA testing on the gloves, they performed DNA testing on the duct tape and they did DNA testing underneath the fingernails of the deceased, and they found three different profiles, which was great from an investigative standpoint. The DNA profile from the tape and the DNA profile from the gloves, through different investigative means they found these two individuals were in that location at the time. So that, you know, was probable cause for them.

The DNA under the fingernails came from a man whose name was Lukis Anderson, and he was a homeless man who apparently couldn't find any real link to him and the crime scene other than the DNA under the fingernails. Come to find out, pretty earlier that day Mr. Anderson was found very inebriated when the ambulance was called and he was driven to the hospital in this ambulance. He was in the hospital at the time that this crime was

committed, and people were checking on him every 15 minutes because of his state, so he couldn't have performed this -- you know, this crime. After further digging and digging, they realized that the ambulance that had picked up Mr. Anderson was the same ambulance and ambulance team that picked up the deceased. And the idea is that possibly the pulse oximeter that's put on the finger of both of these individuals was the mechanism of transfer of that DNA.

Q. So we're trying to compare that this is how transfer works in real life, right?

A. Right. That's an example of it.

Q. Got you. And through the idea of transfer DNA, it's possible that Ms. Armstrong's DNA could be found somewhere but not Colin Strickland's, right?

A. Yes, that's possible.

Q. Is it possible to say whether Ms. Armstrong's DNA is there via touch or transfer DNA?

A. No. Just the presence of DNA somewhere doesn't give any indication of how that DNA got there.

Q. DNA doesn't tell us how it got there. It just tells us it's there.

A. Tells us who is there.

Q. Got you. I think I asked this question wrong yesterday, but what is wear DNA?

A. So wear DNA is DNA you would expect on someone that is wearing an item of clothing. Like my shirt I am wearing right now, you might expect to find my DNA kind of around the neck of the collar where it's rubbing against my neck. So me wearing this, you may see on the cuffs of my sleeves, around my neck, you may expect my DNA just because I am the one wearing this shirt and owns this shirt.

Q. And I've shown you a picture that's -- or a screenshot of a video that's been entered into evidence of Mr. Strickland and Ms. Wilson riding on a motorcycle.

A. Yes. You showed me that, yes.

Q. And there was a helmet. Can you tell us would that helmet be a good source of DNA?

A. Possibly. A helmet, especially a full face helmet that's covering the mouth, it could capture DNA. If you can imagine riding on a motorcycle and talking really loud to the person in front of you or talking to anyone, maybe coughing, sneezing, it may get caught in that mouthpiece or the piece that covers the mouth. Additionally, any time you're putting the helmet on and off, you know, it's going to be rubbing against your ears, rubbing against your skin, going to capture hair in there. The chin strap around your chin, if you tighten it really tight, opening and closing it, DNA from your

fingers could be on the buckle or the clasp that you tighten it or let it loose, and also around the chin strap, you know, where it's rubbing against your chin. So there are several places that could be good places where DNA could be left behind.

Q. It looked like that helmet kind of covered the mouth, right?

A. It appeared so.

Q. Okay. So that -- potential for lots of DNA in that helmet?

A. Yeah. Could be, yes.

Q. Okay. So if someone -- say somebody is wearing a hat and they take their hat off with one hand, right?

A. That's one way to take it off, yes.

Q. Yes. Thank you. And then touches something else with the same hand, is it possible any DNA from that hat can get onto that other item?

A. So their own DNA? They are wearing their own hat?

Q. Say it's somebody else's.

A. So if they are wearing someone else's hat, I mean, if there's DNA, a sufficient amount of DNA present in the location that they're touching, it could transfer to their hand, and if there's enough there, it could transfer to the next thing that they touch, yes.

Q. Yeah. I gave you a bad example, didn't I?

A. That's okay.

Q. So if it was somebody else's hat -- say it was my hat, had my DNA on it, you were wearing it, you took it off with your hand and then you came and touched one of those computers?

A. It's possible. Like if I touched a location that had a sufficient amount of DNA to transfer to my hand and there's DNA on my hand, that's step one, and then there's enough DNA for me to touch something else and transfer it there, then you have to have enough DNA to still be detectable. So it is a possibility.

Q. Thank you for clarifying that.

A. Sure.

Q. What's your opinion of whether or not Ms. Armstrong's DNA could have been located on the bicycle without her even touching it?

A. That's a possibility. Again, the DNA is there. It lets us know who is there. It doesn't tell us how it got there.

Q. That's kind of what the analyst said yesterday, right?

A. Correct.

Q. Possibility. You agree that a person's DNA can be present in a place they have never even been?

A. That's correct, yes.

Q. And can be on an item that they've never even seen, yet alone touched?

A. Correct, yes.

MS. DUGGAN: I pass the witness, Judge.

CROSS-EXAMINATION

BY MR. JONES:

Q. Good morning, Mr. Quartaro.

A. Good morning, sir. How are you?

Q. How are you doing, sir?

A. Doing good. How are you?

Q. Good. Just a few questions.

I want to talk about this. Is possibility and probability the same thing?

A. I mean, possibilities have different probabilities.

Q. Yes. Correct, right?

A. Correct, yes.

Q. You play the lottery?

A. Not that much. When it gets really high, I may buy a ticket just in the hopes something turns up, but I'm not a usual lottery player.

Q. I played the lottery when it was a billion dollars. Did you play when it was a billion dollars?

A. I do tend to buy a ticket or two when it gets

that high.

Q. Was it not a possibility that you would win?

A. There is a possibility I would win.

Q. But it wasn't likely, was it?

A. Not likely.

Q. Okay. Now, we talked about this touch DNA. She asked you is it possible for Ms. Armstrong's DNA to be on that bicycle without Ms. Armstrong having ever touched that bicycle, correct?

A. She did, yes.

Q. Is it possible?

A. It is possible.

Q. It is also possible that Ms. Armstrong's DNA is on that bicycle because Ms. Armstrong touched that bicycle?

A. That is a possibility as well, yes.

Q. Now, you talked about the fact that transfer DNA is possible, correct?

A. Yes.

Q. Does degradation play a part in whether there's DNA left to be able to be transferred?

A. Degradation will affect the amount of DNA that's present in the sample. So if we start with a large deposit of DNA and over time or through different factors it gets degraded, there will be less DNA there to

potentially transfer to something else.

Q. Okay. Now, did you receive any information at all that Ms. Armstrong ever had that helmet on that we're talking about?

A. I was given information that it was her helmet.

Q. It was her helmet?

A. Or the one that she wears.

Q. Oh, is that the information you were given?

A. Yes.

Q. Who gave you that information?

A. From the defense, yes.

Q. Oh, they didn't tell you it was Colin Strickland's helmet, correct?

A. They told me it was the helmet that she wore when she road the bike with him.

Q. Oh, okay. Did they tell you that she hadn't been on that bike for over a month?

A. No.

Q. Would that affect degradation?

A. I mean, there could possibly be degradation. Degradation doesn't happen overnight. There has to be -- you know, different factors can cause degradation to occur at different rates.

Q. Okay. How about other environmental factors, heat?

A. Heat can. It can promote some degradation.

Q. How about Mr. Strickland putting the helmet on and off several times before Mo Wilson puts it on?

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Q. That's if Ms. Armstrong had any DNA on the helmet in the first place, correct?

A. Correct. There was no testing done of the helmet, so I don't know.

Q. You didn't receive any information that she had that helmet on, did you?

A. Again, the information I was given is that was the helmet she wears when she rides the motorcycle with Mr. Strickland.

Q. Did she give you that information?

A. Who?

Q. Ms. Armstrong, the defendant.

A. No. I haven't talked to her.

Q. Okay. I just want to be sure.

How about if -- assuming there were DNA in that helmet, what if Ms. Wilson or Colin Strickland put the helmet on and took the helmet off and the DNA became on their person and they went swimming, would that affect

the DNA they had on?

A. That could remove some of the DNA that's there, yes, if it did transfer.

Q. If it transferred, the swimming may wipe it off?

A. Correct.

Q. Now, you also talked about skin cells, epithelial DNA, correct, when you handshake or something like that?

A. Yes.

Q. And you talked about the level of some people are more -- shed more?

A. They can, yes. And they can change based on environmental factors too, yes. Some persons -- some people in one -- one instance maybe leave a lot of DNA behind. Like if your hands are a little bit sweaty, a little nervous, I may leave a little bit more DNA behind, you know. When I'm sitting on my couch all relaxed, you know, I may not shed as much DNA because my hands aren't sweaty or my hands are clean.

Q. You're saying if you're nervous, you might shed a little bit more?

A. That is one possibility.

Q. Okay. Let me ask you a hypothetical. You don't have a weapon, do you?

A. No, sir.

Q. Okay. But if you had one and you were getting ready to shoot me in about 15 minutes, might you be a little nervous and heightened if you've never done it before?

A. Possibly, yes.

Q. And if you got nervous because of that, would it potentially cause your DNA to shed a little more?

A. I wouldn't know if I would call it nerves make you shed more DNA, but potentially sweaty hands. You know, again, friction is another way that DNA can transfer. So I wouldn't say that nervousness itself causes you to shed more DNA, but some of those physical reactions to nerves may.

Q. You testified that because you're nervous, your hands were sweaty and that may cause more DNA?

A. Correct. Correct.

Q. Would the hypothetical I just described to you, do you think that might make you nervous and sweaty?

A. Potentially, yes.

Q. Okay. Now, also, you talked about that -- those -- an Indianapolis study, correct?

A. Yes.

Q. Was that study in pristine lab conditions?

A. They try to control it as best as possible. So in the beginning, they'd sort of rinse their hands off.

One person would -- wore rubber gloves to prevent any contamination from any outside sources. Again, an extended handshake, extended handling of the knife, that was in controlled conditions.

Q. Right. But in that hypothetical, nobody went on vacation for 30 days before they came back and touched that knife, did they?

A. No, sir. It was an immediate shake hands, touch the knife.

Q. Nobody went swimming and came back and touched that knife, did they?

A. No, sir. It was immediately after.

Q. So those factors might affect the DNA to get transferred to that knife?

A. The immediacy of the touch.

Q. How long, whether they went swimming before they touched the knife?

A. Sure. Anything that happens between when DNA is deposited on one thing and comes into contact with someone else could affect how much DNA is present to transfer.

Q. Now, what is tertiary transfer?

A. Primary DNA transfer is where I touch something and leave skin cells behind. Secondary transfer is where someone else comes by and touches it and the DNA

transfers to their hand. And then tertiary would be them moving that DNA to a different object or person.

Q. Is there another level where you go a fourth time?

A. Quaternary.

Q. Quaternary?

A. Yes.

Q. I wanted you to say it so I wouldn't screw it up.

A. I don't know if I said it right.

Q. I don't know if you said it right either. So would all those levels affect the amount of DNA that might be available to transfer, assuming you had some in the first place?

A. Sure. So any DNA transfer that occurs typically doesn't take all of the DNA from that initial transfer. So if I touch this counter here and I leave DNA behind, someone else may come by, touch it, and just take a portion of that DNA. And then whatever is on their hands when they touch something else, they could just leave a portion of that DNA. It's not going to take all the DNA off their hands and transfer it. So it's not like -- you think of it as like an in-tact unit. It's not like passing along from one transfer to the next. It's just a portion of that DNA that's getting transferred to the

next step.

Q. So does that mean that with every transfer, the possibility of the existence of DNA may be diminished?

A. If you are talking about the same sample, right. So if you're talking about a particular pool of DNA, for lack of a better word, but then someone or something touches and transfers and transfers, yes, I would expect there to be less DNA in subsequent transfers.

Q. What about if I shook your hand just briefly and then I came back, grabbed my water bottle, if you transfer DNA, might I deposit some on my water bottle?

A. That's a possibility, yes.

Q. And I would possibly have less on my hand?

A. Correct.

Q. And I left this building and turned the doorknob, could I then deposit some more on the doorknob?

A. Yes, you could.

Q. If I picked up my phone to use my phone, assuming there's any left, could I also transfer it to my phone?

A. Yes.

Q. So then me going and touching a fourth item, wouldn't a possibility of me having DNA left on my hand, if you, indeed, did transfer it to me, would be diminished significantly?

A. The amount of DNA there would be much less, yes.

Q. Now, if Mr. Colin Strickland was the primary wearer of his helmet, would you expect his DNA to be on his helmet?

A. Yes.

Q. Would you expect his DNA to be the primary source on his helmet?

A. I can't say yes because I don't know. There's a lot of factors that come into play there.

Q. Tell me those factors.

A. If he wears it all the time and someone else wears it one time and has a cold, they sneeze a lot, you can expect more DNA there. So while someone who wears it often may leave their DNA behind there, again, people shed at different rates. There's different factors that can affect how much DNA someone wearing that helmet subsequent or in the middle could leave behind on an item.

Q. Okay. So once again, you're not here today to tell us how the defendant's DNA got on Ms. Wilson's bike, are you?

A. No, sir. Again, DNA doesn't tell us how DNA ended up somewhere.

Q. And you don't have any personal knowledge or you haven't been given any information to refute the fact

that her DNA may have been there because she touched the bike, do you?

A. That is a possibility.

MR. JONES: Just one second, Your Honor.

Q. (By Mr. Jones) Do you know a scientist by the name of Bruce Budowle?

A. Yes.

Q. Would you consider him respected in this field?

A. Absolutely.

Q. How about Peter Gill?

A. Yes.

Q. Would you consider him a respected opinion?

A. I do, yes.

MR. JONES: No further questions. I pass the witness, Your Honor.

REDIRECT EXAMINATION

BY MS. DUGGAN:

Q. Body fluid is a rich source of DNA, right?

A. It is, yes.

Q. Would you say more rich than skin cells?

A. Again, it's hard. You're comparing apples to oranges, right. So blood, saliva, semen are very rich sources of DNA. If I were to compare that to one light touch of an item of this counter top, I would expect, you know, a visible amount of blood or saliva or semen to

contain more DNA there. So it's hard to like pound for pound like say which one. I would expect saliva, semen, and bodily fluids to contain higher concentrations of DNA potentially. I mean, again, depends on the touch and a lot of different factors.

Q. When we were talking about the helmet, we weren't just referencing skin cell DNA but maybe also sweat, right?

A. Correct.

Q. You wear a helmet, it could be hot outside?

A. Yes.

Q. Do you live in Texas?

A. I do, yes.

Q. What is May like in Texas?

A. Mostly I'm inside. It's hot.

Q. Especially this year, right?

A. Yes.

Q. And we were just kind of using the helmet as one way, but there could have been other ways that DNA was transferred, right?

A. Right. Again, I can't tell you how the DNA got there. There could be many different possibilities for how the DNA ended up there.

Q. Does the presence of moisture affect transferability of DNA?

A. It can aid in, you know, providing a mechanism to make it more likely or transfer more DNA if there's moisture available to remove any skin cells or saliva or bodily fluids to a different item.

