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APPROVAL OF THE APPELLATE DIVISION

SUPERIOR COURT OF NEW JERSEY
APPELLATE DIVISION
DOCKET NO. A-0103-17

STATE OF NEW JERSEY,

Plaintiff-Respondent,

v.

DANIEL ROCHAT,

Defendant-Appellant.

APPROVED FOR PUBLICATION

January 28, 2022

APPELLATE DIVISION

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Argued November 9, 2021 – Decided January 28, 2022

Before Judges Hoffman, Geiger and Susswein.

On appeal from the Superior Court of New Jersey, Law Division, Bergen County, Indictment No. 13-07-1002.

David A. Ruhnke argued the cause for appellant (Ruhnke & Barrett, attorneys; David A. Ruhnke, on the briefs).

Ian C. Kennedy, Assistant Prosecutor, argued the cause for respondent (Mark Musella, Bergen County Prosecutor, attorney; Danielle Grootenboer, Chief Assistant Prosecutor, David A. Malfitano, Chief Assistant Prosecutor, and Ian C. Kennedy, of counsel and on the briefs; John J. Scaliti, Legal Assistant, on the briefs).

Tamar Y. Lerer, Assistant Deputy Public Defender, argued the cause for amicus curiae Office of the

Public Defender (Joseph E. Krakora, Public Defender, attorney; Tamar Y. Lerer, of counsel and on the brief; Julie Fry, Director, Forensic Science Unit, on the brief).

The opinion of the court was delivered by

GEIGER, J.A.D.

Defendant Daniel Rochat was convicted of the murder of Barbara Vernieri and related charges and sentenced to life in prison. He appeals his convictions, primarily arguing that certain disputed DNA evidence was improperly admitted at trial. The disputed DNA evidence was obtained through a technique known as low copy number (LCN) DNA testing performed by the Office of the Chief Medical Examiner of the City of New York (OCME). One of the samples was analyzed by OCME using its Forensic Statistical Tool (FST) software program. Defendant argues that both LCN DNA testing and FST are not generally accepted in the scientific community. We agree, and because the error in admitting the evidence was not harmless, we reverse defendant's conviction and remand for a new trial.

I.

We derive the following facts from the record. Shortly after noon on September 14, 2012, Sinan and Holland Logan, who rented the upstairs apartment in Vernieri's residence, heard a beeping sound coming from Vernieri's downstairs living space. When they opened the door that led to the

stairwell connecting the living spaces, they smelled gasoline. They descended the stairs, rang Vernieri's doorbell, and knocked on her door. When she did not respond, Sinan called her cell phone, which she did not answer. He then called her daughter who told him to call 911.

Vernieri's body was found lying face down in her sitting room. She was nude, her hair was scorched off, and she had burns on her back, arms, and legs. Investigators discovered burn patterns on the floor and determined that gasoline was "applied to areas in this room, including her body and . . . set on fire." A large, suspected blood stain was found on the carpet.

Vernieri was pronounced dead at the scene. The medical examiner determined that the cause of death was blunt force head injuries, and the manner of death was homicide.

Sergeant Gary Boesch of the Bergen County Prosecutor's Office interviewed defendant at 10:15 p.m. on September 14, 2012. Defendant told Boesch that on September 12, 2012, at about 7:15 p.m., his car overheated near Vernieri's home. He pulled over and decided to pay her an unannounced visit. When she answered the door, she was speaking on the phone to her "companion from Florida." She hung up the phone and he visited with her for about one hour. During the visit, Vernieri was cooking, and defendant drank two bottles of water but had nothing to eat. He denied drinking beer. They

discussed the real estate business and relationships. Defendant asked her if she needed help moving anything, but she declined.

Defendant told Boesch that the last time he saw Vernieri was on the afternoon of September 13, 2012, when he stopped in at the Kurgan-Bergen Real Estate Agency, where Vernieri had worked for approximately twenty-seven years, to check his emails. The agency was owned by defendant's father. Before leaving, he chatted with Vernieri and gave her his phone number at her request in case she wanted to take him up on his offer to help move her things.

Defendant also told Boesch that he woke up at around 11:00 a.m. on September 14, 2012, and a little later went to see his father to borrow money from him. He then went to a deli in Woodbridge and then drove to the Jersey shore.

On September 17, 2012, investigators obtained communication data warrants for defendant and Vernieri's cell phones. On the morning of September 18, 2012, Boesch and Detective James McMorrow conducted a recorded interview of defendant at his apartment after defendant refused to accompany the detectives to their office. Defendant was advised of his

Miranda[1] rights. He said Vernieri was a long-time family friend who worked for his father's real estate agency.

Defendant described that on September 12, 2012, as his car was about to overheat, he pulled over about two blocks from Vernieri's house and decided to walk to her home. He estimated that he arrived at her house at 7:20 p.m. It was the first time he had ever visited Vernieri's home. She was on the phone with a man she was seeing in Florida but invited defendant into her house. She offered defendant something to drink and gave him a bottle of water. She also offered him food, but he declined. He visited with her for about one hour.

When asked if he only had a bottle of water during the visit, defendant stated that Vernieri offered him a beer, which he drank. He clarified that he had two beers and two bottles of water. Vernieri took defendant to the basement of her home so that he could choose the beer from her basement refrigerator. Defendant commented to Vernieri that he had never been in her home before, and she gave him a "quick tour." While he was there, defendant asked her if she needed help moving anything, but she declined.

Defendant told the detectives that he saw Vernieri on September 13, 2012, when he stopped by his father's real estate office that afternoon. He

[1] Miranda v. Arizona, 384 U.S. 436 (1966).

spoke briefly with her; she asked for his cell phone number in case she needed help moving anything.

Defendant recounted that on September 14, 2012, he woke up between 11:00 a.m. and noon and then drove to Lyndhurst to get a bagel. Afterwards, he stopped at a condominium on Van Winkle Avenue in East Rutherford that was managed by his father. The property had been sold by defendant's father to an Egyptian family who visited the United States regularly. Defendant and his father managed the property when the owners were absent. Defendant was permitted to keep his truck there and had access to the garage area. Defendant said he kept tools and cleaning supplies there for his truck. After stopping at the condominium, defendant returned to his apartment to shower and went to his father's office to get money. He then returned home to pack for a stay at his parent's shore house.

Defendant said he went to the shore later that night after stopping to see a friend, Kristen Henke, who was house sitting for her parents in Ridgewood. He was with Henke when his father called to tell him about Vernieri.

After recounting these events, defendant changed his story and said he saw his father after visiting Henke and drove to the shore immediately thereafter. He could not remember what time it was when he drove to the

shore but believed it was early that evening. He denied being on Shepard Terrace, the street where Vernieri lived, at any time on September 14, 2012.

Defendant said he was wearing either his Nike Air Max or Adidas athletic shoes when he visited Vernieri on September 12, 2012. The detectives showed defendant a photograph of an impression of an Adidas shoe taken at Vernieri's house and defendant showed the detectives Adidas shoes he may have been wearing when he visited Vernieri.

McMorrow informed defendant that his cell phone records showed he received a call at 10:39 a.m. on the morning of September 14, 2012. Defendant claimed that he did not remember getting the call. Additional calls were made to defendant's phone at 11:06, 11:10 and 11:42 a.m. but were not completed. McMorrow said that showed that defendant's phone had been turned off. McMorrow told defendant that they were able to map where his phone was and that he was on Shepard Terrace at 10:39 a.m. Defendant denied he was there. He refused to speak further with the detectives.

McMorrow then informed defendant that they had a search warrant for his apartment and that he needed to accompany them to the prosecutor's office for fingerprinting and DNA collection. Sergeant James Brazofsky, along with other officers, executed the search warrant. Brazofsky testified that Adidas

sneakers retrieved from defendant's apartment matched the shoe impression found at the crime scene.

On September 19, 2012, Boesch obtained a search warrant for the Van Winkle Avenue condominium. In his affidavit supporting the issuance of a search warrant, Boesch recited the following facts:

- Sinan Logan reported hearing sounds from Vernieri's residence between 10:10 a.m. and 10:30 a.m., which he attributed to Vernieri's grandchildren, and which he described as "a struggle, or two people wrestling, and a yell or a shriek."
- Vernieri's daughter reported that Vernieri had a "strange encounter" with defendant, who stopped by Vernieri's house unannounced on September 12, 2012, something he had never done before.
- Vernieri's daughter reported that her mother told her defendant had two beers while he visited, that he asked her to "take him on a walk-through to see the house," and asked her about diamond jewelry.
- Joanna Connelly and Joanne DeMauro, who were both friends of Vernieri, reported that Vernieri described defendant's September 12, 2012, visit as an "odd" or "unusual event," and that Vernieri

told them she offered him a beer and a sandwich, which he accepted;

- In his first statement to police, defendant denied having beer at Vernieri's house and said he only had two bottles of water and nothing to eat.
- Shoe impressions of an Adidas shoe were found at the crime scene.
- Cell phone records identified the location of defendant's cell phone as in the area of Vernieri's home and the parking lot behind it when an incoming call was received at 10:39:57 a.m. on September 14, a time coinciding with the disturbance heard by Logan;
- In his first statement to police, defendant claimed that he slept until about 11:00 a.m. on September 14, and in his second statement he claimed that he slept until sometime between 11:00 a.m. and noon.
- In his second statement to police, defendant said that after waking on September 14, he drove to Lyndhurst for a bagel and then stopped at a condominium on Van Winkle Avenue to get cleaning supplies for his vehicle.

- A friend of defendant identified the condominium unit on Van Winkle Avenue that was utilized by defendant and a nearby resident described a man, matching defendant's description, who drove vehicles matching the description of those owned by defendant, that he observed at the property on multiple occasions.

Investigators, including McMorrow, executed the search warrant on the Van Winkle Avenue condominium. Samples were taken from two areas of the kitchen sink that reacted to Leuco Crystal Violet, a substance used by investigators to detect blood. The swabs were sent to OCME for analysis. On October 2, 2012, McMorrow received the OCME lab test results and was authorized to arrest defendant.

Boesch and McMorrow were part of the team that arrested defendant on October 3, 2012. The arrest was effectuated through a motor vehicle stop. Defendant ignored numerous commands to turn off the engine, open the door, and exit the vehicle. Officers physically removed defendant from the vehicle and when he refused to place his hands behind his back, he was taken to the ground and forcibly handcuffed.