Q. If somebody was swimming, that could help. Or what other -- what other form of moisture would that be?

A. I was thinking sweat.

Q. Got you. DNA doesn't tell you how long it's been sitting there?

A. Correct.

Q. Just tells you there's some form of DNA there?

A. Right. Tells you potentially whose DNA it is.

MS. DUGGAN: Pass the witness, Judge.

RECROSS-EXAMINATION

BY MR. JONES:

Q. You said that May in Texas is hot, correct?

A. Yes, sir.

Q. Now, just to be clear: You were given some information that that was not Colin Strickland's helmet. Is that what you testified to?

A. I may have -- what I was told was this was the helmet that she wore when she was riding the motorcycle with Colin Strickland.

Q. But you didn't tell she hadn't been on the motorcycle in over a month. You weren't told that, were

you?

A. I have no information as to how often, when, the last time, any of that.

Q. What if I told you that on the day of this murder that Mr. Colin Strickland had that helmet on and he road from South Austin to North Austin to a dentist appointment, is it possible he was sweating in the Texas heat?

A. That's a possibility, yes.

Q. And what if I told you that later on that day, he road that motorcycle back in the May Texas heat from North Austin to East Central Austin, is it possible he was sweating with that helmet on?

A. I would imagine that's a possibility, yes.

Q. With those facts and if I also told you if Ms. Wilson had the helmet -- or Ms. Armstrong had the helmet on, it was more than 30 days ago, what would you expect from all that sweat from Mr. Strickland to be inside the helmet?

A. Again, I don't know what is inside the helmet, right. There was no DNA testing that was performed inside of the helmet. Could there be a lot of Mr. Strickland's DNA there because it's his helmet, absolutely. Could there be DNA from other people who also wore the helmet, absolutely. That's about as much

information as I can say seeing how the helmet wasn't tested.

Q. You also testified that if the DNA was to get on someone, them going swimming could potentially wash it off?

A. It could, yes.

MR. JONES: Okay. Pass the witness, Your Honor.

MS. DUGGAN: No questions, Judge.

THE COURT: Thank you. You may step down.

Ladies and gentlemen of the jury, we'll take a 15-minute break.

(Recess)

(Open Court, Defendant and Jury Present)

THE COURT: Defense.

MR. PURYEAR: Judge, defense calls Bill Tobin. This was the witness the Court previously allowed virtual testimony for, Your Honor. We're just getting that logistically worked out.

THE COURT: You're getting it worked out or has it been worked out?

MR. PURYEAR: It has been worked out. We are trying to -- in light of cross-examination, Your Honor, and I think some documents it sounds like that may be shown to the expert, we are trying to get that

EXHIBIT E

on the issue of our request as to Count Two of the indictment and perhaps --

MR. SYLESTINE: Paragraph One.

MR. PURYEAR: Paragraph One. I'm sorry.

THE COURT: Yes. Your request is denied.

MR. PURYEAR: Okay. Thank you, Your Honor.

(Open Court, Defendant and Jury Present)

THE COURT: Defense.

MR. COFER: The defense rests.

THE COURT: All right. State.

MR. JONES: Your Honor, State calls Dr. Tim Kalafut.

TIM KALAFUT,

Having been first duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. JONES:

Q. Mr. Kalafut, please introduce yourself to the jury.

A. My name is Tim Kalafut. I am a professor at Sam Houston State University teaching forensic science.

Q. And, Dr. Kalafut, how long have you been at Sam Houston State University?

A. This is my fourth year.

Q. And have you taught the same thing the whole time you've been there?

A. Yes. For four years I've focused on the area of forensics that is the DNA portion.

Q. And what did you do before you was at Sam Houston State University?

A. I was a DNA practitioner in two different crime labs. I started out in 1999 at the Southwestern Institute of Forensic Sciences in Dallas, Texas, the Dallas County Crime Lab; and then I spent almost 19 years at the United States Army Criminal Investigation Laboratory, which is located just outside Atlanta, Georgia.

Q. Dr. Kalafut, tell me about your education and training.

A. I have a bachelor's degree in chemistry and a music minor from Whitworth -- I would call it Whitworth College. They moved up in the world now. They are Whitworth University. And then I went to Texas A&M to get a PhD in toxicology.

Q. Tell me about your training and experience to be a forensic scientist.

A. In the two jobs that I worked at, we did on-the-job training. You get spun up to speed on the specific aspects of the protocol of those labs. I was involved in doing a lot of validation and testing of the DNA kits, testing the science. I have been to continuing

education all year and once a year all year for 20 some-odd years. And somewhere along the line, I had a midlife crisis, went back to school, but now I'm teaching instead of attending classes.

Q. And, Dr. Kalafut, have you testified as an expert in the State of Texas before in DNA?

A. Yes, back in 1999 through about I guess calendar year 2001. That's when I moved to Atlanta.

Q. What did you do when you were in Atlanta?

A. Same thing. Analyze evidence for biological material and then generate DNA profiles from that biological material, do the comparisons, and then go to court as needed.

Q. And, Dr. Kalafut, approximately how many times have you testified in court?

A. Somewhere around a hundred times.

MR. JONES: Your Honor, I'd like to offer Dr. Kalafut as an expert in DNA.

MS. DUGGAN: May I take him on brief voir dire, Judge?

THE COURT: Yes.

VOIR DIRE EXAMINATION

BY MS. DUGGAN:

Q. Hi, Doctor.

A. Hello.

Q. Have you produced any sort of publications on DNA?

A. Yes. I'm an author, a coauthor on probably somewhere around seven to 10 different papers.

Q. Okay. And do you do any sort of continuing education regarding DNA studies?

A. I do those studies now at SHSU as a researcher, yes.

Q. Understood.

MS. DUGGAN: Thank you, Judge. I have no objection to the expert.

THE COURT: All right. You may proceed.

DIRECT EXAMINATION CONTINUED

BY MR. JONES:

Q. Dr. Kalafut, you have consulted in this case; is that correct?

A. Yes. I have been kind of asked to come in towards the end of the process to take a look at a few specific things.

Q. And do you know Samantha Perkins?

A. Yes.

Q. Did you review her work?

A. Yes, I did.

Q. And do you for the most part agree with her findings?

A. In terms of her DNA interpretations of who really can't be a source of the DNA, yes. In terms of persons who might be considered possible sources, I agree with that also. So her interpretation of the four reference swabs that were collected from the four persons in the case, yes, I agree.

Q. Dr. Kalafut, I asked the defense DNA expert and I'm going to ask you the same question. What is sub-source level proposition?

A. So the levels of proposition date back to a paper from last century, 1998, where all forensic evidence, not just DNA, is dealt with at levels of the hierarchy. So this hierarchy is essentially what the Court is interested in.

At the pinnacle of this hierarchy would be was whatever brought us here an offense or not. And we forensic scientists, we stay away from that. That's your job. Not my job.

The next level down is considered the activity level. Can forensic science kind of help understand what happened or when something happened.

Below that in the DNA field is the source level. That's dealing with maybe who was the source of the blood, who was the source of the semen in a case, that type of thing. But that was 1998. So now DNA

showed up and they kind of had to dig a basement. So now we have the sub-source level, which deals with the question who might be the source of the DNA that was recovered. And now that we have quantitative DNA techniques, meaning we can tell who -- one person gave more DNA than another, we now have the sub sub-source.

So these kind of levels of the hierarchy of propositions, the propositions are the things that the parties argue about in court. And then the things that the DNA person is supposed to evaluate the evidence, given these issues, this is a fundamental foundation of all forensic science, and it's been formally in the literature for about 25 years now.

Q. And, Dr. Kalafut, with regards to this case -- first of all, I would like to ask you about a study. The defense expert talked about a study in Indianapolis. Are you aware of that study?

A. Yes.

Q. Tell me about that study.

A. This is a study where they had people shake hands and then immediately swap the knife. They tried to see how often the person who did not handle the knife was found on the knife. Two different groups published rebuttals to that study, one focussing on the provocative nature of the title, what the paper was called Secondary

Transfer, falsely placed someone at the scene of a crime. Well, the study was done in a lab where people -- it went bing, bang, boom. There was no crime scene involved. But more than that, the participants in this study wore latex lab gloves for 90 minutes, for an hour and a half, before they shook hands. If you've never been in a lab and wore latex gloves for 90 minutes, when you pull those gloves off, it's a sweaty gooey mess. And then they didn't just shake hands. They shook hands for two minutes. So let me know when this starts being awkward for two minutes (indicating). And then they immediately grabbed the knife and they immediately sampled the knife. So, yes, it -- the best-case scenario for indirect transfer, and only five out of 20 some-odd replicates did they find a major DNA profile. That was considered misleading by two different groups that published rebuttals to that study. Not that the study is bad or that we can't learn something from it, but I don't know what cases that study applies to. I don't know people that wear latex gloves for 90 minutes and then hold hands for two minutes and then grab a knife and go out and do something with that knife.

Q. So even if -- it was almost like manufactured results, would you agree?

A. If I were going to do a study to try and

maximize this indirect transfer, that's probably the way I would do the study. Only thing would be worse is if you deal directly with the body fluids such as blood or semen. That would cause more DNA to be in that indirect transfer. But other than that...

Q. Is it true that blood and things like that have more DNA than a hand touch?

A. Oh, yes, yes.

Q. Now, Dr. Kalafut, you were given information about this case; is that correct?

A. Yes.

Q. And I gave you two propositions; is that correct?

A. Essentially, yes.

Q. Okay. And one proposition is that based on Doctor -- I mean Samantha Perkins, there was DNA on the bicycle that belonged to Mo Wilson.

A. Yes.

Q. Okay. And we are talking about two propositions of -- now, you can't tell me how that DNA got there, can you?

A. Not directly, but you have said DNA of Mo Wilson was on the bicycle.

Q. DNA that was on Mo Wilson's bicycle of the defendant.

A. Okay. So I'm not -- yeah. So now that we're there. So one proposition is that the defendant's DNA was found on the bicycle of Mo Wilson.

Q. Okay. What's the second proposition?

A. You didn't quite finish your proposition. You told me your theory is that the DNA is on that bicycle because the defendant grabbed that bicycle and hauled it out of the apartment and disposed of it some place nearby. That would be the entire activity that is in her proposition.

Q. Correct. And what is the other proposition, proposition two that we talked about previously?

A. The other proposition you asked me about, we spoke about is related to a series of activities resulting in a series of DNA transfers. But before I say too much about a transfer, transfer is only one piece of the puzzle. Sure, DNA can move from point A to point B, but it has to persist. It has to stick around long enough that it can be sampled later or be picked up by something else and moved farther down the chain. There's a concept called prevalence, and that kind of deals with how much background DNA is there, is there some other reason for someone's DNA to be on an item that has nothing to do with what brings everyone to court. And finally recovery. Sometimes can you actually recover

that DNA becomes the issue. Having said all that, those are four factors that play into the activity level of proposition. So when a DNA expert evaluates DNA evidence, given activity level propositions, which is what your proposition is, we think about those things. Okay.

The alternate proposition would have to do with the defendant transferring her DNA to a motorcycle or a helmet because going on a motorcycle ride. So the actual activity would be going on a motorcycle ride that implies this direct transfer from the defendant to the motorcycle or to the helmet. And then there would -- then in order -- the next step in the chain that you discussed with me was DNA going from either that motorcycle or that helmet to the body of Mo Wilson.

Q. Correct.

A. And then ultimately when Mo Wilson comes home, it ends up on that bicycle, although no one is quite -- I have no case information provided to me of any known interaction between Mo Wilson and her bicycle. So that last step of the chain is kind of unknown, if it ever occurred.

Q. Correct.

A. Based on what you talked to me about.

Q. Right. Let's talk about the proposition with

the motorcycle.

A. Okay.

Q. And the factors that might affect the prevalence of the DNA.

A. Yes.

Q. Assuming the people on the motorcycle went somewhere and they went swimming, how might that affect DNA that may have been transferred on the way to the pool once they got in the water?

A. So if you're a passenger or a rider on a motorcycle and there might have been DNA on that motorcycle from someone previous, you know, that's a pretty big if right there, but if that were to be true and you collect that DNA onto your hands, body, whatever and then you go and jump in the swimming pool, I would suggest that any DNA on your body is probably going to be gone.

Q. And that proposition, would Mo Wilson have to get back on that motorcycle and get additional DNA on the way back home?

A. So if -- okay. So if we're still concerned about DNA on Mo Wilson having already gone from the defendant to the motorcycle, either went to her once before the pool and then she gets back on the motorcycle and more gets on her or it somehow survived the swimming

pool. All of those things are in my mind adding -- lowering the probability of the evidence given this discussion that we're having. I wouldn't have a very high expectation at all of finding DNA on a bicycle down the chain based on what we've already spoken about. But I don't know -- kind of common sense if there's DNA on a motorcycle seat or in a helmet and you interact with it once and you go away and come back to it, if the source of that DNA wasn't replenished, if new DNA wasn't deposited, I'm not sure how the DNA on those items would kind of hang out and wait until the second motorcycle ride to get onto Mo Wilson.

Q. Can you explain to the jury what tertiary transfer is?

A. So in our chain of events, primary transfer would be direct transfer. That would be going from the defendant to the motorcycle or the defendant to the helmet. Secondary transfer would then be going from the motorcycle or the helmet to Mo Wilson. Tertiary transfer is where does it go that Mo Wilson interacts with. That would be a tertiary transfer. And what we know is every time DNA moves down through that chain of activity events, there's less and less DNA available for the next place where you're going to try and recover the DNA from.

Q. Okay. Is there a level above tertiary?

A. We can talk about quaternary. So that might be, for example, if someone were wearing a motorcycle helmet --

Q. Okay.

A. -- and picked up motorcycle -- picked up DNA on their face or head area from something that had been in that helmet, in order to get on the bicycle, it doesn't just go from the helmet to the bicycle. It goes from the helmet to her hands and then from her hands to the bicycle. So there's another step that would be called quaternary transfer, but I am unaware of any studies that can detect quaternary transfer in the first place. The two studies I am familiar with are tertiary transfer.

Have y'all seen the movie Spinal Tap? Where this guitar amplifier goes to 11. The character is bragging about how powerful his amplifier is. One of the studies in order detect tertiary transfer has to basically take the DNA system and turn it to maybe even past 11 in order to detect it. Samantha did not do that at the Texas DPS lab in this case.

Another study that tried to deal with tertiary transfer kind of basically said we know who the folks were that we used to do our study, but we can't tell the difference between them and pretty much anybody else who would ever try and compare.

So tertiary is hard enough. I'm unaware of any quaternary studies. I am not saying they are not out there. I'm not saying it's an impossible chain of events. I'm saying I'm unaware of it from a study point of view.

Q. Let's assume for a second, Dr. Kalafut, that the DNA on the bicycle is in two different places. Handlebars and the seat.

A. Okay.

Q. Which means that someone had to have touched the handlebars and the seat to get DNA on both of them. Can we agree on that?

A. Yeah, if it's in two places. If you're talking a primary transfer, someone grabbing ahold of the bike, probably need to grab both spots, yes.

Q. So in one of our hypotheticals, if we take the assumption that the DNA came from inside the helmet as opposed to outside the helmet, okay, so the first transfer would be from the defendant to the motorcycle helmet?

A. Yes, primary.

Q. And from the motorcycle helmet to Mo Wilson?

A. Yes.

Q. The face?

A. Yes.

Q. Right?

A. Yes.

Q. For her to touch her face and get it on her hands, would that be considered another transfer?

A. That's three steps, tertiary.

Q. And for her to go home and ride that motorcycle and then touch the handlebars and the seat of the bike, what would that be?

A. That would be four. That would be this quaternary transfer that I have an extremely low expectation of finding DNA on any item given four sets of activity like that if we're not talking about blood or a body fluid like that. If we're talking about a case involving blood or some type of sexual assault case involving semen, I might have that expectation.

Q. What if the person coughed in the helmet?

A. Who would have coughed in the helmet?

Q. If someone had the helmet on, if anybody coughed in the helmet, would that --

A. So I would expect that there might be DNA inside that helmet, yes. But my understanding, if the defendant wore the helmet -- I don't know if she did or didn't, I wasn't there. If she wore the helmet -- it's also my understanding that time had passed since the last time she had worn that helmet, and in the meantime,

Mr. Strickland had been wearing that helmet. So one of the things I'm curious is, is if this is such a good chain of events -- and I don't think it is -- but if it is such a good chain of events to get DNA where it was ultimately found, where would be the DNA of Mr. Strickland, who was the habitual normal wearer of that helmet. We're not finding his DNA anywhere.

Q. Now, in this proposition, if you got information that Mr. Strickland picked up Mo Wilson about 5:30 p.m., from 2 o'clock p.m. until 5:00 p.m., he had that helmet on riding in the Texas heat, and then once he picks Mo Wilson up to go swimming, he gives her the same helmet that's he's had on for three or four hours in the Texas heat, would you expect to see his DNA, if anybody's?

A. On the helmet?

Q. Yes.

A. Absolutely in the helmet. I would be pretty confident his DNA was there. If it were, I would have a higher expectation of his DNA then being on the head of Mo Wilson than the defendant, who according to the information given to me and what you're asking me about, last wore that helmet some weeks prior. Never say never. But if we talk about what am I going to expect if I did this experiment in the lab, I would expect to get DNA, given it came from the person who had just been wearing

the helmet, compared to if it came from someone who had worn it a month ago when somebody else wore it in between.

Q. Dr. Kalafut, also, with regard to Samantha's profile, there were a mixture of three people.

A. Yes.

Q. Does that tell us anything about when the third person's DNA may have been put on that item?

A. No. But it doesn't tell us about anybody else either, other than we can expect Mo Wilson's DNA was on her bicycle because she had just ridden it earlier that day. So we can perhaps kind of date her DNA just out of common sense.

Q. So it doesn't give you any information about this third contributor?

A. No. I have no information that has anything to do with a third donor one way or the other.

Q. Now, based on all the DNA evidence that you reviewed from Samantha Perkins, is there anything in that data that tells you that that DNA from the third contributor might have been deposited on May 11th, that same day?

A. No.

Q. Is there any way to tell?

A. No.

Q. Within the two propositions that we told you, one, where the defendant, Kaitlin Armstrong, touched that bike or Mo Wilson put the defendant's -- Armstrong on that bike to a quaternary transfer, which one is more likely?

A. In my opinion, this evidence is more likely if it was a direct interaction with the bicycle by the defendant than if it was this series of indirect activities.

Q. Let me ask you this. Assume for a second that Mo Wilson did have DNA on her hand when she got back home. Would reaching in the bag potentially scale some of it off, reaching in her handbag?

A. Okay. So we're going to assume for the sake of argument that this original DNA of the defendant persisted and managed to survive all of these transfers and now Mo Wilson is ready to go inside a locked apartment.

Q. Correct.

A. So if we make -- think about what you do when you walk up to your locked door. You might be fumbling around in your purse or your pocket. You might be unlocking with a key. You might be pushing a key pad.

Q. Assume she pushed key pads.

A. You know, there's DNA on your hands. And,

again, where would Mr. Strickland's DNA be if he -- she had been on the motorcycle ride perhaps holding onto him on the ride. Every time you're interacting with something, you are leaving some DNA behind. And so this adds a whole nother layer of complication that the DNA didn't get left behind on these other items that Mo Wilson interacted with but somehow held on long enough to then be deposited on that bicycle. I would -- this is lowering my expectation of these results when we start thinking about those types of things.

Q. Now, how about when she went to the swimming pool. They went to the swimming pool. Got out. Had a burger. Touched the burger and the burger paper and touched at least two different drinks. Would that affect any kind of DNA that might have been on her hands?

A. The more -- so there's been a recent study where they talked about following the activities between the activities. So there are activities of interest that in this trial or in any trial that might be the key activities that people are thinking about, but this study kind of videotaped people moving around when they kind of wanted them to do certain activities of interest, and I don't think it's a very earth-shattering conclusion from this study, but people don't walk through life with their hands up in the air not touching anything until it comes

time to touch the one thing that's related to something the Court may care about. So the more these interactions are happening with other objects after the last opportunity to collect the DNA that y'all care about, all of this little interactions should be sucking up some of that DNA, and we talked about how after three transfers or certainly after four, there may be nothing left.

Q. So of the two propositions, one is more -- highly more likely than the other?

A. I don't make my comment on which proposition is more likely. I make my comment on the evidence. And I'm comfortable saying that, in my opinion, this evidence is much more likely if the first proposition that the defendant grabbing the bicycle to do something with it than if this other chain of events happened.

MR. JONES: Pass the witness, Your Honor.

CROSS-EXAMINATION

BY MS. DUGGAN:

Q. Yes or no, you can not determine how DNA got somewhere?

A. No, you can't.

Q. It's possible, yes or no, that DNA is somewhere that someone has never been?

A. If by "possible" you mean a nonzero probability, yes. But possible is not math. That's not very

scientific.

Q. Neither is probability.

A. Probability is. You can go and get a PhD in probability.

Q. Is it possible someone's DNA can be somewhere that they have never been?

A. Yes. There are studies that make that happen. It happens in real life. That is true.

Q. That DNA can also be somewhere that someone hasn't touched?

A. Somebody might have -- I mean, not quite following that one.

Q. Sweat can get somewhere and that would leave DNA, right?

A. Yes.

Q. Doesn't have to be something somebody touched, right?

A. How did the sweat get there?

Q. I don't have to touch something to drip sweat on something, right?

A. Oh, okay. So that would be a direct contact with the -- so I call that a primary transfer, direct transfer.

Q. Got you.

A. It's not from the body, but it's from the sweat

that you -- you know, you keep asking me questions, I might get sweaty and start dripping sweat here. I would say that's a direct transfer.

Q. Got you. And I just want to clarify. You said you were brought in kind of late in the game. When did the prosecution reach out to you to discuss this case?

A. Maybe within the last three weeks.

Q. Okay. What all evidence did you review before coming to testify?

A. Basically the Texas DPS case file, and then I asked for as much case information as I could possibly get ahold of in terms of what various folks may or may not have thought that happened.

Q. Okay. Did you get the case info from the State like to review the data?

A. Yes.

Q. Okay. And by "case data," was it hypotheticals from the State or was it the raw data from Ms. Perkins?

A. No. I got the actual computer generated data copies of the case files. It was a lot of pages.

Q. Got you. Do you know if that helmet was ever swabbed?

A. I didn't see anything in the case file about a helmet.

Q. Did you review any court transcripts of people

testifying?

A. From time to time. I mean, I don't have a good source of that on a continuing basis, no.

Q. Court transcripts relating to this case, did you review any of those?

A. No.

Q. You said you don't have any information -- and I'm not trying to trick you, so correct me if I am saying this wrong. You don't have any information on that third unknown individual; is that right?

A. Yes. I mean, my understanding is there were four references submitted. Two were excluded. Two it was decided they may have had something to do with the bicycle. And I say "may" because I don't know. I didn't see it happen. And that kind of leaves one donor, if you will, unaccounted for on both the handlebars and the seat, a trace-level donor.

Q. Did you review that data related to the unknown individual?

A. It was in the electropherogram. It was in the DNA peaky thing that we look at on the page, yes.

Q. Were you able to make any conclusions relating to an X or a Y chromosome of those unknown profiles?

A. Yes. I think it's fair to say at least one, if not two of the samples, there was a Y chromosome present.

I would have to double-check the notes at this point. I didn't particularly focus on that.

Q. The reference samples were referring -- one of them was to Colin Strickland, which would have been a male profile, right?

A. Yes.

Q. So that kind of puts in: Do we know if it was Colin's known profile?

A. My understanding is that the experts agreed that he was excluded and I would agree with that also.

Q. So that unknown individual has a Y chromosome but Colin Strickland is excluded?

A. Yes.

Q. We can't tell how long DNA has been present on a surface, right?

A. No.

Q. Could be a long time, could be a short time?

A. Yes.

Q. What affect does moisture have on DNA?

A. In general it's not very good for it. If you can get things dried off, you let it dry out it, it doesn't really have much effect if it gets dried within a few hours or day or so.

Q. But moist DNA is probably richer, right?

A. So there's a difference between is DNA on an

item and that item gets wet, that's what I took by moisture, compared to DNA from a body fluid. A body fluid that's wet has a much higher source of DNA typically than what we talk about coming off of us when we interact by touching, handling items, using items.

Q. The prosecution went through a couple of scenarios with you, right?

A. Yes.

Q. The reality is you weren't there, right?

A. Correct.

Q. You don't know how it got there?

A. I have no clue how it got there.

Q. DNA doesn't tell you how it got there?

A. No, it does not.

Q. Do you usually testify for the State or the defense?

A. These days I'm being engaged fairly equally. In my time at the Army crime lab, generally my findings are extremely favorable for the defense. The case didn't move forward. But I also say my experience in the Army crime lab compared to when I was in Dallas County is that, yeah, the defense would call us from time to time. That didn't really happen to me at the county level crime lab. But these days I'm available to anyone that decides they might be able to use my help.

Q. Your bio talks about testifying as an expert witness in numerous state trials. Are those mostly State or defense?

A. That would have been prosecution here in the State of Texas when I was at SWIFS, yes.

Q. Got you. Were you paid to be here by the State?

A. Yes, I was.

Q. If it's more likely that Ms. Armstrong's DNA is a direct transfer, I would think it's more likely the unknown profile was direct too, right?

A. So I don't comment on what profile was likely. I comment on the evidence. If the evidence makes sense, if something happens. So you're asking me -- let me turn this into something I can answer. I think what you're asking me is is this -- in this evidence profile, is this evidence profile more likely if the third person was a direct transfer compared to if the third person was some type of indirect transfer. We can't answer that without any information related to that third person. Just that's an empty question. I can't offer anything to answer that.

MS. DUGGAN: No further questions, Judge.

REDIRECT EXAMINATION

BY MR. JONES:

Q. Mr. Kalafut, do you know anything about this

trial?

A. I know that I'm here and I know that we talked about a bicycle and a motorcycle and series of activities that could account for the DNA.

Q. And you, of course, know that Ms. Armstrong is the defendant and she's on trial for murder?

A. Yes.

Q. Would you expect wet DNA to stay wet for 30 days?

A. No.

Q. With regards to that third person, we don't have any information about a third person, do we?

A. All we know is there is some DNA that's unaccounted for.

Q. But we do know that Kaitlin Armstrong, the defendant who is here charged with murder, has a profile on that seat and the handlebars. Do we not know that?

A. So she cannot be excluded as a source of that DNA. So this is where we kind of have to be careful how we cross boundaries because Samantha's testimony is very much focussed on the question of whose DNA it might be, and DNA experts are very careful not to say it's this person's DNA. That goes outside our lane. In order for us to discuss what we're discussing now, I have to make a logical inference that we know whose DNA we are talking

about. But to be clear, I don't know whose DNA is on that. I am speaking as though the room has kind of decided for the sake of argument that we know whose DNA it is, but I don't know whose DNA is. Got it?

Q. But you read those results, right?

A. Say that again.

Q. You read those results from Ms. Perkins?

A. Yes. I reviewed her results and I agree with them.

Q. Do you agree that Ms. Armstrong cannot be excluded?

A. Yes. Yes.

MR. JONES: No further questions.

MS. DUGGAN: No questions, Judge.

THE COURT: Thank you. You may step down.

State.

MR. JONES: Your Honor, State calls --

THE COURT: Not funny.

MR. JONES: State rests.

MR. COFER: Defense rests and closes.

THE COURT: All right. State closes?

MR. JONES: Yes, Your Honor.

THE COURT: Defense closes. Okay.

Ladies and gentlemen of the jury, you have now heard all the evidence that you will hear at this

EXHIBIT F

DPS #	Description	APD #	Quant	Hid	strmix
01-01	Handlebars	2935470-4	0.0343	yes	49,400
02-01	Seat	2935470-5	0.0138	yes	224 billion (2.24E11)
05-01	Armstrong-S (KA)	2946455-1		yes	
06-01	Wilson-V (AMW)	2937116-16		yes	
11-01	Under seat	2949399-1	0.0029	yes	Drop at quant
13-01	Strickland-E-M (CS)	2936297-1		yes	
14-01	Cash-E-F (CC)	2935470-3		yes	

Armstrong and Wilson each of 37 alleles in their full profiles.
30 alleles of Armstrong on seat (19% donor)
30 alleles of Wilson on Seat (73% donor)
81% allele recovery

Swabs of handlebars and seat submitted – swabbed by APD? Would like to know particulars – how much area, what parts, etc. Pictures? Condition? Bar tape swabbed? Center of bars with no bar tape?

Caitlin Cash – Landlord? How much time to Caitlin spend in the place?

Confirm time between motorcycle ride and shooting.

What does Strickland say about the motorcycle ride? How did Wilson hang on?

Where was the bike when it was swabbed? Property room? Wilson's place? Where was it found?
Where was Armstrong (and any items associated with her) swabbed/sampled in relation to the bike?

I need to know more about theory of interaction between Wilson and Armstrong, and/or what any theories about what Armstrong was doing prior to the events.

STRmix decons
Seat:
Victim is ~73% donor
Suspect is ~20% donor
Third person is ~7% donor

Handlebars
Victim is ~93% donor
Suspect is ~5% donor
Third person is ~2% donor

Propositions

H1 = Armstrong removed bike from Wilson's rental home/house/apartment after a high stress encounter.