On July 15, 2013, a Bergen County grand jury returned an indictment charging defendant with first-degree murder, N.J.S.A. 2C:11-3(a)(1), (2) (count one); first-degree felony murder, N.J.S.A. 2C:11-3(a)(3) (counts two

and three); second-degree burglary, N.J.S.A. 2C:18-2 (count four); second-degree aggravated arson, N.J.S.A. 2C:17-1(a) (counts five, six and seven); first-degree attempted murder, N.J.S.A. 2C:5-1 and N.J.S.A. 2C:11-3 (counts eight and nine); second-degree desecrating and/or damaging and/or destroying human remains, N.J.S.A. 2C:22-1(a) (count ten); third-degree obstruction, N.J.S.A. 2C:29-3(b)(1) (count eleven); third-degree hindering prosecution, N.J.S.A. 2C:29-3(b)(4) (count twelve); fourth-degree false swearing, N.J.S.A. 2C:28-2(a) (count thirteen); and third-degree resisting arrest, N.J.S.A. 2C:29-2(a)(3)(a) (count fourteen).

Defendant moved for a Frye[2] hearing to determine the admissibility of LCN DNA test results issued by OCME. On August 6, 2015, the court issued a written opinion denying defendant's motion.

Defendant subsequently moved to dismiss the indictment; dismiss counts twelve through fourteen of the indictment; sever counts twelve through fourteen; suppress his statements; and for a Franks/Howery[3] hearing. On February 7, 2017, a different judge issued an order and lengthy written opinion denying defendant's motion in its entirety.

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[2] Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).

[3] Franks v. Delaware, 438 U.S. 154 (1978); State v. Howery, 80 N.J. 563 (1979).

The State moved to admit certain out-of-court statements of the victim and defendant. On March 16, 2017, the court granted the motion in part and denied it in part. The court ruled that statements made by the victim to DeMauro two nights before the murder were admissible as present sense impressions.

THE TRIAL TESTIMONY

A jury trial was conducted on eighteen nonconsecutive days from April 11, 2017, through June 14, 2017. At trial, Maurice Paul Murphy testified that he had been involved in a relationship with Vernieri since 2011, and that he spoke to her "[p]robably every night." He was speaking to her at approximately 9:00 p.m. on September 12, 2012, when her doorbell rang and "startled" them. Vernieri said "nobody comes here this time of night." He remained on the phone while she answered the door and could hear her greeting the person as someone that she knew. When Vernieri returned to the phone, she told Murphy that it was someone from the office, everything was fine, and she would call him tomorrow. Vernieri told Murphy the next morning that her visitor was male.

DeMauro testified that she had been friends with Vernieri for at least fifty years and they spoke every night. She spoke to Vernieri at around 9:30 or 10:00 p.m. on September 12, 2012, and Vernieri told her that defendant had

visited her that evening because his car broke down and he knew that she lived nearby. Vernieri recounted that she invited defendant into her home, offered him dinner, and showed him around the house because he had never seen it. Defendant ate and had a beer and when he asked for another, Vernieri told him he could get it himself, which he did. Vernieri told DeMauro that she was surprised by the visit because defendant had never been there before.

Melissa Huyck testified for the State as an expert in forensic biology and statistical analysis associated with DNA testing. She testified that while working at OCME in 2012, she analyzed two sets of swabs sent to OCME from the Van Winkle condominium kitchen sink using LCN DNA testing. A single DNA profile was developed from the first set of swabs, labeled 1.2.4 and 1.2.5 (Sample 1), that was "consistent with that of Barbara Vernieri." Huyck explained that, statistically, one would expect to see that same profile in 1 in 88.1 billion people.

Testing of the second set of swabs, labeled 1.2.1 and 1.2.2 (Sample 2), showed a mixture of DNA from two people. Using FST, Huyck determined that the mixture "was approximately 71.2 million times more likely to have come from Barbara Vernieri and another person rather than that mixture coming from two unknown, unrelated people." However, "the mixture was 575 times more probable to have come from Barbara Vernieri and an

unknown, unrelated person rather than having come from Barbara Vernieri and [defendant]." Hyuck said the DNA test results "indicate[d] strong support that the DNA from the kitchen sink was from Barbara Vernieri and an unknown person, rather than having come from Barbara Vernieri and [defendant]." She agreed that she could not tell when the DNA mixture was created and that there could have been DNA in the sink before the blood was put there.

Huyck tested additional samples obtained from Vernieri's home, defendant's apartment, and his car. The samples from Vernieri's home did not test positive for defendant's DNA. The samples from defendant's apartment and car did not test positive for Vernieri's DNA

The New Jersey State Police (NJSP) also conducted DNA testing of several samples obtained from Vernieri's home and person. Kimberly Michalik of the NJSP Office of Forensic Sciences, testified for the State as an expert in forensic DNA analysis. She stated that defendant could not be excluded as a contributor to the DNA found in fingernail clippings from Vernieri's left hand. The DNA profile obtained would be "expected to occur . . . no more frequently than . . . 1 in 333 of the Caucasian population" but would occur in all of defendant's paternal male relatives. No other DNA implicating defendant was found in any of the other samples tested by the NJSP laboratory.

FBI Special Agent Ajit David testified for the State as an expert in historical cell site analysis. He was "absolutely certain" that defendant's cell phone interacted with Vernieri's home cell phone tower and sector at 10:39 a.m. on September 14, 2012. David testified that it was not possible for that tower and sector to service defendant's cell phone if he was at his apartment, which was approximately one mile from the tower.

Heather Coyle, Ph.D., testified for the defense as an expert in DNA analysis and DNA statistical analysis. She opined that LCN DNA testing was not reliable.

Manfred Schenk testified for the defense as an expert in historical cell site analysis and radio frequency engineering. He opined that the location of defendant's cell phone could not be determined based upon the cell phone records relied upon by the State's expert. He stated that cell phones do not always use the closest cell tower and that a phone can access a tower that is up to 21.75 miles away.

Counts six through nine and fourteen were dismissed before the case was submitted to the jury.

THE JURY INSTRUCTIONS

Relevant to the issues on appeal, the trial court gave the following final instructions to the jury:

Proof of other crimes, wrongs or acts, New Jersey Rule of Evidence 404(b). The State has introduced evidence that on October 3, 2012, this defendant ignored police commands to turn off his vehicle, get out of his car and submit to being handcuffed.

Normally, such evidence is not permitted under our rules of evidence. Our rules specifically exclude evidence that a defendant has committed other wrongs or acts when it is offered only to show that he has a disposition or tendency to do wrong and therefore, must be guilty of the charged offenses. Before you can give any weight to this evidence, you must be satisfied that the defendant committed the other wrong or act.

If you are not so satisfied, you may not consider it for any purpose. However, our rules do permit evidence of other wrongs or acts, when the evidence is used for certain, specific, narrow purposes. Here, the evidence has been offered to attempt to convince you that the defendant's refusal to follow the police commands is evidence of a consciousness of guilt on defendant's part regarding the other charged offenses, particularly, the murder and arson.

You may not draw this inference unless you conclude that the defendant did, in fact, ignore police commands to turn off his vehicle, get out of his car and submit to being handcuffed on October 3rd, 2012. Whether this evidence does, in fact, demonstrate consciousness of guilt is for you to decide. You may decide that the evidence does not demonstrate defendant's consciousness of guilt and is not helpful to you at all.

In that case, you must disregard the evidence. On the other hand, you may decide that the evidence does demonstrate consciousness of guilt and use it for

> that specific purpose. However, you may not use this evidence to decide that the defendant has a tendency to commit crimes or that he is a bad person. That is, you may not decide that just because the defendant has committed other wrongs or acts, he must be guilty of the charged crimes.
>
> I've admitted the evidence only to help you decide the specific question of defendant's consciousness of guilt. You may not consider it for any other purpose and may not find the defendant guilty now simply because the State has offered evidence that he committed these other wrongs or acts.

The jury convicted defendant of the remaining counts, including murder.

Defendant moved for a judgment of acquittal and a new trial. On July 28, 2017, the trial judge denied both motions. That same day, defendant was sentenced to life, subject to the No Early Release Act, N.J.S.A. 2C:43-7.2, on the murder charge, a consecutive five-year term on the obstruction charge (count eleven), and terms that run concurrently to count eleven on the remaining counts, except counts two and three, which were merged into count one for sentencing purposes.

Defendant appealed his conviction. On September 26, 2017, we granted defendant's motion for a remand and directed the trial court to conduct a N.J.R.E. 104(a) hearing to determine the admissibility of LCN DNA evidence under the standards established in Frye and State v. Harvey, 151 N.J. 117 (1997). We retained jurisdiction. We denied the State's motion for

reconsideration. The Supreme Court denied leave to appeal. State v. Rochat, 232 N.J. 151 (2018).

THE FRYE HEARING ON REMAND

The Frye Hearing was conducted over six nonconsecutive days in May and June 2018. Multiple expert witnesses testified during the hearing.

The State's Witnesses

Craig O'Connor, Ph.D., a geneticist, testified for the State as an expert in forensic DNA analysis and the statistical significance of those results. O'Connor began working for OCME in May 2008. He performed both conventional short tandem repeat (STR) DNA testing and LCN DNA testing. Between 2008 and 2012, he processed hundreds of cases using LCN and conventional DNA testing. He also used FST "dozens if not over a hundred" times.

By 2014, O'Connor was promoted to a position responsible for overseeing all aspects of the testing done at the laboratory. He very rarely performed DNA testing himself but was still proficient in the testing techniques. In August 2017, O'Connor was promoted to assistant director of the Forensic Biology Department, a position he still held at the time of his testimony.

O'Connor testified that the relevant scientific community for LCN DNA testing was international. He identified several individuals that he claimed were members of the relevant scientific community, including Peter Gill, a pioneer in LCN DNA testing from the United Kingdom; John Buckleton, a pioneer in LCN DNA testing and probabilistic genome typing from New Zealand; Hinda Haned, a pioneer in probabilistic genome typing programs from the Netherlands; and John M. Butler, a scientist with the National Institute of Standards and Technology (NIST), who has published several books on forensic DNA analysis, including one that has a chapter devoted to LCN DNA testing.

O'Connor claimed that the Scientific Working Group on DNA Analysis Methods (SWGDAM) was also part of the relevant scientific community. SWGDAM is part of the Federal Bureau of Investigation (FBI) and is comprised "of professionals within the scientific community that look at DNA testing and typing, methods and interpretations, and . . . put out guidelines, and occasionally standards." He also considered the New York State Commission on Forensic Science (CFS), which accredits all laboratories in the state, and its DNA Subcommittee, which reviews validation studies and laboratory procedures, to be part of the relevant scientific community.