H2 = Armstrong was passenger on Strickland's motorcycle from time to time. Wilson rode as passenger a single time and picked up Armstrong's DNA from the motorcycle. Wilson came home, and moved/used her bicycle, that's how Armstrong's DNA got on the bicycle.

H1 is a single activity – removing the bike and leaving it in the alley –

Transfer: This implies a direct transfer.

Persistence: DNA would be expected to persist assuming no cleaning of the bike, not much use

Prevalence: No known reason to expect Armstrong's DNA on bike for other reasons

Recovery: Easy to recover DNA from bike, but seat material, bar tape, where items were swabbed may play a role. (More porous could make it harder to recover DNA, especially from a brief encounter.)

H2 is a series of activities – Armstrong to motorcycle, motorcycle to Wilson, Wilson to bike

Transfer: This implies a tertiary transfer.

Persistence: Each step requires persistence,

1. Armstrong's DNA on the motorcycle since last time riding. (Expect much more persistence of Strickland's DNA on the motorcycle.)
2. Armstrong's DNA on Wilson's hands. (Wilson didn't wash hands or handle things prior to touching the bike.
3. No issues with persistence on the bike. (similar to H1)

Prevalence: No known reason to expect Armstrong's DNA on bike for other reasons. But expect much DNA of Strickland on the motorcycle from normal use.

Recovery: Easy to recover DNA, but seat material, bar tape, where items were swabbed affect. (Similar to H1)

If H1 is true,

High expectation of Wilson's DNA on her own bike.

Low expectation of finding Armstrong as minor/trace donor in a mixture with Wilson's DNA.

Extremely low expectation of finding Armstrong as a significant/major donor or as a single source profile.

In all cases, high expectation of finding DNA from unknown donor.

Unknown items:

Some riders may keep the bike very clean.

How was handlebars/seat swabbed?

What was general condition of the bike?

If H2 if true,

High expectation of Wilson's DNA on her own bike.

Low expectation of finding Strickland's DNA as a minor/trace donor in a mixture with Wilson's DNA.

Extremely low expectation of finding Armstrong's DNA

Things to consider:

Traditionally in “Activity” probability assignments, there is much uncertainty, so we try to avoid probabilities that give an impression of “precision”. Examples include “92.1% probability of the evidence if X happened…” For something that has a very low expectation, we try not to say, “There is only a 0.0002% chance of this evidence if Y happened.”

This case is challenging, because I have a low expectation of this evidence if the H1 proposition happened (a onetime grabbing and carrying a bike to out of the house). Typically, if I am going to use a number to reflect a “low” probability, I will assign a value of 10%. A “very low” probability would be 1%, and I try to avoid decimals.

However, in this case, the expectation of Armstrong DNA to the motorcycle (primary or 1° transfer), the motorcycle Wilson (secondary or 2° transfer), and Wilson to the bicycle (tertiary or 3° transfer) would be at least an order of magnitude lower for each step of the transfer. For the purposes of this explanation, I will assign an order of magnitude as a decimal place.

But there is more to consider. Given some time passing (a month or so) since Armstrong was last on the motorcycle, we can add another “zero” as this chain of events would have required Armstrong’s DNA to have persisted on the motorcycle for quite some time.

Add another decimal for NOT finding the DNA of Strickland on the bicycle, given information that Wilson was holding onto Strickland during the ride, and there is a much higher expectation of Strickland’s DNA on the motorcycle than Wilson since Strickland is the owner/driver of the motorcycle. We might expect a relatively high “prevalence” of Strickland’s DNA on the motorcycle.

Since the bicycle was being stored in a home where Cash was living on a regular basis, I expect her DNA to be throughout the home. This can be thought of as prevalence, or background DNA. Presumably, Wilson interacted with Cash (or at least items/objects that Cash had previously interacted with) to a higher degree than Wilson would have interacted with the DNA of Armstrong on the motorcycle, assuming Armstrong’s DNA was actually on the motorcycle. This means I would have a higher expectation of finding Cash on the bicycle than Armstrong.

Finally, I have no information that Wilson is known to have interacted with her bicycle between coming home from the motorcycle ride and the shooting.

Expert opinion:

All of this is to say I will not give a “number” as to how much more likely this evidence is given the first proposition than the second. I will only give a qualitative assessment that in my opinion, the DNA profile recovered from the bicycle is much more likely if Armstrong carried the bicycle out of the home of Cash

and disposed of it than if Wilson picked up DNA of Armstrong, but not of Strickland (or Cash) from a motorcycle that Armstrong had been on a month or so prior and Wilson deposited it on the bicycle.

This opinion is based on the information I have described here. If this information is incomplete or incorrect, my evaluation of this evidence may need to be reassessed and my opinion may be modified. New information may not change my overall opinion or it may change it significantly.

EXHIBIT G

(Shortened titles listed)

Not much in the literature on tertiary studies. Most papers say things along the lines of "Tertiary transfer can happen under certain conditions" and most studies involve laboratory conditions involving pristine items, not bicycles and motorcycles in the real world.

1. Gill et al. "ISFG Guidelines"

BLUF: DNA experts should not take the stand and discuss "possible transfers" as this offers nothing in the way of evaluating the likelihood of the DNA evidence given actual alleged activities. This is giving an opinion on "what happened" and is inappropriate. Experts need to give their opinion on the likelihood of the evidence given activities of interest to the court. This evidential weight allows the jury to consider the DNA evidence, along with the rest of the evidence they will hear, as the jury has to decide "what happened."

This paper goes through some "do's and don'ts" of assessing and communicating the evaluation of DNA evidence given questions of activities. Many experts provide their own explanations of things that "might" be "possible" or "could happen". These things are often vaguely defined, and focus on "primary transfer vs secondary transfer" or "touching" items. The guidelines speak to these things directly.

My summaries of some of the more pertinent points follow.

Page 2, bottom right:
Recommendation 1:
Providing a list of explanations at court is not relevant, as it doesn't allow the jury to assess the weight of the evidence. A Likelihood ratio should be given based on case-specific propositions.

Page 4, bottom right:
Recommendation 3:
Scientists must not give an opinion on "primary vs secondary" transfer, as that is a comment on the activities. The scientist is supposed to assess the weight of the evidence given activities that are in dispute between the parties, not comment on what the scientist thinks is the most likely way the evidence got there.

Page 6, middle left and bottom:
Recommendations 5, 6, and 7 (combined into one take away):
Case information is needed to define propositions that are specific to the case. Factors such as "primary or secondary transfer" are NOT part of the propositions. Transfer (along with persistence, prevalence, and recovery) is a factor that requires expert knowledge to assess while evaluating the evidence given specific alleged activities. Vague propositions such as "contact" are not activities. These are "pseudo-activities".

Page 7, bottom left
Recommendation 8:
The assessment of DNA evidence is based on actual activities that imply direct or indirect transfer. The expert should not discuss the evidence using "transfer" terms.

Considerations 1 and 2 (page 7 bottom and page 8 middle) discuss transfer, persistence, prevalence, and recovery. These are NOT activities and require an expert to consider these factors while evaluating DNA evidence given case-specific activities.

2. Warshauer et al. “Evaluation of transfer of saliva DNA”

BLUF: Tertiary transfer is so hard to detect, the authors had to “violate protocol” to detect it.

Started with saliva (Volunteers ran their thumbs down their tongues), then touched various things in sequence for primary, secondary, and tertiary transfers. Only a 30-minute delay before primary transfer event.

Primary:
45/64 trials gave full DNA profiles on the second object after primary transfer.

Secondary:
90.6% of the profiles gave less than half the expected genetic markers (alleles)
Of these, 65.5% failed to give a single genetic marker.

Tertiary:
Based on poor results of secondary, all tertiary experiments used 34 PCR cycles rather than 28.
(This is a huge, massive increase in the sensitivity of the DNA testing. This is never done these days for casework.)
87.5% of the profiles gave less than half the expected alleles – at 34 cycles.
“These findings were consistent with the concept that tertiary transfer substantially diminishes the amount of recoverable DNA.”

3. van Oortschot et al. “Activities between the activities that matter”

BLUF: In real life, people have “activities” between the activities of interest at trial. This can have effects on the results that are NOT part of studies.

“As more items are contacted by the originally deposited biological sample, the greater the likelihood of it no longer being detected on the surface it was originally deposited on, or on the surface it was considered ultimately to have been transferred.”

In other words, for DNA to persist on someone’s hands after a secondary transfer (Armstrong to motorcycle, motorcycle to Wilson), Wilson shouldn’t take off helmets, open doors, use cell phones, etc. to have enough DNA of Armstrong to deposit on a bicycle and that DNA still be detectable.

4. Fonnelop, Egeland, Gill “Secondary and subsequent transfer”

BLUF: Even using volunteers “known to frequently provide full profiles from touched items” only about 7 of 30 trials were similar to % allele recovery as this case.

After much handwashing and assurance that there was no DNA on any items used in this study (cleaning, ethanol wipes, multiple sterilization procedures), it's really hard to recover DNA three steps away, even on heroically cleaned items. This study used people called "good shedders" meaning they tend to leave lots and lots of DNA behind (relatively speaking) when they touch things.

5. Davies, Thomson, Kennedy "Assessing primary, secondary and tertiary DNA transfer"

BLUF: Even with known donors, it was hard to tell if they were detecting tertiary transfer or background DNA.

"Unambiguous tertiary transfer was difficult to establish due to the complexity of the final mixtures. […] this was at a level which could not be distinguished from DNA from non-donors. As such, in most datasets it was not possible to establish if there was a partial DNA profile from a tertiary donor or interference from a low level of non-donor DNA."

EXHIBIT H

Laboratory A
Forensic Genetic Unit
(Postal address)

Name and function
General information (phone, email)

Mr Prosecutor
Postal address

Lausanne, April 29th, 2020

Your reference : XX-YY-ABC
Police reference: DEF-20|1234
Our Ref : 20-T11234
See also Report XYY_111213

DNA report where the key issue regards the activities.
Case #789: Attempted burglary at the Musical school XYZ on December 27th, 2019.

In your letter dated March 24th, 2020, you requested our laboratory to answer the following questions on the behalf of the defendant's (Mr John Smith) council, Mr Lawyer.

I. *In report XYY_111213, Mr Expert and Ms Expert from the forensic genetic laboratory A, reported that the DNA mixture could be characterised as a major profile with non-interpretable components. Can you determine what is the probability that the 'minor non interpretable profile' is from an unknown person rather than M. John Smith?*

II. *Can you provide an evaluation of the DNA results taking into account the activities based on the following allegations from prosecution and defence:*

- *M. John Smith used the screwdriver (item #9876) during the attempted burglary at the Musical school XYZ on December 27th, 2019.*
- *Following the theft of his toolbox during early December 2010, an unknown person used Mr Smith's stolen screwdriver (item #9876) during the attempted burglary at the Musical school XYZ on December 27th, 2019.*

Question I: Can you determine what is the probability that the 'minor non interpretable profile' is from an unknown person rather than M. John Smith?

The minor non-interpretable components do not originate from Mr John Smith. However, no valid information can be obtained from a non-interpretable fraction. The minor components present are not of sufficient quantity nor quality: they could be explained by the DNA presence of one or several persons in very small quantities or/and by artefacts. Because of this, no comparison can be made with these minor components and it is not possible to infer any information on the source(s) of the 'minor non interpretable profile', as by definition they are not interpretable.

Question II: Evaluation of the results given the alleged activities

1. Context of the case

Uncontested information
According to the information given to us by Insp. J.B by email on April 3rd 2020, the door of the Musical school XYZ, at address XYZ on the third floor, was forced open with a screwdriver. The Director, Mr C.D, surprised the burglar. This burglar, according to Mr C.D, was wearing a black hoodie, blue jeans, black sneakers and did not appear to have any gloves. Surprised and chased by Mr C.D in the stairs, the burglar ran away and dropped a screwdriver in the corridor leading to the main door of the building. Mr C.D called the police who packaged the screwdriver (item # 9876, large red plastic handle screwdriver, see description in **Report XYY_111213**). All measures were taken in order to minimize contamination and any loss of the DNA material.

Insp. J.B -in the same email- also indicated that Mr John Smith said that he did not know Mr C.D, nor was he (or knew of any) student at the Musical school XYZ. When informed of the DNA results, he declared that the screwdriver (item # 9876) belonged to him.

Contested information
According to Mr. John Smith, he has nothing to do with the attempted burglary at the Musical school XYZ that took place on the 27th of December, 2019. During his interview on January 16th, 2020, he indicated that early December someone had stolen his toolbox that he kept at his aunt's house (road, city, postcode) Ms Jane Smith. He had been helping his aunt who had wanted to decorate her house for the Holidays Season. On the 10th of December, when visiting his aunt for her birthday, he could not find his toolbox. He had not declared the theft as he was hoping that it had just been misplaced.

Important remark: The evaluation of the results is crucially dependent on the context of the case (e.g., the burglar was not wearing gloves, anti-contamination measures were in place, timeline). As such they are *conditioning* information. If any of this information is incorrect or if further information is made known, a new interpretation will be needed.

2. Methodology

Assumptions

Based on the available information, I have assumed the following:

1. Based on the fact that the screwdriver belongs to Mr Smith and based on the results described in Report XYY_111213 from our laboratory (DNA profile of Mr John Smith is compatible with the major profile for all 16 loci), it is assumed that the source of the DNA is **not** contested. I have therefore considered that the major proportion of the DNA recovered on the seized screwdriver is from Mr John Smith.
2. The door was forced with a screwdriver by a person who was not wearing gloves.
3. No specific information is available on Mr Smith's DNA shedder status, it was therefore considered that he or an alternative offender are comparable.

The DNA results have been assessed given the following two propositions derived from the context of the case:

- Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019.
- An unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019.

As advised by the forensic community (e.g., European Network of Forensic Science Institutes[1], International Society of Forensic Genetics[2]), to assess the value of the results we have used what is called a likelihood ratio. A likelihood ratio is a measure of the relative strength of support that the biological results give to one proposition against a stated alternative. It is defined in terms of the ratio of two conditional probabilities: (i) the probability of the DNA results given that one proposition is true and given the conditioning information; and (ii) the probability of the DNA results given that the other proposition is true and given the conditioning information.

These probability values are based on published data, but also on expert knowledge and experience: they represent a measure of the scientist's informed opinion regarding the probability of occurrence of a particular event. Probabilities are quantified between zero and one), at times expressed in percent probabilities.

In my assessment, I have used Bayesian Networks (a marriage between graphic theory and probability theory for reasoning under uncertainty), as well as the literature available and my knowledge. I summarise below my reasoning and refer the reader to appendix I for a full description.

[1] S. Willis, et al. ENFSI Guideline for Evaluative Reporting in Forensic Science: Strengthening the Evaluation of Forensic Results Across Europe (STEOFRAE), (2015) With the financial support of the Prevention of and Fight against Crime Programme of the European Union European Commission - Directorate - General Justice, Freedom and Security.