O'Connor testified that the Forensic Biology Department at OCME began doing DNA testing in 1991. In 1994, it started doing STR DNA testing, and was approved for LCN DNA testing, also known as high sensitivity testing or low template DNA testing, by the CFS after a binding recommendation by the DNA Subcommittee in December 2005. LCN DNA testing is used on items of evidence expected to contain small amounts of DNA. It is a modification of the conventional STR DNA technique designed to increase its sensitivity. O'Connor testified that OCME had done LCN DNA testing for the FBI and more than eighty jurisdictions in ten states.

O'Connor explained that except for identical twins, DNA can be used to identify individuals and link them to evidence.

DNA testing involves several steps. The first is to examine evidence for the presence of biological material. The next step is DNA extraction where the DNA is separated from other parts of a cell and measured. Testing is stopped if there is not enough DNA.

After quantification, an analyst decides whether conventional STR DNA testing, also referred to as high copy number testing, or LCN DNA testing should be used. Copies of the DNA at the locations selected for testing are then made using a process called Polymerase Chain Reaction (PCR). Because

there are three to four billion base pairs, testing can be done only on selected locations, referred to as loci.

In 2012, when OCME processed the samples obtained in this case, it was using a product called Identifiler to perform PCR. Identifiler was able to examine sixteen loci. Identifiler's manufacturer recommended twenty-five to twenty-eight PCR cycles but also advised that each laboratory should perform the appropriate validation steps to determine the optimal number of cycles. In conventional DNA testing, twenty-eight PCR cycles were run by OCME, and for LCN DNA testing, thirty-one cycles were run. This process is known as amplification.

DNA is measured in picograms, which are one trillionth of a gram. Each cell contains about six picograms of DNA. In 2012, the optimal amount of DNA for OCME's conventional STR testing was 500 picograms, but the testing could be done with only 100 picograms. LCN DNA testing was done on any sample containing less than 100 picograms of DNA.

Once amplification is complete, capillary electrophoresis is performed, which involves running the sample through a matrix to separate out fragments of DNA by size. The analyst can review and interpret the results of this process on an electropherogram, which represents the different alleles by numbers. An allele is a difference of the DNA at a location. For example, eye

color is a locus on the DNA and the allele would determine the color of a person's eyes.

OCME's validation process for LCN DNA testing began in 2001 and was completed in 2005. The 2004 SWGDAM Validation Guidelines, as well as the FBI's 1998 quality assurance standards, were followed and over 800 samples were tested. O'Connor testified that reliable DNA profiles were obtained from as little as 6.5 picograms of DNA. OCME modeled its validation studies on procedures used in the United Kingdom for LCN DNA testing. Several other countries also used LCN DNA techniques in criminal cases including Australia, Italy, Belgium, the Netherlands, New Zealand, Croatia, and Spain.

O'Connor acknowledged that stochastic, or random, effects are more common in LCN DNA testing than in conventional high copy number testing. Stochastic effects can include increased stutter products, allelic drop-in, allelic drop-out, and peak imbalance.[4] Stutter is a biological phenomenon that happens during PCR. Allelic drop-in "is a term that's used when you see pieces of DNA that aren't expected to be in the sample." Possible causes of allelic drop-in are an additional contributor or contamination. Allelic drop-out is where an allele that should be present is absent. Peak imbalance occurs

[4] These stochastic effects are also referred to as "artifacts."

when there are two alleles at one location that should be the same height on an electropherogram, and one peak is much lower than the other.

OCME made "some general modifications" in its LCN DNA testing protocols to account for stochastic effects. One modification was to increase the number of PCR cycles from twenty-eight to thirty-one "to try and get some more amplification of those products." Another was to test the sample three times during the amplification process and use a combination of the three results. This consensus approach only includes alleles in a DNA profile if they are seen at least twice in the three test results. According to O'Connor, this approach accounts for allelic drop-in because it is a "rare random occurrence" and "you wouldn't expect it to be seen in more than one of the runs." O'Connor testified that most laboratories performing LCN DNA testing use the consensus approach. He identified a comment by Butler in his book, Advanced Topics in Forensic DNA Typing: Methodology (Methodology book) that states, "this replicate amplification strategy has become the core feature of reliable Low Level [DNA] Testing."

O'Connor explained that scientific experiments generally yield reproducible results, meaning that if you ran the test multiple times you would get the same result. However, because of the stochastic effects when dealing with low amounts of DNA in LCN DNA testing, one would not expect the

same allele calls at the same peak height value every time. He agreed that the purpose of triplicate amplification was to try to account for stochastic effects such as drop-in and drop-out. The electropherograms for the three amplifications would be different but "the reproducibility part of it would be that the conclusion is reproducible, not the exact alleles and the exact peak heights." O'Connor claimed that reproducibility of the conclusion was shown to be accurate in OCME's validation studies. He did not deny that LCN testing was "less robust" than conventional STR analysis and acknowledged one would expect to get less information from lower amounts of DNA, which is why OCME modified its interpretation protocols to account for stochastic effects.

O'Connor testified that by 2014, enough laboratories were using "low amounts of DNA that SWGDAM thought it necessary to come out with guidelines [on] how to deal with these enhanced detection techniques." Enhanced detection techniques include extra amplification cycles. The 2014 SWGDAM Guidelines for STR Enhanced Detection Methods (2014 SWGDAM Guidelines) state that if a laboratory chose to use LCN DNA Analysis, "it is strongly recommended that the laboratory incorporate Replicate Amplification Analysis." According to O'Connor, the significance of the 2014 SWGDAM Guidelines is that enhanced detection methods had "become

widespread throughout the scientific or the forensic DNA community and [were] generally accepted [such that] SWGDAM took it upon themselves to offer guidelines to . . . standardize the way that the validation was done with these methods."

O'Connor testified that after an electropherogram is done, the analyst estimates the number of contributors and makes a comparison to a known individual. When there is a single contributor to the DNA sample, a random match probability is calculated, which is the "probability of randomly selecting a person from the population that would also have this DNA profile." Sample 1 from Van Winkle Avenue was a single source sample; the random match probability was calculated as 1 in 88.1 billion people, using the Hardy Weinberg equation, which looks at the frequency of alleles in population databases.

O'Connor explained there are two alleles at each locus in a DNA sample because a person gets half of their DNA from each parent. When most of the loci in a DNA sample have more than two alleles, the sample is identified as a mixture with more than one contributor. O'Connor noted that mixtures are very common in conventional as well as LCN DNA testing. A person can be excluded or included as a possible contributor to a mixture. The National Academy of Sciences, SWGDAM, and other scientific bodies in the forensic

DNA community have recommended that "a statistic should accompany any positive associations" in a mixture sample.

A likelihood ratio is a tool for measuring the probability that a person is included as a possible contributor to a DNA sample. Prior to 2009, only a few programs used likelihood ratios "to determine strength of evidence in mixtures and DNA analysis." Because the programs were not commercially available, OCME developed its own program, FST, to calculate likelihood ratios. By 2015, several other laboratories had developed software like FST to calculate likelihood ratios.

O'Connor described OCME's development and internal validation process for FST. He said that over 400 samples were tested, and more than 500,000 comparisons were performed. George Carmody, Ph.D., a population geneticist and forensic statistician in this field was a member of the DNA Subcommittee when it approved FST. He voted in favor of its approval. In October 2010, the DNA Subcommittee recommended that FST be approved for forensic casework.

Thereafter, FST was modified twice. Shortly after it was first brought online, it was taken offline because it produced a negative likelihood ratio, which was mathematically impossible. At that point, the software had already been validated. Some "unrelated maintenance" that purportedly caused the

problem was addressed and testing verified that it was calculating correctly. Later, some "cosmetic changes" were made. After each of those changes a performance check was done but the software was not re-validated.

FST is used for both conventional and LCN DNA testing. According to O'Connor, "based on the fact that it was properly validated, the results are reliable and the likelihood ratios that are obtained . . . make sense and are reliable based on the data and the comparisons that are being done."

O'Connor testified that FST was not used on single-source samples; it was only used where there was a two- or three-person mixture. FST was used to calculate likelihood ratios for Sample 2, a mixture containing twenty-five picograms of DNA.

FST calculated that it was "approximately 71.2 million times more probable that [Sample 2] originated from . . . Vernieri and one unknown, unrelated person than if it had originated from two unknown, unrelated persons." O'Connor contended the methodology was generally accepted within the relevant scientific community.

In September 2016, OCME wrote to customers describing new technologies to be implemented in 2017. PowerPlex Fusion was a new DNA typing kit that could look at twenty-four loci rather than the sixteen examined by Indentifiler. The change was necessary because the FBI increased the

number of core locations that had to be tested for inclusion in the Combined DNA Index System (CODIS), the national DNA database. In addition, PowerPlex Fusion is more sensitive than Identifiler and allows DNA profiles to be determined from samples as small as 37.5 picograms without using any LCN DNA testing modifications.

O'Connor maintained that moving to PowerPlex Fusion was not a refutation of the LCN DNA testing previously done by OCME. He explained that there was a cost benefit to using PowerPlex Fusion because they could obtain profiles from smaller samples without running additional amplification cycles. At the time of O'Connor's testimony, OCME was still using LCN testing for old cases that were pending trial or might need additional work but had stopped using it on any new cases.

O'Connor testified that the samples from Van Winkle Avenue contained 19.4 picograms amplified of DNA in Sample 1, and 25 picograms amplified in Sample 2. If the samples had been taken after OCME switched to PowerPlex Fusion, the one that was 19.4 picograms would not have been able to be tested. The 25 picogram sample could be tested because the PowerPlex Fusion amplification tube is larger than the one used in Indentifiler and when amplified, the sample would have 37.5 picograms of DNA, which is the lower limit for PowerPlex Fusion. He contended, however, that even if the samples

could not have been tested using PowerPlex Fusion, it did not make the results of the LCN DNA testing unreliable because OCME's validation of the process and review by the DNA Subcommittee showed it was reliable. O'Connor testified that OCME processed dozens of cases with samples below twenty-five picograms.

When OCME began using PowerPlex Fusion it also began using a tool called STRmix to calculate likelihood ratios. OCME did not use FST on any case received after 2017 but was still using it on cases that were amplified using Indentifiler.

O'Connor identified a December 2017 letter from the chair of the DNA Subcommittee written in response to allegations made by the Legal Aid Society (LAS), the primary public defender in New York City, and the Federal Defenders of New York regarding FST and OCME's LCN DNA testing methodology. The letter reported that the DNA Subcommittee had reviewed OCME's response to the allegations and over 1700 pages of supporting documentation.