[2] P. Gill,* T. Hicks*, J. Butler, E. Connolly, B. Kokshoorn, L. Gusmão, N. Morling, R. van Oorschot, W. Parson, M. Prinz, P. Schneider, T. Sijen, D.Taylor. DNA Commission of the International Society for Forensic Genetics: Assessing the value of forensic biological evidence – guidelines highlighting the importance of propositions Part II: Evaluation of biological results given activity level propositions. Forensic Science International: Genetics (2020). Article number 102186.

3. Reminder of the DNA results (see Report XYY_111213)

The DNA analysis of the swab (PCN 12 34567 35) used to sample the plastic handle of screwdriver found in the corridor, close to the main building's door of the Musical school XYZ, shows a DNA mixture with a major fraction compatible with Mr John Smith (PCN 32 583750 77) and a few minor not interpretable components. The total quantity of DNA is in the order of 1ng.

4. Available research data

I have based my evaluation on two main studies by Pfeifer and Wiegand (2017)[3] and by Raymond *et al.* (2009)[4] as well as on my general knowledge on transfer, persistence, recovery and prevalence of DNA.

Study from Pfeifer and Wiegand

This research from Pfeifer and Wiegand (2017) gives information on the transfer and persistence of DNA on tools belonging to one person and used (or not) by another. DNA swabs were performed on 20 tools that 'belonged' to one person and that were used by another in order to break a window or force a door.

Their results are as follow:

- the first user's DNA profile (after the second use) is observed once out of 20 as a minor contributor. In 19 cases, no DNA was observed.
- the second user's DNA profile was observed 16 times out of 20 (80% of the cases). In 4 cases, no DNA was observed.

Study from Raymond *et al.*

Raymond *et al.* (2009) study gives information on the prevalence, transfer and persistence of DNA on handbags and wallets belonging to one person that are then 'robbed' by a second person.

The results of their experiments are as follows:

- the first user's DNA profile (after the second use) was observed (usually as a mixture) in 14 cases. Only once was it not observed.
- the second user's (robber) DNA profile was observed (usually as a mixture) in 14 cases. Only once was it not observed.

Limitations of these studies

As with any research, there are limitations to these studies. First, the number of experiments is limited and second, the analysis methods used are less sensitive than the ones that are adopted in our laboratory. These aspects have been taken into account in the interpretation. I have hence only considered the presence and respectively the absence of DNA attributed to the persons owning or/and using the tools for forcing a door.

[3] Pfeifer and Wiegand, Persistence of touch DNA on burglary-related tools, International Journal of Legal Medecine (2017) 131: 941–953

[4] Raymond *et al*., Trace DNA and street robbery: A criminalistic approach to DNA evidence, Forensic Science International: Genetics Supplement Series 2 (2009) 544–546

5- Evaluation of the DNA results

In order to assess the value of the DNA results (Major DNA profile recovered from Mr John Smith's stolen screwdriver and the reference sample listed as from Mr John Smith yielding to profiles with the same allelic designations and the absence of another interpretable DNA profile), we have considered the probability of these results given the case information and the following propositions:

- Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019.
- An unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019.

The ratio of these two probabilities (of the results under each proposition) form our likelihood ratio, a standard metric used to assign the value of forensic results.

A. If we consider that Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019, then according to the data from the above-mentioned studies and my personal knowledge, I would expect to observe the given DNA results in the majority of the cases. Indeed, given this proposition, he would have used the tool during December and would also have used the tool on the 27th for forcing the door. There would be an accumulation of DNA due to previous use of the tool and the use on the 27th of December. Considering these elements, I have assigned the probability of the DNA results given prosecution's view as being in the order of 90%.

B. If now we consider that an unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019, then we have to account for the presence of a DNA profile matching Mr Smith and the absence of a DNA profile from the unknown offender. Given the research of Raymond *et al.* (2009)[3], and Pfeifer and Wiegand (2017)[4] as well as my knowledge, I expect to observe the obtained DNA results in about one case out of 15. In most cases, we would expect to observe a profile matching the person using the tool to force a door.. On that basis, the probability of observing a DNA mixture with a major fraction matching Mr John Smith (PCN 32 583750 77) and no other interpretable profile if an unknown person tried to force the door with Mr Smith's screwdriver stolen during the month of December, is in the order of 6%.

The probabilistic network (also called Bayesian network) that has been used to specify the causal relationships and combine the above probabilities is presented in appendix.

The ratio of two above probabilities allows to assign the relative strength of support that the DNA findings give to one proposition against the stated alternative (i.e., the likelihood ratio). This ratio is in the order of 10. Therefore, in my opinion, the DNA results are in the order of 10 times more probable if Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019, rather than if it was some unknown person with Mr John Smith's stolen screwdriver.

6- Conclusion

The issue in this case regards the activities (i.e., how the DNA matching Mr John Smith got on the screwdriver: by normal use or/and by forcing the door of the Musical school XYZ). DNA results cannot be used directly to answer this question, but combined with the other elements of the case, they can help the court reach a decision.

Based on the research of Raymond *et al.* (2009) and Pfeifer and Wiegand (2017), the case information and my knowledge, I am of the opinion that DNA results are in order of 10 times more probable if Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019 rather than if an unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019. Whatever the odds of the first proposition versus the alternative based upon other elements (that I do not know), the DNA results makes these odds 10 times higher than they were before.

I wish to underline that a likelihood ratio indicates the extent to which DNA analysis results support one proposition over another. It is not possible, on this basis alone, to determine which is the most likely proposition. To assign which of the two propositions is the most likely, the DNA results should be combined with other information in the case. This is not considered to be the domain of the expert.

My approach to the examination and interpretation of the findings in this case is crucially dependant on the information made available to me. If any of this information is incorrect or if further information is made known, it will be necessary to reconsider my interpretation.

I confirm that I have acted, to the best of our knowledge and belief, in accordance with the Code of Conduct published by XYZ. I also confirm that the contents of this report (consisting of 8 pages) are true to the best of my knowledge and belief and that I make this report knowing that, if it is tendered in evidence, I would be liable to prosecution if I have wilfully stated anything which we know to be false or that we do not believe to be true.

X, expert in DNA

Town, XX:YY:ZZZ.

Laboratory XYZ

7- Appendix I: Bayesian Network

Node 1 : The proposition node with two options, one representing the view of prosecution and one representing the view of defense, based on the provided information. The proposition representing prosecutor's view (noted Hp) is that Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019. The proposition representing defense's view (noted Hd) is that an unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019. It assumes that Mr. Smith screwdriver was stolen. As prior odds are not the scientist duty but have to be input in order to use the program, I have assigned equal prior probabilities to the propositions. This has the effect that, for that node, the ratio of the updated probabilities obtained, once evidence is entered in the Bayesian Network, will equate to the likelihood ratio (which is the responsibility of the scientist).

1. Propositions	Hp: Mr Smith forced the door	0.5
	Hd: An unknown person forced the door with Mr Smith's screwdriver	0.5

Node 2 : Mr S owns the seized screwdriver.
This node considers that Mr Smith owns the screwdriver, which has occurred under both defense and prosecution view.

1. Propositions		Hp	Hd
2. Mr Smith owns the screwdriver	Yes	1	1
	No	0	0

Node 3 : Mr Smith used the screwdriver on the D-day (i.e., used it to try and force the door)
This node considers that the suspect used the screwdriver to force the door, which has occurred only given prosecution's view.

1. Propositions		Hp	Hd
3. Mr Smith used the screwdriver on the D-day	Yes	1	0
	No	0	1

Node 4: An alternative offender (AO) used the screwdriver on the D-day (i.e., used it to try and force the door). This screwdriver was stolen from Mr Smith.
This node considers that an unknown person used the stolen screwdriver to force the door, which has occurred only given defense's view.

1. Propositions		Hp	Hd
4. AO used the screwdriver on the D-day	Yes	0	1
	No	1	0

Node 5 Mr Smith's DNA transfers to tool handle through normal use (and remains after the use by someone else or by Mr Smith).
This node considers that Mr Smith's DNA was transferred (or not) to the screwdriver handle because of normal use, and that after this normal use, the screwdriver was used to force the door (which may remove/cover some of the DNA present). The numbers in the table under "Yes" are the counts of the experiments that have been considered.

2. Mr Smith's owns screwdriver (first user)		Yes	No
5. Mr Smith's DNA transfers to tool handle	Observation of a DNA profile	1+14=15	0
	No DNA profile observed	19+1=20	1

We have considered the studies by Pfeifer and Wiegand (2017) and the studies of Raymond *et al.* (2009). The results are not straightforward to use, the analytical conditions are not the same as ours and the packaging differs. However, it can inform our probabilities. In the study on the tools by Pfeifer and Wiegand (2017), the first user 's DNA profile (after the second use) is observed 1 time out of 20. In 19 times, no DNA was observed. For the wallets and purses by Raymond *et al.* (2009), the DNA of the first user was observed (usually as a mixture) in 14 cases. Only once was it not observed. We add these counts for DNA observed (1+14=15) and not observed (19+1=20).
If Mr Smith's screwdriver was not used, then we always expect to find no DNA that would align with his DNA profile.

Node 6 (Mr Smith's DNA transfers to tool handle if he used it (or not) to try and force the door).
This node considers that an Mr Smith's DNA was transferred to the handle because of forcing the door. The numbers in the table under "Yes" are the counts of the experiments that have been considered.

3. Mr Smith's used the screwdriver on the D-day the door (second user, door forcing)		Yes	No
6. Mr Smith's DNA transfers to tool handle	Observation of a DNA profile	16+14=30	0
	No DNA profile observed	4+1=5	1

We have considered again the studies by Pfeifer and Wiegand (2017) and the studies of Raymond *et al.* (2009) but this time for the second user. In the study on the tools by Pfeifer and Wiegand (2017), the second user DNA profile is observed 16 times out of 20. In 4 case, no DNA was observed. For the wallets and purses by Raymond *et al.* (2009), the DNA of the second user was observed (usually as a mixture) in 14 cases. Only once was it not observed. We add these counts for DNA observed (16+14=30) and not observed (4+1=5).
If Mr Smith's did not force the door, then we always expect to find no DNA that would align with his DNA profile because of the activity of forcing the door.

Node 7 (AO DNA transfers to tool handle). This node considers that an unknown person's DNA was transferred to the handle of the stolen screwdriver because of forcing the door. The numbers in the table under "Yes" are the counts of the experiments that have been considered.

4. An alternative offender (AO) used the screwdriver on the D-day (second user)		Yes	No
7. AO DNA transfers to the tool handle.	Observation of a DNA profile	16+14=30	0
	No DNA profile observed	4+1=5	1

We have considered the same probabilities as above. We indeed assumed that the persons (Mr Smith and an alternative offender - AO) would transfer DNA in a comparable fashion.

Node 8 (DNA results similar to Mr Smith's DNA on tool handle). This is a findings node that combines the nodes 5 (Mr Smith's DNA transfers to tool handle because of normal use) and 6 (Mr Smith's DNA transfers to tool handle because of him forcing the door of the Musical School). It is a cumulative node. It is only when there is No DNA transferred following both activities that we have a probability of one of observing no DNA from Mr Smith. For all other cases, we will observe a matching DNA profile.

5. Mr Smith's DNA transfers to tool (normal use) 6. Mr Smith's DNA transfers to tool (forcing door)		Yes DNA		No DNA	
		Yes DNA	No DNA	Yes DNA	No DNA
8. Mr Smith DNA comparison results on the tool handle	Yes, matching DNA	1	1	1	0
	No matching DNA	0	0	0	1

Node 9 is a result node that accounts for DNA from the unknown alternative offender (AO). We have assumed that the unknown offender has a different DNA profile from Mr Smith and that there is no background DNA on the screwdriver (DNA from an unknown person).

7. Alternative offender's DNA transfer to screwdriver handle		Yes, DNA from AO	No, DNA from AO
9. Non matching DNA on tool handle	Yes DNA non matching	1	0
	No DNA non matching	0	1

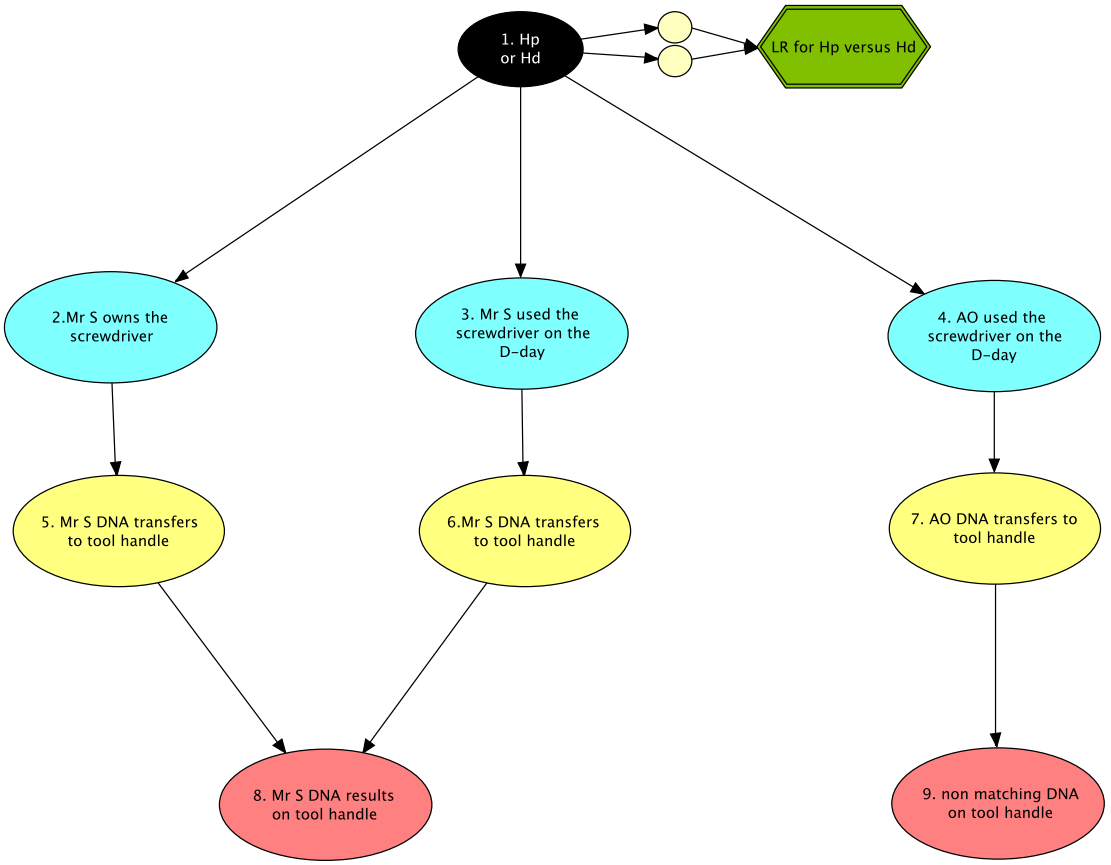

Figure 1: Bayesian Network considering the case scenarios. The black node is the propositional node, blue nodes are the activity nodes, grey are the root nodes, yellow are the transfer and persistence nodes and red are the findings nodes.