The letter stated the "DNA Subcommittee concludes it was appropriate for the OCME to use 31 PCR cycles in accordance with the OCME's validated casework protocols" and that "[b]ased on the validations performed by the OCME, the DNA Subcommittee believes that the OCME could, using their

LCN methodology, potentially identify a major contributor to a DNA mixture regardless of the number of minor contributors." It also stated that "OCME performed adequate performance checks prior to the use of Versions 2.0 and 2.5 [of FST]" and "[a]ccordingly, the DNA Subcommittee [did] not believe that any re-validation was required." In addition, "OCME used reasonable scientific methods to estimate the role of allelic drop-out in [its] FST software." O'Connor felt that the letter represented an acceptance of OCME's LCN DNA testing methodology by members of the relevant scientific community.

On cross-examination, O'Connor testified that LCN DNA profiles can be uploaded to state and local databases, but the FBI does not allow them in the national database. The FBI Laboratory DNA Case Work Unit (DCU), Case Acceptance Policy, states that "the usage of test strategies to enhance the detection of DNA, sometimes referred to as . . . LCN testing, is currently being researched by the FBI laboratory; however, none have yet demonstrated the necessary reliability for use in forensic case work by the DCU nor [are any] approved for uploading [into CODIS]." O'Connor disagreed that the FBI had deemed LCN testing unreliable and claimed that the FBI was not commenting on OCME's research or validation but, rather, was only commenting that

through its own research, the FBI had not yet demonstrated the "necessary reliability to be used in their casework."

O'Connor acknowledged that there are members of the relevant scientific community that oppose the use of LCN testing and likelihood ratios in criminal casework. He claimed that was not surprising because "there have been dissenters [to] every single technology that has been used in forensic DNA since the beginning." He was unaware of any current dissenters to high copy number testing but said in the early days there were people opposed to its use in criminal cases.

Howard Baum, Ph.D., also testified for the State as an expert in forensic DNA analysis and the statistical significance of those results, molecular biology, and LCN DNA analysis. Baum began working for OCME in 1990. He was tasked with setting up OCME's DNA laboratory. Early on in his role as Technical Leader, Baum reviewed every DNA case processed by the laboratory.

Baum worked at OCME for eighteen years and served as its Deputy Director for his last eight years. He also retained his position as Technical Leader and in that role was "responsible for directing and reviewing validation of new and modified techniques" and oversaw the validation of OCME's LCN DNA testing. Baum left OCME in 2008.

Baum considered LCN DNA testing to be "an extension of an existing methodology" rather than a new methodology. He explained that LCN testing is "basically performed the same way as high copy number . . . testing." DNA is extracted, quantified, and amplified "essentially in the same way, but with lower amounts." Even though amplification is run three times, the DNA is "still separated the same way [and] the peaks or alleles are detected the same way."

Baum related that in the late 1990s, Gill published a paper addressing LCN DNA analysis. At the time, less than 200 or 300 picograms was considered LCN and analysts were unable to obtain satisfactory DNA profiles from such samples. Gill determined that DNA profiles could be obtained from smaller amounts of DNA by increasing the number of amplification cycles. Gill recognized that the analysis had to account for artifacts such as peak imbalance and allelic drop-in and drop-out. He suggested that by amplifying more than once and developing a consensus profile, the effects of these artifacts could be mitigated. Based on Gill's work, OCME began to research LCN DNA testing. The research phase took several years. Once a protocol was established the validation phase began.

Validation involved multiple experiments to test the limits of DNA detection and issues with artifacts. One goal during validation was to

minimize or mitigate the artifacts. During the four to five years of research and validation, OCME scientists also conferred with other laboratories that were working on LCN testing. Baum testified that OCME's LCN validation was the most extensive validation he had ever overseen.

OCME submitted the validation data to the DNA Subcommittee, which made a binding recommendation to the CFS that OCME be permitted to employ LCN testing in forensic case work. OCME's protocols, which were approved by the DNA Subcommittee and the CFS, required thirty-one PCR cycles, three cycles of amplification, the formation of a consensus profile, and considered artifacts that could occur. Baum identified the members of the DNA Subcommittee as members of the relevant scientific community.

Baum claimed that the LCN technique was generally accepted within the relevant scientific community, "but not with unanimity." He recalled that in the mid-1990s there was also opposition to conventional STR testing by some members of the relevant scientific community. One objector was Bruce Budowle, who oversaw the FBI's research division. By the late 1990s, the FBI instituted STR testing.

Baum testified that Butler was a member of the relevant scientific community. In one of his reference books, Butler pointed out "some of the concerns and how to solve [them]" regarding LCN DNA testing. Butler also

commented that replicate amplification strategy, which is used to create a consensus composite profile, "has become the core feature of reliable low level DNA testing." Baum stated that consensus profiles had been used for regular STR typing in the "earlier days of DNA testing," and were now used in "next generation sequencing" and "mitochondrial DNA sequencing."

A peer-reviewed article that Baum co-authored described the protocol OCME was using for LCN DNA testing and reported that amplification of 100 or less picograms of DNA generated reproducible results. The article stated the interpretation protocol achieved 100 percent "accurate allele assignments for over 107 non-probative case-work samples and 319 forensic case work samples." The article concluded that LCN DNA testing was "reliable and robust" and that "an appropriate quality control program" ensures that LCN DNA testing "is suitable for forensic purposes."

Baum testified that LCN DNA profiles were included in the New York City and New York State databases but were not allowed in CODIS. He agreed that some held the view that the profiles were not allowed in CODIS because they are inherently unreliable, but he did not agree.

Baum contended that the fact that the source code for FST was not publicly available did not make the program unreliable as long as it was tested properly. He considered approval by CFS and the DNA Subcommittee to be

an indication that the program was properly tested. He also asserted that the 2014 SWGDAM Guidelines addressing LCN testing would not have been issued "unless they felt it was a relevant issue that is being practiced in the community." Baum noted that in 2015, SWGDAM issued "Guidelines for the Validation of Probabilistic Genotyping Systems" that were significant because probabilistic genotyping systems were "an important issue that is being practiced in the community and gaining more acceptance and more usage."

Baum testified that PowerPlex Fusion was developed "because the FBI increased the number of required loci from 13 to 20" and the new program was needed to meet that requirement. Baum was aware that OCME began using PowerPlex Fusion in January 2017 and is no longer using the LCN DNA testing technique. He viewed the switch as a change to updated technology and did not believe it rendered the LCN DNA testing technique unreliable.

On cross-examination, Baum agreed that Budowle, Coyle, Arthur Eisenberg, Angela Van Daal, Ranajit Chakraborty, Eli Shapiro, Deborah L. Hobson, Jill B. Smerick, and Jennifer A.L. Smith were all members of the relevant scientific community. He was aware that Eisenberg, Budowle, and Van Daal had written papers criticizing the use of LCN DNA testing in forensic criminal cases.

He testified that Chakraborty was on the DNA Subcommittee when it considered OCME's LCN validation and that, at the time, Chakraborty was in favor of validating the technique but has since had a "change of heart."

Baum was asked about a paper written by Budowle, Hobson, Smerick, and Smith that noted the authors had problems with the use of LCN in forensic criminal trials. Baum said the paper was an "early objection" regarding the kits that were in use before Identifiler and that OCME had some of the same issues with the earlier kits. Baum acknowledged that Budowle and others also wrote a paper that was critical of LCN DNA testing that was published in the same issue of the Croatian Medical Journal as Baum's paper.

Baum admitted that some of the members of the DNA Subcommittee may not have been familiar with LCN DNA testing and that not all members of the Subcommittee read the documentation that OCME provided to them.

Baum considered LCN DNA testing to be reproducible. However, when the sample is run three times, the same alleles may not all be present in each run, but the consensus profile is reproducible. Baum stated that during the OCME's validation process, which involved 800 samples, they were able to "account for 100 percent of the validation data by doing three runs."

The Defense Witnesses

Angela Van Daal, Ph.D. testified as an expert in genetics and molecular biology, forensics, statistics, and probability. In 1991, Van Daal was hired by Adelaide Forensic Science (AFS) Laboratory to implement DNA typing for use in court proceedings. The laboratory used high copy number DNA testing and she used LCN only for research purposes. After spending seven or eight years with AFS Laboratory she taught undergraduate and graduate forensic science courses, followed by consulting in forensic sciences, which involved reviewing case work issued by forensic labs globally.

Van Daal testified that some laboratories in Europe started using LCN testing after Gill published his paper describing the technique in 1999 but OCME was the only laboratory in the United States to implement the technique. Van Daal believed that Gill was "one of the top five recognized people in this field." According to Van Daal, the LCN technique used by OCME differed from that of other laboratories because many of the other laboratories only do two replicates and must see the allele in both to include it in a DNA profile, whereas OCME does three replicates and includes an allele if seen in two out of the three.

Van Daal testified "[t]here are numerous problems with LCN" testing including allele drop-out, stutter,[5] contamination, and that the results are not reproducible. She explained that when the replicates are run, "different alleles are seen in different replicates." Van Daal criticized OCME's use of a consensus profile, pointing out that alleles that are not part of the consensus are ignored in the interpretation. Also, because such small amounts of DNA are involved, the process "is extremely sensitive to contamination." Further, peak height imbalance makes results difficult to interpret. Van Daal asserted that "[t]he issues with LCN are widely recognized in the forensic community."

According to Van Daal, the results reported by OCME for the samples obtained from the Van Winkle Avenue condominium were unreliable. She explained that LCN mixture samples are very difficult to interpret, and the difficulty is compounded by missing alleles and imbalanced peak heights. She claimed that "mixtures can appear to be from a different number of contributors than they truly are" and opined that Sample 1 appeared to have "potentially two or more contributors," while Sample 2 "looked to have more than two contributors."

[5] Van Daal explained that stutter is a peak that appears in an electropherogram that was not the true peak.

Van Daal maintained that "the main use of LCN [testing] is for investigative purposes in missing persons cases." In those cases, the sample is from a single source and can be compared to a known reference sample. LCN testing is also used in the "medical arena," such as "pre-implantation genetic diagnosis" where both parents are known, and a single source sample is involved. Van Daal claimed that in those settings, the stochastic effects associated with LCN testing could be accommodated, and its use was "perfectly acceptable".

Van Daal testified that SWGDAM did not endorse the use of LCN testing. She pointed out that the 2014 SWGDAM Guidelines state that "this document does not offer an opinion on the viability of any Enhanced Detection Methods, including Low Template and [LCN] DNA Analysis." She believed the guidelines were developed "for the laboratories doing DNA identification work from missing persons and remains" and did not endorse LCN testing in other applications.

Van Daal opined that the relevant scientific community has not accepted LCN testing as reliable. She claimed that "numerous" other scientists believed LCN testing was unreliable and that the majority of scientists she talks to "would not think it's a reliable method." Van Daal pointed out that in the twelve years since OCME began using LCN DNA testing, no other laboratory

in the United States adopted this method. She asserted "that the lack of use of LCN by laboratories around the world is indicative of the lack of acceptance of it."

Van Daal further testified that OCME is the only laboratory to use FST "as a statistical interpretation tool." She opined that FST had "significant limitations in interpretation." She claimed that most LCN samples are degraded, and testified that OCME developed a degradation model for FST. When the model did not work, it was abandoned and FST, therefore, does not account for degradation. Van Daal opined that the samples from Van Winkle Avenue tested by OCME appeared to be degraded.

Van Daal criticized OCME's FST validation because it did not account for degradation and because if you incorrectly "nominate the number of contributors to the profile . . . the weighting is also incorrect." Van Daal opined that FST could not give reliable results. She noted that FST has not been peer reviewed because no one had access to the proprietary code. Van Daal testified that the relevant scientific community has not accepted FST as reliable.

On cross-examination, Van Daal said that except for two members, the members of the DNA Subcommittee were all academics who had never done forensic work, so she was not sure if they would be considered members of the

relevant scientific community. Van Daal agreed that Butler was a member of the DNA forensic science community, and she used his Methodology book as a textbook for her students. She acknowledged that in the book, Butler identified several laboratories around the world, including OCME, that were using enhanced detection protocols in LCN DNA case work. Butler reported that by early 2010, the United Kingdom's Forensic Science Service (FSS), had used LCN analysis in over 21,000 cases. He also stated that in 2008, Great Britain's Crown Prosecution Service concluded after an internal review that there was "no reason to believe that there [was] any inherent unreliability in the [FSS's] LCN DNA analysis process[,] provided that it is carried out according to the prescribed processes and the results are properly interpreted." Van Daal acknowledged that Andrew Rennison, a British forensic science regulator, issued a statement that the science underpinning the process was sound.

Van Daal also acknowledged that Butler devoted an entire chapter in his Methodology book to "Low Level DNA Testing: Issues, Concerns and Solutions." Van Daal did not believe that including this chapter showed general acceptance in the scientific community. She disagreed with Butler's statement that replicate amplification "has become the core feature of reliable

low level DNA testing." She stated that her research showed fewer stochastic effects when samples were not split and subjected to replicate analysis.

Eli Shapiro, Ph.D., testified as an expert in forensic biology and forensic DNA analysis. He was hired by OCME in 2000 as a training coordinator. In that role, he trained scientists in laboratory techniques used in DNA forensic work, including the interpretation of results. Shapiro also did case work at OCME and was eventually promoted to assistant director. He was in charge of case work and training for the mitochondrial DNA group. Shapiro was with OCME for over ten years, but never used FST while employed there.

Prior to joining OCME, Shapiro had no forensic experience. Nor had he authored an article relating to forensic DNA or statistics in a peer-reviewed journal. Shapiro was not a member of any professional organization related to forensic DNA analysis.

Shapiro called FST a "black box" because at first, "OCME would not let anyone look at the source code" and, therefore, "you could not independently reproduce that software and get the same result." He acknowledged, however, that OCME was ordered to release the source code in 2015 or 2016.

Shapiro criticized the estimated drop-out rates used in the validation of FST. He testified that "if you underestimate drop out which is the basic strategy of the FST, you will overestimate the strength of the evidence."

Shapiro claimed that was "part of the design" of FST. "The difference between a 50% and a 5%" drop-out rate "could make a difference . . . in the likelihood ratio . . . in the tens of thousands, or hundreds of thousands or millions."

Shapiro also criticized the "pristine, very high quality buccal exemplar swabs" used in the validation claiming "[t]hat does not relate at all to . . . the casework situation" where "touch samples" may have degraded and "have a lot more drop in than the pristine samples." He asserted that "the dropout rates and the conditions that were set by the validation are not applicable or relevant to the actual casework." Shapiro contended that OCME "got lower estimates of the dropout rates by using very high quality samples [and] by also running [the samples] with the highest injections to limit the number of drop out[s]."

Shapiro also testified that OCME "changed the numbers" when it did not observe any drop-out in its validation experiments. According to Shapiro, OCME arbitrarily lowered drop-out rates below empirically observed rates. He opined that "for most of the casework examples [in the validation,] the drop out rates [were] underestimated," and the drop-out rate used by FST for mixture samples was "way too low." Shapiro asserted that OCME investigated a degradation model for drop-out rates during validation, but it did not work and was not included in the final version of FST. He opined that ignoring

degradation in probabilistic genotyping was not generally accepted in the scientific community.

Shapiro explained that the number of contributors was "an important part of the math formula" used by FST to calculate likelihood ratios. He found it problematic that OCME ignored alleles that appeared only once when constructing a consensus profile. He also noted that OCME's protocols ignored peaks appearing on an electropherogram below a certain threshold, which could be alleles signifying a potential new contributor or potential drop-out

Shapiro opined that FST was not generally accepted in the scientific community and that many of the assumptions FST makes are not generally accepted. For example, "using the original quantitation as the step to setup a lot of the parameters." In addition, "using preset drop out and drop in rates without access, or even attempting to match it to the evidence is not generally accepted in the probabilistic genotyping [community]." Shapiro noted that FST was the only program that used preset drop-in and drop-out rates and opined that practice was not generally accepted in the scientific community "because it's divorced from the real data." He stated that only OCME used FST and no one other than OCME ever conducted controlled experiments using FST.

On cross-examination, Shapiro admitted that he did not review any of the raw data from the FST validation study. Instead, he "only looked at a limited part of the validation," which included the "charts, tables, summaries, conclusions, drop out rates, drop in rates, et cetera."

Shapiro acknowledged that the members of the DNA Subcommittee were members of the relevant scientific community. He also acknowledged that Butler was a member of the relevant scientific community and that in his book, Advanced Topics in Forensic DNA Typing: Interpretation, Butler listed probabilistic genotyping software programs, including FST, and commented that such software "can produce standardized and uniformed results from complex mixtures."

Coyle, who was previously qualified at trial as an expert in DNA analysis and the statistics associated with it, testified for the defense. She stated that LCN DNA testing was "very similar" to conventional STR testing except that "the quantity that you start out with is less than 100 picograms and the test amplifications are performed in triplicate." However, with LCN testing "there's a higher rate of non-reproducible alleles . . . that are not reported or included in the consensus profile." She claimed LCN testing was not reproducible because "you cannot get exactly the same profile most of the time," and explained that in "normal scientific testing" it was important to get

the same result each time a piece of evidence was tested to show that the results are reliable and scientifically accurate.

Coyle maintained that proponents of LCN testing, like Butler, have set an arbitrary number of three replicates because in their validation studies they realized they had to run additional replicates to find reproducible alleles. She noted that in LCN testing, you usually do not obtain the same results when you run three replicates because many alleles do not repeat. Coyle agreed that all labs using LCN DNA testing build consensus profiles from triplicate runs.

Coyle disputed that the consensus profiles rendered LCN DNA testing reproducible and opined that it is not scientifically reliable because it is not reproducible. She asserted that a consensus profile "really is cherry-picking only the reproducible alleles and omitting information about all of the other scientific data that we see." Coyle characterized such profiles as a "slight of hand" to "force-fit[] the data . . . to make it reproducible."

Coyle claimed that omitting non-repeating alleles from the consensus profiles is problematic when attempting to determine "how many contributors are actually in the sample." She maintained that "[i]f you only count the [alleles] in the consensus profile, you can underestimate the number of true contributors." To get a correct statistical result from FST, the true number of

contributors to a DNA sample must be known, and therefore, ignoring the non-repeating alleles was scientifically incorrect.

Coyle testified that no contaminant alleles were permitted in OCME's conventional DNA testing, but up to nine contaminant alleles were allowed in LCN DNA testing. Moreover, OCME often does not know where those alleles came from and there is "no way, scientifically, to determine if . . . those alleles are actually contaminants or if they're from another donor that was on the sample . . . ." Coyle believed it was "scientifically inappropriate" to allow the contaminant alleles in LCN testing. Moreover, artifacts including stutter, allele drop in and dropout, and peak height imbalance are all exaggerated with LCN DNA testing and reduce the ability to reliably interpret the data.

Although Coyle recognized that it was appropriate to use LCN DNA testing to identify skeletal remains in the context of missing persons, she maintained that "[m]issing persons identifications [are] not the same as criminal casework where you're dealing with very trace amounts of DNA with high contamination in the background." Coyle testified that crime scene samples are often contaminated because "a lot of the crime scene personnel are not trained in [LCN] testing and how to collect [samples]." She opined that LCN testing "should not be used [in] criminal case work because of the contamination issues and the difficulty in interpreting the PCR artifacts." She

further opined that LCN DNA testing was not generally accepted by the scientific community for use in a forensic setting "because of the high contamination risk." On cross-examination, she acknowledged that the LCN testing technique was the same whether used for criminal casework or missing persons identification.

Coyle was aware that there were laboratories in other countries that use LCN DNA testing, but she was unfamiliar with their procedures and did not know which used the technique for criminal casework. She noted that while Gill favored using LCN testing as a tool, he did not represent the entire forensic science community. She identified Budowle, Van Daal, Shapiro, and Eisenberg as other scientists who do not believe LCN testing is reliable. She claimed that many authors "have questions and concerns about [LCN] testing." Coyle noted a 2008 letter to the editor of the International Journal of Legal Medicine signed by six authors stated:

> [T]he stochastic effects associated with the small amount of template, allele drop-out and drop-in, exaggerated peak [im]balance, and stutter coupled with the diminished ability to ascertain the tissue source of DNA samples or how long they have been associated with an article, dramatically reduced the weight that can be attached to the finding of an LCN DNA profile match. Given the acknowledged lack of consensus in [] interpretation, among other concerns, as well as the availability of viable alternative approaches . . . it is unlikely that LCN test[ing] . . . will be embraced by crime laboratories in the [U.S.] or

> that such results would be deemed to be admissible if they were challenged.

Coyle emphasized that LCN testing was still not accepted by most crime laboratories in the United States.

Coyle identified an article titled "Low Copy Number Typing Has Yet to Achieve General Acceptance." The article was critical of OCME's use of LCN DNA testing, stating: "The OCME approach is inconsistently applied and overstates the weight of the evidence." A 2001 article titled "Low Copy Number Considerations and Cautions," stated that the success rate of LCN testing is low and "[o]ften, the results cannot be interpreted or are meaningless for the case." The authors of that article, Budowle, Smerick, Hobson, and Smith, all worked in the in the FBI's laboratory division.

Coyle noted that while the 2014 SWGDAM Guidelines provided guidance to laboratories interested in LCN technology, the guidelines did not impose standards, endorse the technology, or approve it for use.