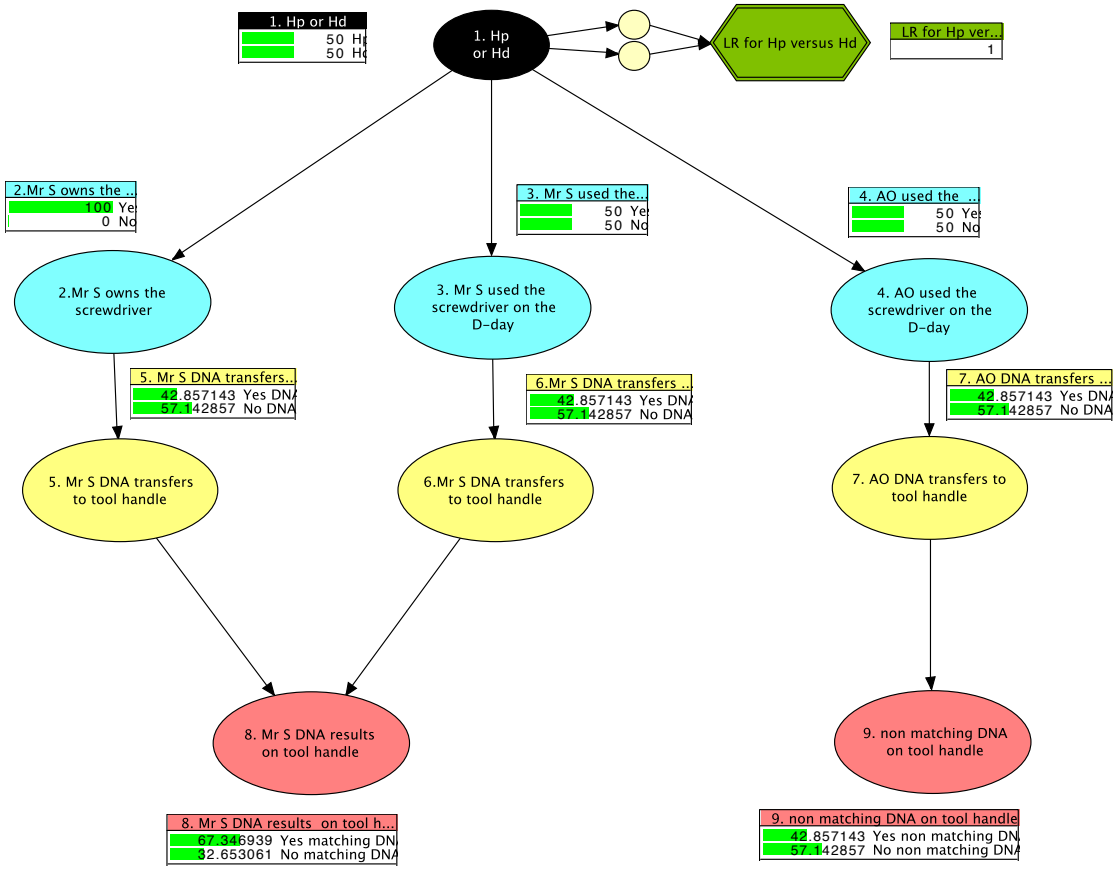

Figure 2: Bayesian network with the monitor windows displayed.

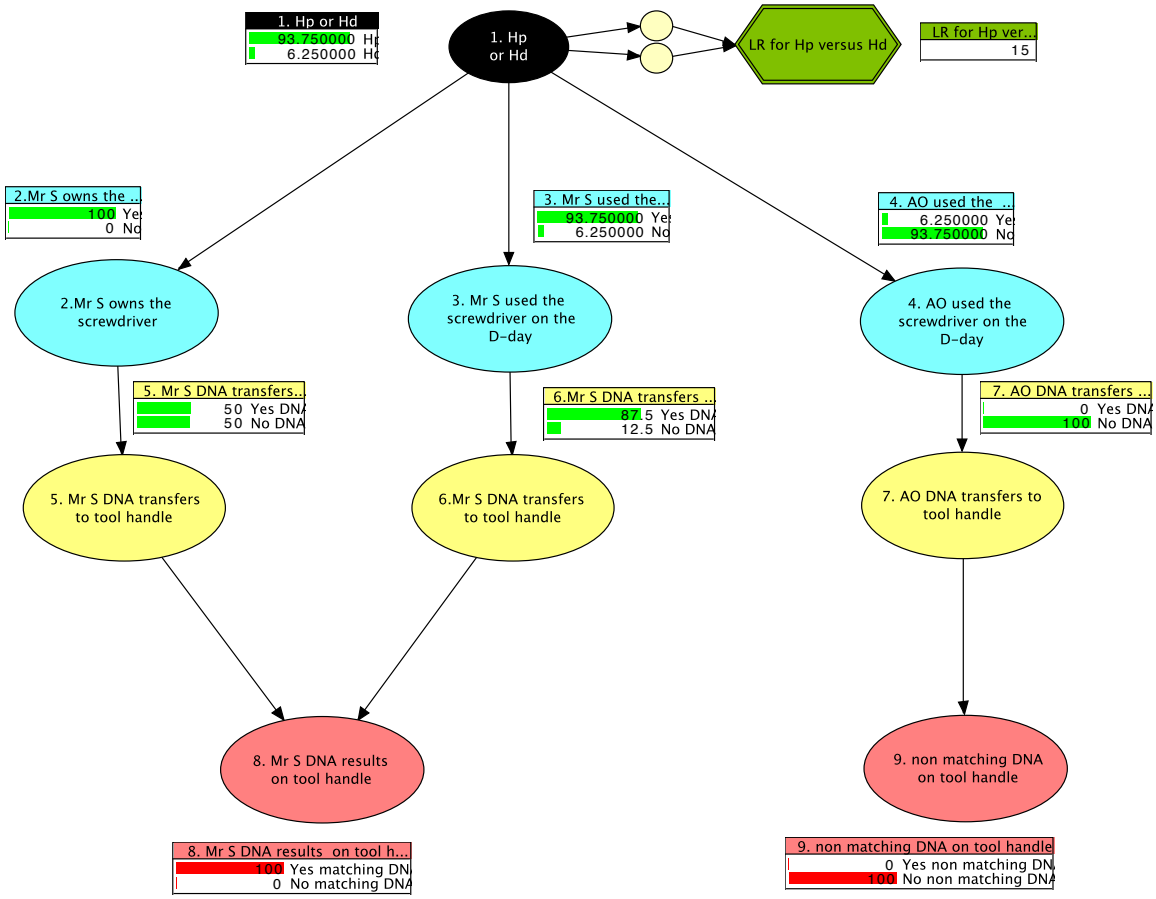

Figure 3. Bayesian Network considering the case scenarios. The results are instantiated (DNA matching for node 8 and no DNA non matching for node 9). Our LR is in the order of 10 (LR = 15).

8- Appendix II: Example of the impact of the value of the results on the probability of the propositions in function of the other information available to the court.

In order to assign the probability of an event (whether it was Mr John Smith who tried to force the door of the Musical school on the 27th of December 2019 or if it was some unknown person with Mr Smith's stolen screwdriver), one has to consider all the elements of the case: the DNA results and all the other elements. This is why this task is the duty of the court. Forensic scientists can help the court in this task by giving the value of their scientific results. Below is an illustration of the impact of DNA results with a likelihood ratio of 10 on the whole case, depending on the amount of information.

The point of these examples is to illustrate that the probability of when and how the DNA was deposited, depends not only on DNA results, but on the case as a whole. The illustration is based on a mathematical idealisation that one's belief about a set of propositions is updated based on the (value of the) DNA results. Part of this framework is used to evaluate results given two different propositions summarizing the point of view of the parties as understood in the case. The value of the results is given by the expert in the form of a Likelihood Ratio (LR). The focus of the LR is always on the DNA results, not on the proposition. The value of results (LR) presented by the expert can then be combined with the other elements to update the decision maker's beliefs in the proposition. To our knowledge outside paternity cases, this is not generally done with numbers nor does it need to be, what is important for this illustration is to realise that one needs to combine all the elements in order to decide in the case.

Three cases are illustrated, but on demand it is possible to consider more:

- The first case illustrates the situation where the other elements in the case favour the proposition that 'Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019**'** (with a probability of 0.9) rather than 'an unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019**'** (with a probability of 0.1). After the information provided by the DNA results, the probability that 'Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019' increases from 0.9 to 0.99. The reverse probability (i.e., 'An unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019') decreases from 0.1 to 0.01.

- The second case illustrates the situation where the other elements in the case do not favour any proposition over the other (both are equally probable based on all the other information). One can see that after knowing the results of the DNA results, the probability that 'Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019' increases from 0.5 to 0.9. On the other hand, the probability that 'An unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019' decreases from 0.5 to 0.1.

- The third case illustrates the situation where the other elements in the case favour the alternative proposition that 'An unknown person tried to force the door of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019 ' (with a probability of 0.9) rather than 'Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019' (with a probability of 0.1). After considering the information given by the DNA results, the probability that 'Mr John Smith tried to force the door of the Musical school XYZ with his screwdriver on December 27th, 2019' increases from 0.1 to 0.5. On the other hand, the probability that 'an unknown person tried to force the door

of the Musical school XYZ with Mr John Smith's stolen screwdriver on December 27th, 2019' decreases from 0.9 to 0.5.

Summary of the examples above:

		Without DNA Probability of the **first** proposition vs Probability of the **alternative**	Value of the DNA results (LR)	**Including DNA** Probability of the **first** proposition vs Probability of the **alternative**
Belief in the propositions based on the other elements	Stronger belief (10 times more) in the **first** proposition	**0.9** vs **0.1**	10	**0.99** vs **0.01**
	Same belief in both propositions	**0.5** vs **0.5**	10	**0.9** vs **0.1**
	Stronger belief (10 times more) in the **second** proposition	**0.1** vs **0.9**	10	**0.5** vs **0.5**

EXHIBIT I

EXAMPLE REPORT

EVALUATIVE REPORT ON THE EXAMINATION OF ITEMS IN THE CASE INVOLVING:

Complainant
(Complainant)

and

Defendant
(Defendant)

by

The Scientist
Forensic Scientist

Case Number	**123456**
Incident Report Number(s)	**17/X123456**
Apprehension Report Number(s)	**17/Y123456**

Report dated Date

This report should be read in conjunction with the report dated Date identified by case number 123456, written by The Scientist, that details the results of DNA profiling

Contents of this report:

1.0 - Case Information:

The following information was provided to me by Police on the Request form and via email communications:
The complainant was staying at the defendant's home at the time of the alleged offence. The defendant is the complainant's full biological brother. The complainant alleged that the defendant bit her on the vagina, outside her underwear twice.

I will refer to the above as the prosecution's proposition.

I attempted to obtain the defendant's version of events, but have been told that he has made no comment. I will therefore assume that his version of events is that he did not bite the complainant, had no direct contact with her underwear and has cohabitated with her at the time of the alleged offense.

I will refer to this as the defence scenario.

Note that the complainant's regular place of habitation is with her biological mother and father. The defendant is the full brother of the complainant and so would be expected to have the same Y-STR profile as any paternal relative, for example, the complainant's father, which I will refer to as the 'Family Y-STR profile'. The father is not suspected of any criminal activity.

My approach to the examination and interpretation of the results in this case is crucially dependant on the information made available to me. If any of the above information is incorrect or if further information is made known to me, it will be necessary for me to reconsider my interpretation. I have made the assumption that the issue in this case is not one of consent between the defendant and complainant, but alleged activities as outlined above.

2.0 - Description of the items received and results of examination:

Detailed descriptions of the items received and the DNA results can be found in the report dated 01/05/2017, with case number 123456, written by The Scientist (hereafter called the DNA report). The results that I will use in the evaluation given activity level propositions[1] are a summary of the findings presented in the DNA report and can be grouped into the following main results:

1) An area of the crotch of the underwear of the complainant (Item #1) gave a positive reaction to an RSID saliva test
2) Faecal staining was present on the inner and outer surfaces of the underwear
3) A cutting taken form the outer surface of the underwear yielded high levels of female DNA that corresponded to the complainant's reference, and I assume that this is her DNA, and a low level of male DNA. The male DNA could only be profiled using Y-STR profiling and doing so yielded a partial Y-STR profile that matched the defendant's reference. I am assuming that the male DNA present on the complainant's

[1] See Appendix for the definition of the notion of 'activity level proposition'.

underwear is either from her father (transferred due to cohabitation) or from the defendant.

3.0 - Evaluation:

I explain my evaluation with regards to the points in section 2.0. In my assessment, I have used Bayesian Networks (graphical models for reasoning under uncertainty), as well as the literature available and my knowledge. I summarise below my reasoning, and refer the reader to the appendix for a full description.

Exhibit 1: Complainant's underwear (Item #1)

I have assessed the probability of the results (i.e. RSID positive results, low levels of the Family Y-STR profile on the underwear) given both prosecution and defence's propositions.

DNA results:

Under the prosecution case information, there are three mechanisms by which we could expect to see the family YSTR profile present on the complainant's underwear, either:

a) The defendant transferred his DNA to the complainant's underwear from biting.
b) The defendant's DNA was transferred to the complainant's underwear from cohabitation.
c) The complainant's father's DNA was transferred to the complainant's underwear from cohabitation.

Note that the scenarios above are not mutually exclusive, i.e. both a) and b) can occur together as can a) and c) or b) and c).

The probability of DNA being transferred to the underwear has been assigned as 0.84 for high levels, and 0.08 for low levels and none given prosecution's proposition (of biting) based on the work of [1-3].

Under the defence view as it was understood, there are two mechanisms by which the family Y-STR profile could have come to be on the underwear (mechanisms 'b' and 'c' from above). Given defence proposition, the probability for high levels, low levels or no DNA transfer has been assigned as 0.09, 0.43 and 0.48 based on the work of [4].

The results (i.e. low levels of the family YSTR profile on the complainant's underwear) are therefore about 5 times more probable given the defence proposition rather than prosecution's.

RSID saliva findings:

I have assigned the probability of the results (i.e. an RSID saliva positive test result from a cutting of the complainant's underwear) given both prosecution and defence's propositions.

Under the prosecution case information there are three mechanisms by which we could expect to see a positive RSID saliva test result from a cutting of the complainant's underwear, either:

a) The defendant transferred his saliva to the complainant's underwear from biting.
b) There were background levels of saliva on the complainant's underwear.
c) The RSID saliva test result gave a positive reaction due to the presence of faeces on the complainant's underwear

Note that the scenarios above are not mutually exclusive, i.e. both a) and b) can occur together as can a) and c) or b) and c) or a), b) and c).