Coyle criticized OCME's FST validation, noting that when DNA samples were treated with ultraviolet light, which was similar to exposing them to sunlight, OCME "could not effectively model or use the FST." In these degraded samples, OCME "could not distinguish between people who had actually touched items and people who had never touched the item" and there was "a lot of false matching due to the partialness of the profiles that they

obtained back." Coyle contended that OCME could not determine consistent drop-out rates for degraded samples, so FST uses drop-out rates for pristine samples. She opined that it was not generally accepted in the scientific community to ignore degradation when calculating genotyping statistics.

Coyle further opined that FST was not generally accepted by the scientific community. She explained that FST was an in-house software program that was not commercially available and could not be tested by anyone else. According to Coyle, other members of the scientific community believe FST is not reliable including Budowle and Chakraborty, who was a member of the DNA Subcommittee that approved FST and who has since changed his mind.

On cross-examination, Coyle acknowledged that Butler devoted an entire chapter to LCN DNA testing in his Methodology book, which listed several laboratories that performed LCN DNA testing. She agreed that two of the laboratories in the United Kingdom as well as laboratories in the Netherlands and New Zealand were using the technique for criminal cases in 2018, and that the scientists working at those laboratories were members of the relevant scientific community. Coyle also agreed that Butler reported that increasing the number of PCR cycles from twenty-eight to thirty-one improved the success rate for a correct DNA profile.

Coyle testified that using LCN DNA testing to exonerate someone was a different matter than using the technique to incriminate someone. She conceded that when an analyst performs the testing, they do not know whether the test results will implicate a defendant. She identified issues with contamination as the basis for treating the results differently.

Coyle acknowledged that the members of the DNA Subcommittee were members of the relevant scientific community. She agreed that the DNA Subcommittee reviewed OCME's LCN DNA testing protocols in 2005, 2014, and 2017, and that in an October 2010 letter, the DNA Subcommittee also made a binding recommendation to the CFS that "the use of FST by the OCME be approved for forensic casework."

Coyle further acknowledged that the 2014 SWGDAM Guidelines state that if a laboratory chooses to do LCN testing "it is strongly recommended that the laboratory incorporate [] replicate amplification analysis." The guidelines further state: "Where replicate analysis is required, the laboratory must have an interpretation procedure to determine how to generate the final consensus DNA profile." Coyle agreed that OCME performs replicate amplification and has written procedures for generating a consensus profile.

Coyle also acknowledged that between 2000 and 2010, the FSS lab in Great Britain processed 21,000 items of evidence using LCN testing. She

understood that some other scientists disagreed with her and "believe[d] in the three-replicate process and building a consensus profile."

THE TRIAL COURT'S FRYE HEARING DECISION

On August 23, 2018, the trial court issued a lengthy written opinion that concluded the State had "met its burden under the Frye standard and clearly established that the LCN DNA testing technique and the FST [are] generally accepted in the relevant scientific community and therefore, admissible." An accompanying order denied defendant's motion for a new trial.

The court found O'Connor, Baum, Van Daal, and Shapiro to be credible. The court found Coyle "credible in her knowledge of scientific principles concerning LCN DNA" but "less than credible, when she testified that LCN DNA testing methods were not reliable in forensic cases where the information was used to include a defendant as a suspect, but were reliable and should be used in cases where the information was utilized to exclude a defendant as a suspect."

The court took note of five scientific articles submitted by the defense that were critical of LCN testing and FST, and seven articles submitted by the State in support of the techniques, along with the Butler books. The court also took judicial notice of twenty-one New York state court decisions, fourteen of

which were unpublished.[6] In all but two of the cases, the courts determined that LCN and FST evidence was admissible after holding Frye or Daubert[7] hearings or determining that a Frye hearing was unnecessary. In one unpublished case, a Frye hearing was ordered but never took place. In the final case, People v. Collins, 49 Misc. 3d 595, 629 (N.Y. Sup. Ct. 2015), both LCN DNA and FST evidence were held to be inadmissible under the Frye standard.

In finding that both LCN testing and FST met the Frye standard for admissibility, the court relied on the similarities between LCN and conventional high copy number testing, endorsement of the LCN technique by Gill and Butler, who the court identified as leading scientists in the field, OCME's "extensive validation procedures," the approvals of the CFS and DNA Subcommittee, and the New York court decisions. The court concluded that it could not "be credibly argued . . . that LCN DNA results are reliable to rule suspects out, but not to implicate suspects." It further determined:

> LCN DNA testing is not a novel technique, it is not junk science, it is not even experimental; it is demonstrable, has been used by renowned scientists here and abroad, and validated and approved multiple

[6] Unpublished opinions do not constitute precedent, are not binding, and with limited exceptions, shall not be cited by any court. R. 1:36-3.

[7] Daubert v. Merrell Dow Pharms., Inc., 509 U.S. 579 (1993).

> times . . . by the DNA Subcommittee and the [CFS]. The method has been discussed favorably (and unfavorably) in learned treatises and ruled accepted in the scientific community in a majority of judicial proceedings.

The court also found that defendant's concerns regarding contamination and stochastic effects had been addressed by OCME's LCN testing protocols and those concerns go to the weight of the evidence, not its admissibility. This appeal followed.

We granted leave to appear as amicus curiae to the Office of the Public Defender. Defendant raises the following points for our consideration:

> POINT ONE
>
> THE TRIAL COURT ERRED IN ITS CONCLUSION, FOLLOWING THE POST-VERDICT FRYE HEARING ORDERED BY THIS COURT, THAT LOW COPY NUMBER DNA TESTING ("LCN") AND THE FORENSIC STATISTICAL TOOL ("FST") UTILIZED IN THIS CASE MET THE FRYE/HARVEY STANDARD AS GENERALLY ACCEPTED WITHIN THE RELEVANT SCIENTIFIC COMMUNITY FOR FORENSIC DNA TESTING.
>
> . . . .
>
> POINT TWO
>
> THE AFFIDAVIT IN SUPPORT OF THE SEARCH WARRANT FOR THE VAN WINKLE [AVENUE] PROPERTY WAS INSUFFICIENT TO ESTABLISH PROBABLE CAUSE THAT APPELLANT HAD PARTICIPATED IN THE MURDER OR THAT

EVIDENCE OF THE MURDER WOULD BE FOUND AT A SEARCH OF THAT LOCATION.

POINT THREE

THE TRIAL COURT ERRED BY ADMITTING THE HEARSAY STATEMENTS OF THE DECEASED VICTIM AS "PRESENT SENSE IMPRESSION."

POINT FOUR

THE TRIAL JUDGE ERRED BY INSTRUCTING THE JURY, OVER OBJECTION, THAT APPELLANT'S REACTION TO HIS ARREST WAS POTENTIALLY RELEVANT TO HIS "CONSCIOUSNESS OF GUILT."

II.

"In criminal cases, [our Supreme] Court has continued to rely on the Frye standard to assess [the] reliability" of expert evidence. State v. Ghigliotty, 463 N.J. Super. 355, 374 (App. Div. 2020) (first alteration in original) (quoting State v. J.L.G., 234 N.J. 265, 280 (2018)); accord In re Accutane Litig., 234 N.J. 340, 399 (2018). That standard "requires trial judges to determine whether the science underlying the proposed expert testimony has 'gained general acceptance in the particular field in which it belongs.'" J.L.G., 234 N.J. at 280 (quoting Frye, 293 F. at 1014).

"Proof of general acceptance within a scientific community can be elusive." Harvey, 151 N.J. at 171. It "entails the strict application of the scientific method, which requires an extraordinarily high level of proof based

on prolonged, controlled, consistent, and validated experience." Ibid. (quoting Rubanick v. Witco Chem. Corp., 125 N.J. 421, 436 (1991)). "The proponent of the technique has the burden to 'clearly establish' general acceptance." State v. Cassidy, 235 N.J. 482, 492 (2018) (quoting State v. Johnson, 42 N.J. 146, 171 (1964)). "Essentially, a novel scientific technique achieves general acceptance only when it passes from the experimental to the demonstrable stage." Harvey, 151 N.J. at 171.

"[T]here are three ways to establish general acceptance under Frye: expert testimony, authoritative scientific and legal writings, and judicial opinions." J.L.G., 234 N.J. at 281. "Proof of general acceptance does not mean that there must be complete agreement in the scientific community about the techniques, methodology, or procedures that underlie the scientific evidence." Ghigliotty, 463 N.J. Super. at 375 (quoting State v. Chun, 194 N.J. 54, 91-92 (2008)). Nor does it "require complete agreement over the accuracy of the test or the exclusion of the possibility of error." Harvey, 151 N.J. at 171. Thus, "the party proffering the evidence need not show infallibility of the technique nor unanimity of its acceptance in the scientific community." Ghigliotty, 463 N.J. Super. at 383 (quoting Cassidy, 235 N.J. at 492). "[T]he State's burden is to prove that the . . . test and the interpretation of its results are non-experimental, demonstrable techniques that the relevant scientific

community widely, but perhaps not unanimously, accepts as reliable." Ibid. (alterations in original) (quoting Harvey, 151 N.J. at 171).

"Generally, appellate courts apply an abuse of discretion standard to the evidentiary rulings of a trial court." In re Commitment of R.S., 339 N.J. Super. 507, 531 (App. Div. 2001), aff'd, 173 N.J. 134 (2002). However, "when the matter involves novel scientific evidence in a criminal proceeding, 'an appellate court should scrutinize the record and independently review the relevant authorities, including judicial opinions and scientific literature.'" Ibid. (quoting Harvey, 151 N.J. at 167); accord State v. Pickett, 466 N.J. Super. 270, 303 (App. Div. 2021). Therefore, when a trial court applies the Frye test, we employ a de novo standard of review. Ibid.

"While the trial court is in a better position to shape the record and make credibility determinations, 'appellate courts can digest expert testimony as well as review scientific literature, judicial decisions, and other authorities.'" State v. Torres, 183 N.J. 554, 567 (2005) (quoting Harvey, 151 N.J. at 167).

> The appellate court should carefully review the relevant authorities in determining the correctness of the decision to admit or exclude the disputed testimony. In short, the appellate court need not be as deferential to the trial court's ruling on the admissibility of expert scientific evidence as it should be with the admissibility of other forms of evidence.
>
> [Ibid. (citing Harvey, 151 N.J. at 167).]