The probability of saliva being transferred to the underwear has been assigned as 0.92, and as 0.08 for no transfer given prosecution's proposition (of biting) based on the work of [1-3].

The probability of background saliva being present has been assigned as 0.07, and as 0.93 for no background based on the work of [5].

The probability of obtaining a positive RSID saliva test in the presence of faecal material has been assigned as 0.67 for yes and 0.34 for no based on the work of [6].

The results (i.e. an RSID saliva positive test result from a cutting of the complainant's underwear) are approximately equally probable given the prosecution or defence propositions.

Summary

Altogether, the results (RSID saliva positive staining and the family YSTR profile on the outer crotch of the complainant's underwear) are in the order of 5 times more probable given defence's proposition than given the prosecution's proposition.

4.0 - Conclusion:

The consideration of the factors of transfer and the data upon which I have relied in forming my opinion are provided in the Appendix. I have considered the two following scenarios:

Prosecution scenario

The complainant was staying at the defendant's home at the time of the alleged offence. The defendant is the complainant's full brother. The complainant alleged that the defendant bit her on the vagina, outside her underwear twice.

Defence scenario

I attempted to obtain the defendant's version of events, but have been told that he has made no comment. I will therefore assume that his version of events is that he did not bite the complainant and has cohabitated with her at the time of the offense.

Value of the results

After evaluating the results in light of the two scenarios given above I conclude that it is approximately 5 times more probable to have obtained the observed results if the course of events occurred in the manner described by the defence scenario rather than occurring in the manner described by the prosecution scenario.

This conclusion should be seen as a reinforcing factor to the perception of the propositions that existed before the technical evidence was taken into account. I do **not** give an assessment of how probable it is that the prosecution or defence proposition is true.

The results therefore provide sight support that of events occurred in the manner described by the defence scenario rather than the prosecution scenario.

I remain at your disposal for any questions and/or additional information

signature date

The Scientist | Forensic Statistics
Laboratory
Laboratory address
P: phone number | F: fax number

5.0 Appendix

Formal calculations that are relevant to the opinions provided in the main report

In order to help address the propositions that are relevant to this matter I have considered the findings in the case from the complainant's underwear. By considering these mechanisms of transfer, I have constructed the Bayesian Network (BN) shown in Figure 1. BNs are ideally suited to deal with the complexity of such a case, as shown in the recent literature:

Evett, I. W., Gill, P. D., Jackson, G., Whitaker, J., and Champod, C. (2002), Interpreting small quantities of DNA: The hierarchy of propositions and the use of Bayesian networks, Journal of Forensic Sciences, 47, 520-530.

Taroni, F., Biedermann, A., Bozza, S., Garbolino, P., and Aitken, C. (2014), Bayesian networks for probabilistic inference and decision analysis in forensic science (2nd ed.), ed. V. Barnett, Chichester: John Wiley & Sons, Ltd.

Taylor, D., Biedermann, A., Samie, L., Pun, K.-M., Hicks, T., and Champod, C. (2017), Helping to distinguish primary from secondary transfer events for trace DNA, Forensic Science International: Genetics, 28, 155-177.

In the BN, I have made the following assumptions:

- The complainant's DNA is on the underwear
- The male DNA on the underwear is either from the complainant's father or the defendant (the complaint's brother)

For nodes that rely on counts of experimental observations, I apply a Dirichlet(1,…,1) prior to calculate the posterior mean probability of each count for use in the BN. If state *i* of category *k* has $n_{i,k}$ observations, then the posterior probabilities are calculated by:

$$p_{i,k} = \frac{n_{i,k} + 1}{I + \sum_i n_{i,k}}$$

where *I* is the number of different states that exist in that category

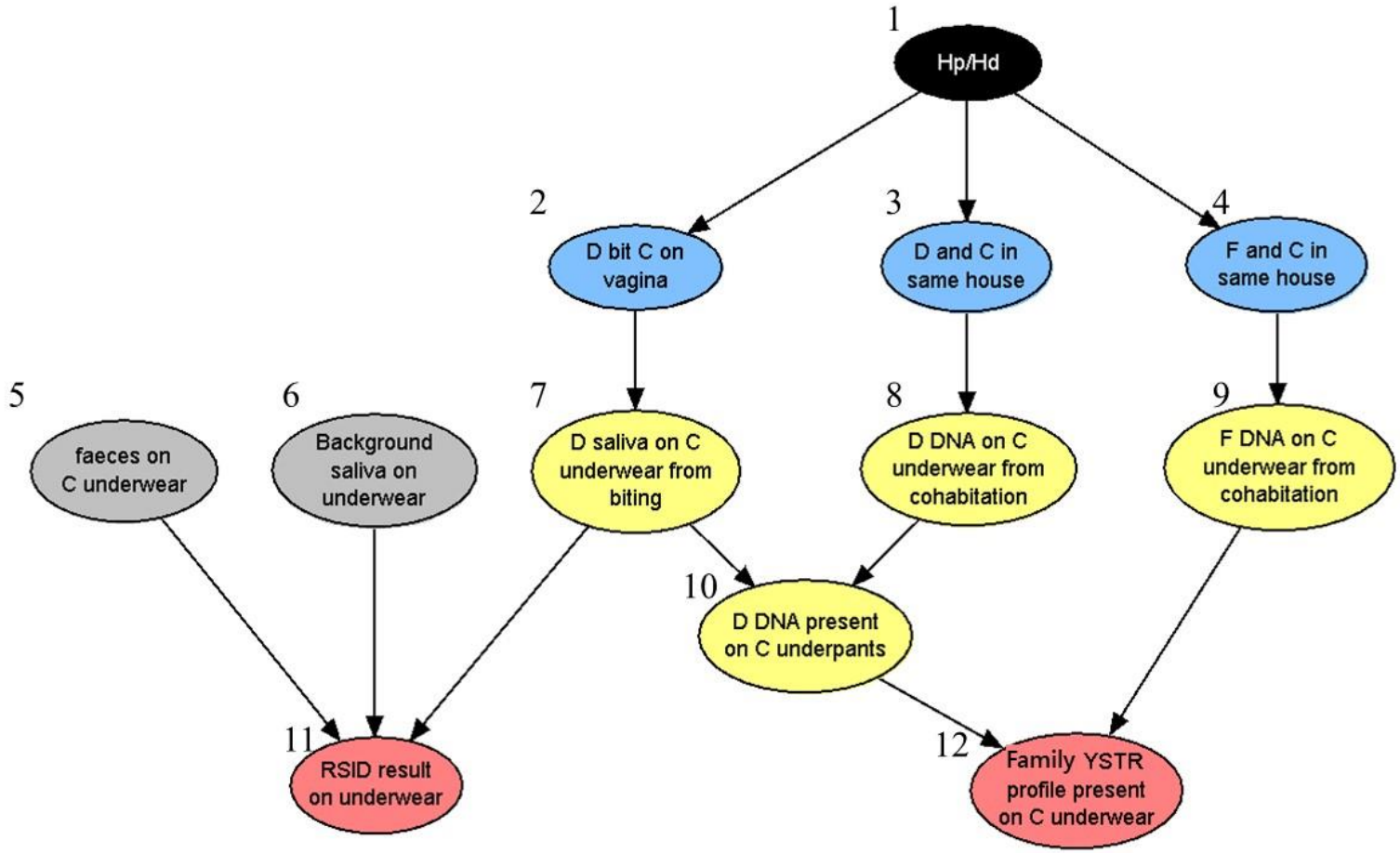

Figure 1: Bayesian network considering the competing versions of the case. Nodes are coloured so that black is the main propositional node, blue are the activity nodes, grey are the root nodes, yellow are the intermediate results nodes and pink are the findings nodes. In the BN, D stands for defendant, C for complainant and F for father of complainant

Node 1 (Hp/Hd): The proposition node with possible values of 'Hp' or 'Hd'. The 'Hp' option is the prosecution's version of the case as given in section 4 of the main report and 'Hd' considers the defence scenario as given in section 4 of the main body of the report. I assign these two options with equal prior probabilities. Note that this does not mean the prior odds in this case are equal, I apply – for technical reasons only – equal prior probabilities[2] for the propositions so that the values obtained by the BN inform me of the likelihood ratio.

Hp/Hd

Hp	0.5
Hd	0.5

Node 2 (D bit C on vagina): This node considers the activity of D biting C on the vagina over her underwear, which has occurred under Hp and not under Hd

Hp/Hd (1)

D bit C on vagina

	Hp	Hd
Yes	1	0
No	0	1

Node 3 (D and C in same house): This node considers the activity of D being in the same house as C, which has occurred under both Hp and Hd

Hp/Hd (1)

D and C in same house

	Hp	Hd
Yes	1	1
No	0	0

Node 4 (F and C in same house): This node considers the activity of the father of the complainant (F) being in the same house as C, which has occurred under both Hp and Hd. This must be considered as the Y-STR profile obtained from the cutting of the victim's underwear could be from either or both D or F (who, being father and son, will possess copies of the same Y-Chromosome)

Hp/Hd (1)

F and C in same house

	Hp	Hd
Yes	1	1
No	0	0

[2] Note that this assumption has no impact on the value of the findings.

Node 5 (faeces on C underwear): This node refers to whether faeces was present on C's underwear, with possible values of 'yes' or 'no'. I assign – again for technical reasons only – equal initial probabilities to these two options. Note that when using the BN for evaluating findings, node 5 will be instantiated (i.e., one of this node's states will be assumed known), so that the probabilities specified in the node table are not are not an issue.

faeces on C underwear

Yes	0.5
No	0.5

Node 6 (Background saliva on underwear): This is a root node that considers the probability of female underpants being tested for the presence of saliva and yielding a positive RSID saliva result when oral intercourse has not immediately taken place. For these values I refer to the work in [5] who found that 4.6% of female underwear gave positive RSID results when the female had refrained from oral intercourse for 12hr prior. This amounted to 2 positive and 41 negative. For the BN I use values of (2+1)/(43+2) ~ 0.07 for present and (41+1)/(43+2) ~ 0.93 for absent

Background saliva on underwear

Present	0.07
Absent	0.93

Node 7 (D saliva on C underwear from biting): A node that considers the probability of the levels of DNA from saliva being transferred to the underwear of C from biting. According to Harvey [1] approximately 0.3mL of saliva is deposited when making a bite mark. I do not have access to the range which was observed, and so I will consider that the amount of saliva transferred could be described by a uniform distribution $U[0,0.6]$. If we then take the results of Quinque et al [2], a distribution for the concentration of DNA (ug/mL) in saliva can be determined as shown below in Figure 2.

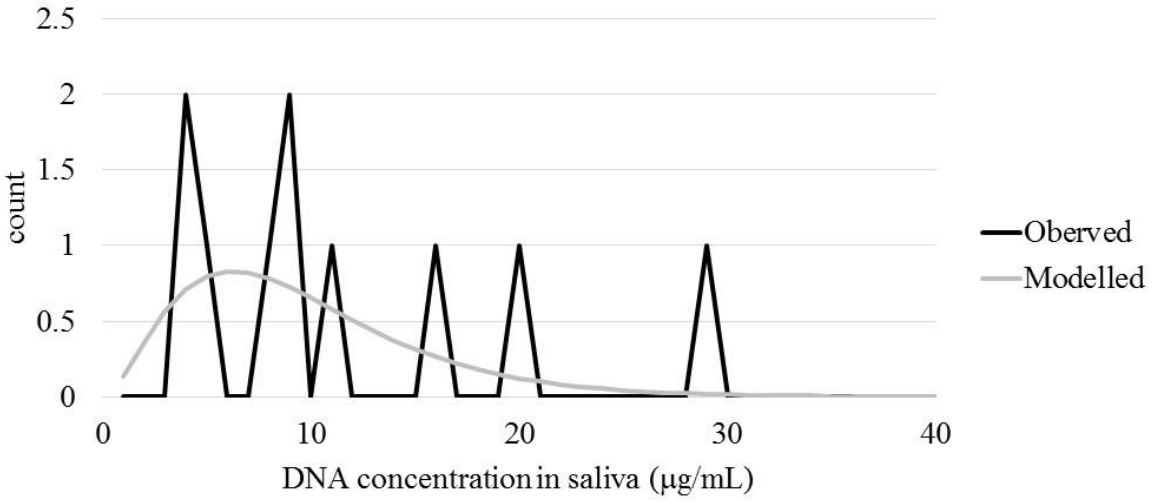

Figure 2: Observations of DNA concentrations in saliva (black) and modelled gamma distribution (grey)

From the 10 observations in [2] a gamma distribution was fit to the observed DNA concentration in saliva using least square difference. The fitted gamma curve was $\Gamma(2.8,3.4)$. In the case at hand there is a sampling effect. A tapelift was used to sample the inner front of the underpants. The work in Taylor et al [3] showed that tapelifts have a sampling efficiency that can be described by a $B(1.9,16.6)$ distribution. To obtain a distribution of DNA that is expected from a bitemark the following process was carried out:

1) Draw a random value from a $U[0,0.6]$ distribution to represent the amount of DNA transferred from a bite in mL.
2) A random value from a $\Gamma(2.8,3.4)$ distribution was drawn and multiplied by 1000 to convert to a ng/mL value
3) A random sampling efficiency was drawn from a $B(1.9,16.6)$ distribution
4) The amount of DNA that is expected from a tapelift of a bitemark can then obtained by multiplying the value from 1) by the value from 2) by the value from 3)
5) Steps 1) to 4) were repeated 500 times to produce a distribution of values that could be modelled by a $\Gamma(1.2,55)$ distribution, as per Figure 3

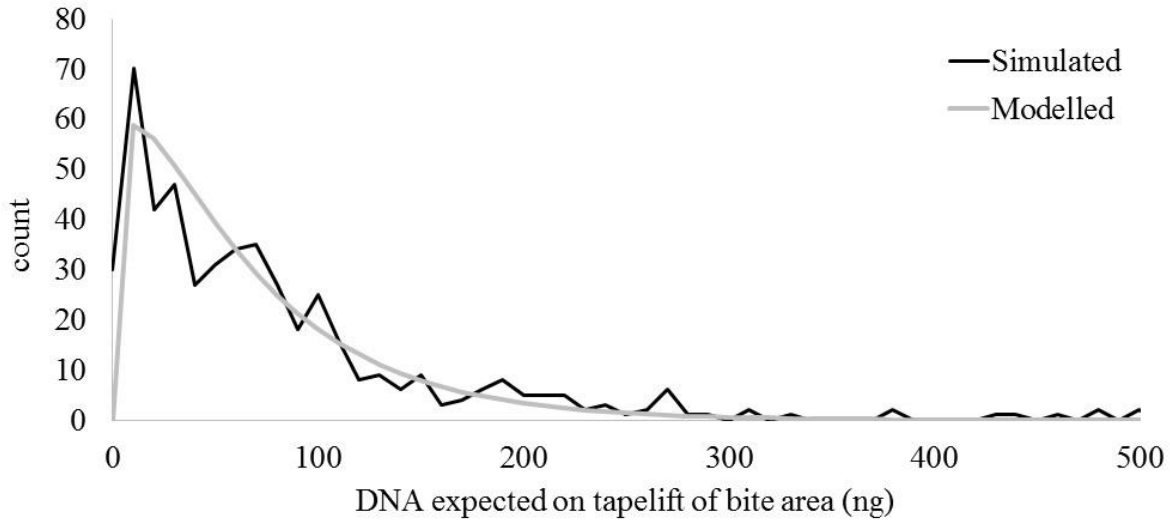

Figure 3: Simulated DNA amounts from a tapelift of a bitemark (black) and modelled gamma distribution (grey)

The proportion of the gamma distribution below 2ng is approximately 0.02. If we take the original number of observations from the Quinque et al [2], i.e. 10 then we would expect 0 (0.2 rounded down to 0) to be below 2ng (and then also 0 to show no DNA). I will use the values (10+1)/(10+3)~0.084 for yes (high) and (0+1)/(10+3)~0.08 for both yes (low) and none.