In Harvey, the Court further explained:

> In the rapidly changing world of modern science, continuing research may affect the scientific community's acceptance of a novel technology. By reviewing posttrial publications, an appellate court can account for the rapid pace of new technology. The continuing review also recognizes that general acceptance may change between the time of trial and the time of appellate review.
>
> [151 N.J. at 167-68 (citing State v. Bible, 858 P.2d 1152, 1189 n.33 (Ariz. 1993)).]

Applying these principles, we engage in the following de novo review of the admissibility of the LCN testing and FST evidence.

THE FST EVIDENCE

The State relies on approval by the DNA Subcommittee and case law from New York to establish general acceptance of FST by the relevant scientific community. Recently, however, the New York Court of Appeals cast considerable doubt on the New York lower court decisions admitting LCN and FST evidence. People v. Williams, 147 N.E.3d 1131, 1140-42 (N.Y. 2020). The court cogently observed that "repetition of a single, questionable judicial determination does not strengthen or add validity to such ruling, and it defies logic that an error, because it is oft-repeated, somehow is made right." Id. at 1140.

The court explained that "FST is a proprietary program exclusively developed and controlled by OCME. The sole developer and the sole user are the same." Id. at 1141. It concluded that those circumstances were "an invitation to bias." Ibid. The court recognized that FST was approved by the DNA Subcommittee but found "that insular endorsement [was] no substitute for the scrutiny of the relevant scientific community." Id. at 1142. Moreover, "rely[ing] solely on the Subcommittee's approval as dispositive of the general acceptance would . . . supplant the courts' obligation to ensure" the Frye standard has been met. Ibid. The court further commented that internal validation by OCME and approval by the DNA Subcommittee were "no substitute for community review." Ibid. It cautioned that "Frye demands an objective, unbiased review" and that "FST should be supported by those with no professional interest in its acceptance." Ibid. The court held that the trial court abused its discretion by admitting LCN and FST evidence without holding a Frye hearing. Id. at 1143.

In a recent published decision considering whether the source code and related documentation for a different probabilistic genotyping software program was required to be disclosed to a defendant for purposes of challenging the reliability of the software at a Frye hearing, the court

commented on the reliability of FST. Pickett, 466 N.J. Super. at 278-79, 307-08. The court stated:

> For example, as part of a Daubert hearing, a federal judge unsealed the source code of [FST], a probabilistic genotyping software that had been developed and used by the [OCME]. In 2017, that review demonstrated the software -- employed in thousands of criminal prosecutions -- was unreliable, did not work as intended, and had to be eliminated.
>
> [Id. at 278 (footnote omitted).]

In a more detailed discussion, the court commented:

> The troubling FST case study demonstrates a rational basis for independent source-code review of probabilistic DNA programs like TrueAllele. After being subjected to an adversarial audit when ProPublica obtained an order for the release of FST's source code, it was revealed that FST had a problem with a certain calculation that was only learned through the adversarial examination of the source code. Steven M. Bellovin et al., Seeking the Source: Criminal Defendants' Constitutional Right to Source Code, 17 Ohio State Tech. L.J. 1, 38 (2021). The audit discovered that certain "loci were removed from the likelihood ratio calculation" without "notice, either intended or actual, provided to the user of FST," nor any "indication that this behavior [was] intended during [the] examination of FST-related publications and the FST [v]alidation materials." Ibid.; see also Stephanie J. Lacambra et al., Opening the Black Box: Defendants' Rights to Confront Forensic Software, Champion 28, 30 (May 2018) (providing a snippet of the source code and explaining that "if the sum of frequencies is greater than 0.97, a row in the raceTable is removed"). As a result, the software was overestimating the likelihood of guilt. Beyond

> undocumented calculations, it was discovered that FST exhibited code smells, which suggested that "the program is below normal professional standards and may have other, not yet detected problems" which are "extremely difficult to detect . . . without access to [the] source code." Bellovin et al., 17 Ohio State Tech. L.J. at 39. At oral argument, the Innocence Project pointed out that, like TrueAllele, FST was subject to multiple validation studies but errors were still found in the source code, proving that validation of this type of evidentiary software is not determinative when evaluating computer science reliability.
>
> [Id. at 307-08 (alterations in original) (footnotes omitted).]

Citing to a New York Times article, the court further stated that "production and review of the code for the since-discontinued FST program proved crucial to identification of significant errors, albeit not before compromised test results had already been used in many prosecutions." Id. at 310 (citing Lauren Kirchner, Doubts and DNA Evidence, N.Y. Times, Sept. 5, 2017, at A1). The court remarked that it could not "ignore these facts when evaluating whether there exists a rational basis for access to the proprietary information here." Ibid. It concluded that "FST serve[d] as [an] important cautionary tale[]." Id. at 323.

The State contends the comments were dicta that "must be wholly disregarded" because there was no adversarial testing of the statements made by the court. We disagree. The scholarly analysis undertaken in Pickett is

sound, illuminating, and persuasive. We give these carefully considered statements due consideration. See In re A.D., 441 N.J. Super. 403, 422-23 (App. Div. 2015) ("Mere obiter may be entitled to little weight, while a carefully considered statement . . . though technically dictum, must carry great weight . . . ." (quoting Barreiro v. Morais, 318 N.J. Super. 461, 468 (App. Div. 1999))), aff'd o.b., 227 N.J. 626 (2017).

As we have noted, our standard of review is de novo. R.S., 339 N.J. Super. at 531. We apply the more stringent Frye test for admissibility. Ghigliotty, 463 N.J. Super. at 374. It was the State's burden to "'clearly establish' general acceptance" of the FST software. Cassidy, 235 N.J. at 492 (quoting Johnson, 42 N.J. at 171). In our view, the State did not satisfy its burden of proof.

The State's reliance on New York cases to clearly establish general acceptance is unpersuasive. Despite the Second Circuit finding no abuse of discretion in a trial court's decision to admit FST evidence, Jones, 965 F.3d at 161-62, the Court of Appeals in Williams was critical of the many New York decisions admitting FST evidence and disapproved of the reliance by those courts on OCME's validation studies and approval by the DNA Subcommittee. 147 N.E.3d at 1140-42. The only other New York case cited by the State is

unpublished.[8] The New York cases do not clearly establish general acceptance.

Another method to establish general acceptance under Frye is through expert testimony. J.L.G., 234 N.J. at 281. Expert testimony in support of FST was provided by O'Connor and Baum. O'Connor, who was working at OCME when FST was developed and implemented, described OCME's extensive validation process for the software, and its approval by the DNA Subcommittee and CFS. Baum, who left OCME before FST was developed and implemented, testified that likelihood ratios are commonly used to interpret DNA mixtures. He believed the program was reliable based on OCME's validation and the approvals by the DNA Subcommittee and CFS.

An internal validation of proprietary software cannot establish general acceptance because the Frye standard requires that "the relevant scientific community widely, but perhaps not unanimously, accepts [the software] as reliable." Ghigliotty, 463 N.J. Super. at 383 (quoting Harvey, 151 N.J. at 171). O'Connor claimed that the relevant scientific community for LCN DNA testing is international. Certainly, the relevant scientific community for probabilistic genotyping software programs extends beyond the scientists at OCME.

[8] See R. 1:36-3; Trinity Cemetery Ass'n v. Twp. of Wall, 170 N.J. 39, 48 (2001) (Verniero, J., concurring) (explaining that unreported decisions "serve no precedential value").

Although likelihood ratios may be generally accepted in the relevant scientific community as a method of determining the probability that an individual is a contributor to a DNA sample, the fact that FST calculates likelihood ratios does not establish the reliability or general acceptance of the program itself.

Because no entity other than OCME used or has examined FST, we must determine whether approval by the DNA Subcommittee and CFS establishes general acceptance in the relevant scientific community. By statute, the CFS must "develop minimum standards and a program of accreditation for all forensic laboratories in New York state" and approve "forensic laboratories for the performance of specific forensic methodologies." N.Y. Exec. Law § 995-b(1) (McKinney 2021). "The minimum standards and program of accreditation [are] designed to . . . ensure that forensic analyses, including forensic DNA testing, are performed in accordance with the highest scientific standards practicable . . . ." Id. at § 995-b(2)(b).

In accordance with New York law, the CFS has established a DNA Subcommittee. Id. at § 995-b(13)(a). The chair of the Subcommittee is appointed by the chair of the CFS, and the remaining six members of the Subcommittee are appointed upon the recommendation of either the Commissioner of the Department of Health or the Commissioner of Criminal Justice Services, with two members each representing the disciplines of

population genetics and forensic science, one member from the field of molecular biology, and one member from the field of laboratory standards and quality assurance regulation and monitoring. Ibid.

By statute, "[t]he DNA [S]ubcommittee shall assess and evaluate all DNA methodologies proposed to be used for forensic analysis, and make reports and recommendations to the [CFS] as it deems necessary." Id. at § 995-b(13)(b). In addition, "[t]he DNA [S]ubcommittee shall make binding recommendations for adoption by the [CFS] addressing minimum scientific standards to be utilized in conducting forensic DNA analysis including, but not limited to, examination of specimens, population studies and methods employed to determine probabilities and interpret test results." Ibid. "Upon the recommendation of the DNA [S]ubcommittee . . . the [CFS] shall designate one or more approved methodologies for the performance of forensic DNA testing, and shall review and act upon applications by forensic DNA laboratories for approval to perform forensic DNA testing." Id. at § 995-b(11).

Defense witnesses Shapiro and Coyle acknowledged that the members of the DNA Subcommittee were members of the relevant scientific community. Approval of FST for forensic casework by the DNA Subcommittee thus establishes acceptance of the program by at least certain members of the relevant scientific community. The issue is whether acceptance by the DNA

Subcommittee establishes "general acceptance" by the scientific community. Frye, 293 F. at 1014.

Because this is a criminal matter, the State's burden is to "clearly establish," Cassidy, 235 N.J. at 492 (quoting Johnson, 42 N.J. at 171), that the challenged technique is "widely, but perhaps not unanimously, accept[ed] as reliable" by the relevant scientific community, Ghigliotty, 463 N.J. Super. at 383 (quoting Harvey, 151 N.J. at 171). Standing alone, approval by the DNA Subcommittee does not clearly establish that FST is widely accepted as reliable. Therefore, the FST evidence was improperly admitted into evidence.

FST was used to calculate likelihood ratios only for Sample 2. Huyck testified that FST calculated that the mixture in Sample 2 "was approximately 71.2 million times more likely to have come from . . . Vernieri and another person rather than that mixture coming from two unknown, unrelated people." The State contends admitting the testimony regarding Sample 2 was harmless error given the other evidence in the case. We disagree.

As recognized in Pickett, "DNA evidence is powerful and compelling." 466 N.J. Super. at 306. For the reasons discussed below, we have also determined that the testimony regarding sample 1 was inadmissible.