D bit C on vagina (2)

D Saliva on C underwear from biting	Yes	No
Yes (high)	0.84	0
Yes (low)	0.08	0
No	0.08	1

Node 8 (D DNA on C underwear from cohabitation): This node considers the level of DNA from the underwear from cohabitation of D and C. For these probabilities I will use the work of [4]. They found that out of 168 cutting from female children's underwear 52% (n = 87) showed the presence of DNA other than the female child who wore them. They further showed that out of 24 cuttings tested for male DNA, 4 of them yielded greater than 2ng. If I take this as representative of the female (non-child) DNA then this would mean that out of the 87 mixed samples approximately 17% (n = 15) had high levels of DNA and 83% (n = 73) had low levels of DNA. I therefore use probabilities (15+1)/(168+3) ~ 0.09 for yes (high), (73+1)/(168+3) ~ 0.43 for yes (low) and (81+1)/(168+3)~0.48 for no.

D and C in same house (3)

D DNA on C underwear from cohabitation	Yes	No
Yes (high)	0.09	0
Yes (low)	0.43	0
No	0.48	1

Node 9 (F DNA on C underwear from cohabitation): This node considers the level of DNA from the underwear from cohabitation of F and C. I use the same values as for node 8

F and C in same house (4)

F DNA on C underwear from cohabitation	Yes	No
Yes (high)	0.09	0
Yes (low)	0.43	0
No	0.48	1

Node 10 (D DNA on C underwear): This node combines the parental node values to consider the defendant's DNA being found on the complainant's underwear. I assume that the combination of the two parental states "Yes (low)" leads to an outcome "Yes (low)" with probability 0.5 and to an outcome "Yes (low)" with probability 0.5.

D Saliva on C underwear from biting (7)		Yes (high)			Yes (low)			No		
D DNA on C underwear from cohabitation (8)		Yes (high)	Yes (low)	No	Yes (high)	Yes (low)	No	Yes (high)	Yes (low)	No
D DNA on C underwear	Yes (high)	1	1	1	1	0.5	0	1	0	0
	Yes (low)	0	0	0	0	0.5	1	0	1	0
	No	0	0	0	0	0	0	0	0	1

Node 11 (RSID results on underwear): This node considers that the RSID saliva positive result could be obtained either through the background levels of saliva on C's underwear, or the presence of saliva from D biting C, or from the false positive reaction of the RSID saliva test to faeces. For this last probability I use the work of Casey et al [6], who tested the faeces of 4 infants and found that three gave a positive RSID saliva result. I use probabilities of

(3+1)/(4+2)~0.67 for the node state "positive" and (1+1)/(4+2)~0.33 for the node state "negative".

Faeces on underwear (5)		Present						Absent					
Background saliva on underwear (6)		Yes			No			Yes			No		
D Saliva on C underwear from biting (7)		Yes (High)	Yes (Low)	No	Yes (High)	Yes (Low)	No	Yes (High)	Yes (Low)	No	Yes (High)	Yes (Low)	No
RSID result on C underwear	positive	1	1	1	1	1	0.67	1	1	1	1	1	0
	negative	0	0	0	0	0	0.33	0	0	0	0	0	1

Node 12 (Family YSTR profile present on C underwear): This node accumulates the two possible sources of the family YSTR profile, F or D, on C's underwear. I assume that the combination of two parental node states "Yes (low)" results in the outcome "Yes (low)" with probability 0.5 and in the outcome "Yes (high)" with probability 0.5.

F DNA on C underwear from cohabitation (9)		Yes (high)			Yes (low)			No		
D DNA on C underwear (10)		Yes (high)	Yes (low)	No	Yes (high)	Yes (low)	No	Yes (high)	Yes (low)	No
Family YSTR profile present on C underwear	Yes (high)	1	1	1	1	0.5	0	1	0	0
	Yes (low)	0	0	0	0	0.5	1	0	1	0
	No	0	0	0	0	0	0	0	0	1

Use of the Bayesian network for evaluating the value of the DNA findings

Having populated the probability tables with values I utilise the following information from the case scenario and item examination:

- The underwear had faecal staining present
- The defendant is the complainant's full brother

I use the following results:

- RSID saliva positive test result for a cutting from the outer crotch of the underwear
- The family Y-STR profile for a cutting from the outer crotch of the underwear. This cutting yielded high amounts of female DNA that corresponded to the complainant's reference. Also present was low levels of male DNA. Low is defined as between 0 and 2ng. In this instance, the male DNA amount was 1.5ng (male DNA concentration of 0.025ng/μL in 60μL of DNA extract).

When the BN shown in Figure 1 is instantiated so as to reflect the above findings, the result shown in Figure 4 is obtained.

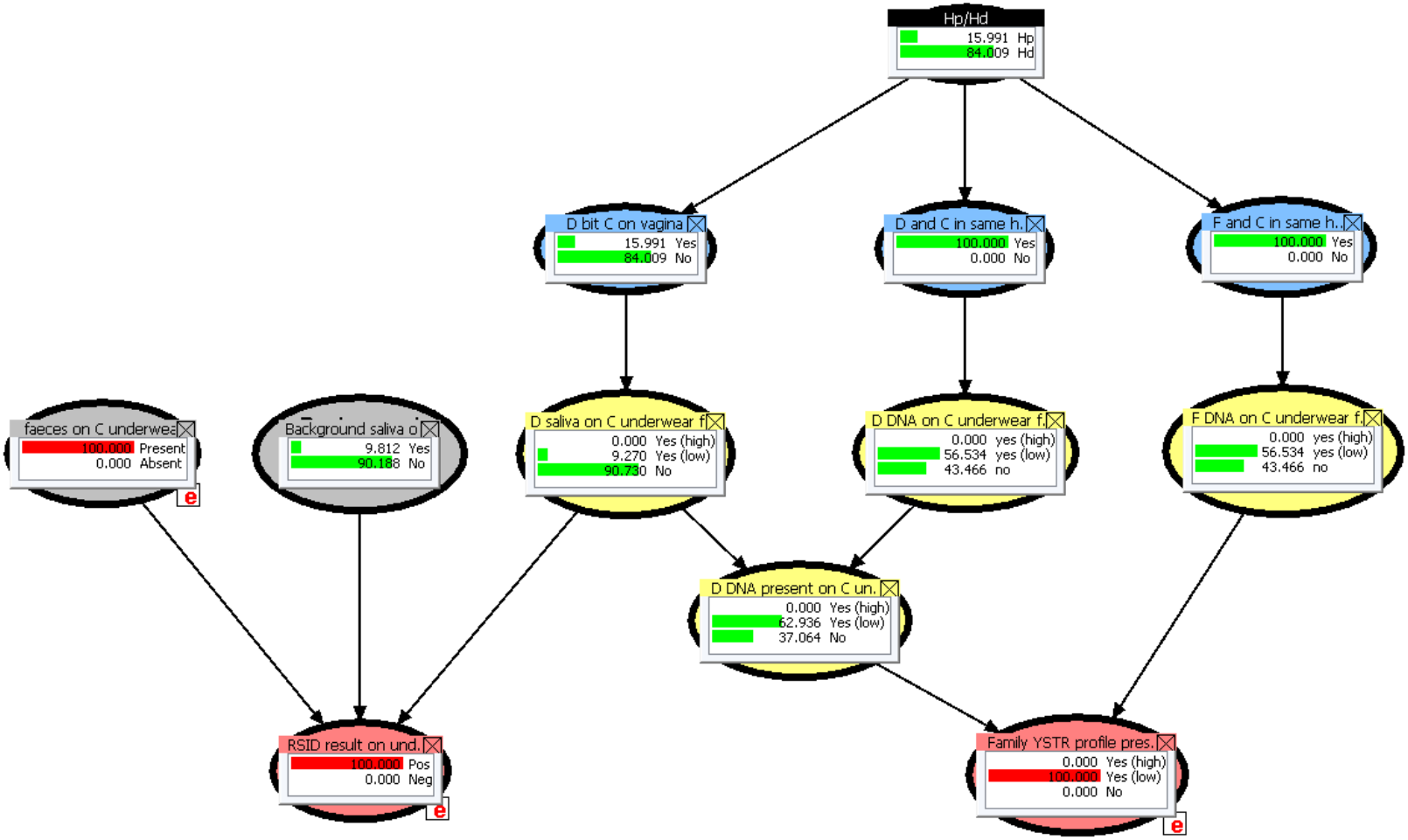

Figure 4: BN from Figure 1 with conditional probabilities entered and instantiations made according to the DNA findings of this case.

Note that the probabilities shown in the 'Hp/Hd' node are posterior probabilities as they are a product of the prior information provided to the states within this node (seen in Tables) and the information provided by me at other nodes. In the *BN* I have constructed, the two states that the 'Hp/Hd' node can take are given equal prior probabilities. The *LR* produced is from a division of the posterior probabilities, $\frac{\Pr(Hp \mid E)}{\Pr(Hd \mid E)}$, however as the priors are equal, the likelihood ratio, $\frac{\Pr(E \mid Hp)}{\Pr(E \mid Hd)}$, (without taking into account prior probabilities) is the same, i.e. $\frac{\Pr(Hp \mid E)}{\Pr(Hd \mid E)} = \frac{\Pr(E \mid Hp)}{\Pr(E \mid Hd)}$ when $\Pr(Hp) = \Pr(Hd)$

In this matter $\frac{\Pr(Hp \mid E)}{\Pr(Hd \mid E)} = \frac{\Pr(E \mid Hp)}{\Pr(E \mid Hd)} \approx \frac{16}{84} \approx 0.2 = (5)^{-1}$

Background explanation on the hierarchy of propositions

The classification in these different levels has been named the hierarchy of propositions: the higher the level, the more information and the more expertise (on behalf of the scientist) are needed, thus enabling more value to be added.

Examples of the different levels in the hierarchy of propositions are given hereafter:

> Sub-level 1 (sub-source): The DNA originated from Mr A versus the DNA originated from an unknown person
>
> Level 1 (Source level): The semen originated from Mr A versus the semen originated from an unknown person
>
> Level 2 (Activity level): Mr A has sex with Ms B versus Mr A only socially contacted Ms B
>
> Level 3 (Offence level): Mr A raped Ms. B versus Mr A had consensual sex with Ms. B.

The verbal equivalence being used

Likelihood ratios are numerical by nature. Words can be assigned to these numerical values that act as verbal descriptors of the level of support that likelihood ratio assigns to one proposition over the other. The definition of verbal descriptions for numerical values is by their nature subjective and a number of different scales have been adopted by convention within the forensic community. The laboratory uses verbal descriptors based on those provided by Evett and Weir [7], which we give below.

Likelihood ratio	**Level of support**
1	Neutral
1 to 10	Limited support
10 to 100	Moderate support
100 to 1000	Strong support
1000 to 1,000,000	Very Strong Support
Greater than 1,000,000	Extremely Strong Support

Aspects regarding quality (assurance/management)

All aspects of relevant quality assurance and control have been maintained throughout the analysis of DNA samples in this case. This involves the minimisation of, and screen for potential contamination. The laboratory is accredited by the National Association of Testing Authorities (NATA) and all members of the scientific group undergo yearly proficiency testing. If any further information is required it can be obtained by contacting the Quality Assurance Manager.

Relevant literature

[1] W. Harvey, Dental identification and forensic odontology, Kimpton, London, 1976.

[2] D. Quinque, R. Kittler, M. Kayser, M. Stoneking, I. Nasidze, Evaluation of saliva as a source of human DNA for population and assoication studies, Analytical Biochemistry 353 (2006) 272-277.

[3] D. Taylor, A. Biedermann, L. Samie, K.-M. Pun, T. Hicks, C. Champod, Helping to distinguish primary from secondary transfer events for trace DNA, Forensic Science International: Genetics 28 (2017) 155-177.

[4] S. Noel, K. Lagace, A. Rogic, D. Granger, S. Bourgoin, C. Jolicoeur, D. Sequin, DNA transfer during laundering may yield complete genetic profiles, Forensic Science International: Genetics 23 (2016) 240-247.

[5] M. Breathnach, E. Moore, Background Levels of Salivary-α-amylase Plus Foreign DNA in Cases of Oral Intercourse: a Female Perspective, Journal of Forensic Sciences DOI: 10.1111/1556-4029.12866 (2015).

[6] D. Casey, J. Price, The sensitivity and specificty of the RSID(TM)-saliva kit for the detection of human salivary amylase in the Forensic Science Laboratory, Dublin, Ireland, Forensic Science International 194 (2010) 67-71.

[7] I. Evett, B. Weir, Interpreting DNA Evidence: Statistical Genetics for Forensic Scientists, Sinauer Associates, Sunderland, MA, 1998.

STATEMENT OF WITNESS

Statement of:	The Scientist
Age:	Over 21
Occupation:	Forensic Scientist
Address:	Laboratory address
Telephone:	Phone number

This statement, consisting of **18** pages signed by me, is true to the best of my knowledge and belief. I understand that if this statement is filed in a Court for the purposes of a prosecution pursuant to Section 104 of the Summary Procedure Act and it is, to my knowledge, false or misleading, I am guilty of an offence pursuant to provisions of the Summary Procedure Act.

The scientist qualifications.

Items have been examined relating to the matter of **Complainant** (Complainant) and **Defendant** (Defendant).

An Evaluative Report, prepared by me, and relating to the examination of the items is attached. The report, signed by me, is identified by Case Number **123456**. I hereby incorporate that report as part of my statement.

Signed:

siganture

Date:
XX/XX/20XX