The only other evidence in the case linking defendant to the crime was his visit to Vernieri two days earlier, the shoe imprint, testimony regarding his

cell phone records, which was disputed by his expert, and DNA evidence from Vernieri's fingernail clippings. This DNA evidence did not positively identify defendant. Instead, it indicated defendant could not be excluded as a contributor and the profile would be expected to occur in 1 of 333 Caucasian individuals. We do not find this evidence to be overwhelming.

In sum, admitting the evidence regarding Sample 2 "raise[s] a reasonable doubt as to whether [it] led the jury to a verdict it otherwise might not have reached." State v. R.B., 183 N.J. 308, 330 (2005) (second alteration in original) (quoting State v. Bankston, 63 N.J. 263, 273 (1973)). We therefore reverse defendant's conviction and remand for a new trial.

THE LCN DNA TESTING

We next address the State's reliance on the LCN DNA testing. As with FST, the State relies on OCME's internal validation, approval by the DNA Subcommittee, and case law from New York to establish general acceptance of LCN DNA testing by the relevant scientific community. For the reasons discussed above, those considerations alone are insufficient to establish general acceptance. Moreover, even though the State provides additional support for its position regarding LCN DNA testing, it has failed to clearly establish general acceptance of the technique by the relevant scientific community.

In addition to relying on New York state case law, the State cites to two federal district court cases. In the one published case, the district court found that LCN DNA evidence was admissible under Daubert, but it did not make any findings as to whether the technique was generally accepted in the scientific community. United States v. Morgan, 53 F. Supp. 3d 732, 740-47 (S.D.N.Y. 2014), aff'd, 675 Fed. Appx. 53 (2d Cir. 2017). In affirming the district court's decision, the Second Circuit commented that

> although LCN analysis is supported by significantly weaker evidence of reliability than traditional DNA analysis, the district court did not abuse its discretion . . . in holding that the proffered expert evidence met the reliability standards of [Fed. R. Evid.] 702: We cannot say that its ruling here was "manifestly erroneous."
>
> [Morgan, 675 Fed. Appx. at 55-56 (quoting Amorgianos v. Nat'l R.R. Passenger Corp., 303 F.3d 256, 265 (2d Cir. 2002)).]

Notably, the Second Circuit "express[ed] no opinion on the propriety of admitting the results of LCN testing in other cases." Id. at 56.

Morgan analyzed admissibility under Daubert, which only "requires the district court to ensure 'that an expert's testimony both rests on a reliable foundation and is relevant to the task at hand.'" Morgan, 675 Fed. Appx. at 55 (quoting Daubert, 509 U.S. at 597). "Although Frye has been replaced in the federal court system in favor of the more lenient standards of [Fed. R. Evid.]

702 as set forth in Daubert, in New Jersey, with the exception of toxic tort litigation, Frye remains the standard." State v. Doriguzzi, 334 N.J. Super. 530, 539 (App. Div. 2000). "Thus, the test in criminal cases remains whether the scientific community generally accepts the evidence." Harvey, 151 N.J. at 170 (citing State v. Spann, 130 N.J. 484, 509 (1993); Windmere, Inc. v. Int'l Ins. Co., , 105 N.J. 373, 386 (1987)); accord Doriguzzi, 334 N.J. Super. at 539.

Moreover, an opinion by a federal district court or parallel federal appellate court is not binding precedent, especially as to the interpretation of our rules of evidence. State v. Reyes, 140 N.J. 344, 357 (1995).

In an unpublished opinion, the Western District of New York concluded that LCN DNA testing was generally accepted in the scientific community. The court relied, in part, on the district court's decision in Morgan, the trial court's decision in this case, and People v. Megnath, 898 N.Y.S.2d 408 (Sup. Ct. 2010), aff'd, 79 N.Y.S.3d 557 (App. Div. 2018),[9] a trial court decision that was roundly criticized by the New York Court of Appeals in Williams, 147 N.E. 3d at 1140, which found the lower court's ruling "was an analysis that did not adequately assess whether OCME's LCN testing was generally accepted within the relevant scientific community." Notably, in Williams the Court of

[9] Apparently, the defendant in Megnath did not raise the issue of the admissibility of the DNA evidence on appeal as the Appellate Division does not mention or address it in its opinion.

Appeals observed that "the People were unable to cite any New York appellate cases, or out-of-state case law, assessing the general acceptance of LCN evidence." 147 N.E.3d at 1140. As we have noted, the Court of Appeals was critical of lower court decisions finding that LCN testing was generally accepted based on OCME's internal validation and evidence that the method was used in other countries. Ibid. For these reasons, the unpublished New York trial court opinion is not persuasive. It also has no precedential value. See e.g., Meadowlands Basketball Ass'n v. Dir., Div. of Taxation, 340 N.J. Super. 76, 83 (App. Div. 2001) (interpretative decision by a New York tax appeal tribunal of a similar New York statute is "not binding or controlling"); State v. Warriner, 322 N.J. Super. 401, 407 (App. Div. 1999) (Connecticut state court and federal district court decisions are not binding on our courts).

In the final case cited by the State, a Maryland appellate court affirmed a trial court's determination that LCN DNA evidence was admissible under the Frye standard. Phillips v. State, 126 A.3d 739, 748-51 (Md. Ct. Spec. App. 2015). The DNA sample at issue was analyzed by the Prince Georges County DNA laboratory. Id. at 748. The court concluded that the "laboratory used generally accepted scientific methodology to analyze the sample," relying upon the laboratory's compliance with the FBI Quality Assurance Standards and its finding that other forensic laboratories used the same methodology

employed by the Prince George's laboratory. Id. at 748. The court did not identify the other laboratories and provided no details regarding the technique employed other than to state that the LCN testing was "particularly susceptible to stochastic effects—random errors that make accurately analyzing the DNA more difficult—and increased risks of contamination." Id. at 749.[10]

We conclude that the two published cases relied upon by the State do not clearly establish that LCN DNA evidence has achieved general acceptance in the relevant scientific community.

As to authoritative scientific and legal writings, in addition to the letters authored by the DNA Subcommittee, the State points to the 2014 SWGDAM Guidelines and seven peer-reviewed scientific articles. SWGDAM "serves as a forum to discuss, share and evaluate forensic biology methods, protocols, training, and research to enhance forensic biology services as well as provide recommendations to the FBI Director on quality assurance standards for forensic DNA analysis." SWGDAM Mission Statement, Sci. Working Grp. on DNA Analysis Methods (SWGWAM), https://www.swgdam.org (last visited Jan. 18, 2022). When the group issued the 2014 SWGDAM Guidelines, it was comprised of "approximately [fifty] scientists representing Federal, State and

[10] The State's witnesses did not identify the Prince George County's laboratory as a facility that was still performing LCN testing for use in criminal cases.

Local forensic DNA laboratories in the United States and Canada." Although, as Van Daal pointed out, the guidelines state that SWGDAM "does not offer an opinion on the viability of any Enhanced Detection Methods, including Low Template or [LCN] DNA Analysis," the guidelines also acknowledge that laboratories "are engaging in methods that will enhance the recovery from low quality DNA samples" and state SWGDAM's purpose is to "provide[] guidelines for the use of Enhanced Detection Methods as applied to forensic casework DNA analysis."

The guidelines recommend procedures followed by OCME including replicate amplification and development of a consensus profile. Baum, who at one time was a member of SWGDAM, testified that the guidelines would not have been issued unless SWGDAM felt LCN testing "was a relevant issue that [was] being practiced in the community."

Regarding the seven peer-reviewed scientific articles cited by the State, there was no testimony regarding six of the articles and the State has not explained how the articles support the view that LCN DNA testing is generally accepted. Baum testified that the remaining article, which he co-authored with at least one other OCME scientist, described the protocol OCME was using for

LCN DNA testing.[11] Although the authors concluded that the LCN DNA protocols and interpretation guidelines used by OCME were "reliable and robust," that conclusion by OCME personnel does not adequately demonstrate general acceptance in the scientific community.

Finally, expert testimony elicited at the Frye hearing demonstrated that there are conflicting views on whether LCN DNA testing is accepted by the scientific community for use in criminal casework. Baum testified that LCN testing was not a new technique; it was an extension of the conventional high copy number testing methodology. He explained that LCN testing was first developed by Gill in the United Kingdom, and identified Butler, who devoted a chapter in his Methodology book to LCN DNA testing, as a member of the scientific community that approved of LCN testing.

O'Connor identified Gill, Buckleton, Haned, and Butler as members of the scientific community that supported LCN DNA testing. He testified that laboratories in Australia, Italy, Belgium, the Netherlands, New Zealand, Croatia and Spain all used LCN DNA techniques in criminal casework. Baum and O'Connor both admitted that LCN testing was not unanimously accepted

[11] Theresa Caragine et al., Validation of Testing & Interpretation Protocols for Low Template DNA Samples Using AmpFlSTR Identifiler, 50 Croatian Med. J. 250 (2009).

by the scientific community but recalled that there was also opposition to conventional high copy number testing early on.

Van Daal testified that some laboratories in Europe started using LCN DNA testing after Gill, whom she acknowledged was highly regarded in the field, published his paper describing the technique in 1999. She believed, however, that OCME's LCN protocols differed from those of other laboratories. She noted there were acceptable uses for LCN DNA testing, such as "for investigative purposes in missing persons cases" and in the "medical arena," for instance in "pre-implantation genetic diagnosis."

Van Daal claimed that many other scientists believed LCN testing was unreliable but named only Budowle and Chakraborty. She agreed that Butler was a member of the relevant scientific community and that he reported in his Methodology book that the FSS in the United Kingdom had used LCN analysis in over 21,000 cases by early 2010. She also agreed that a forensic science regulator in the United Kingdom had issued a statement concluding that the science underlying LCN testing was sound.

Coyle testified that LCN DNA testing was "very similar" to conventional STR testing. She maintained that it was appropriate to use the technique to identify skeletal remains in the context of missing persons but not for criminal

casework. But she acknowledged that the LCN testing technique was the same whether used for criminal casework or missing persons identification.

Coyle identified Budowle, Van Daal, Shapiro, and Eisenberg as members of the scientific community who do not believe that LCN testing is reliable. She discussed three articles and one letter critical of LCN DNA testing written by Budowle, Eisenberg, Van Daal, and others. She acknowledged that laboratories in the United Kingdom, the Netherlands and New Zealand were using LCN DNA testing at the time of her testimony, that the scientists working at those laboratories were members of the relevant scientific community and acknowledged that other scientists disagreed with her opinion.

In Harvey, the Court faced a similar issue. In that case, the Court considered whether a type of DNA testing known as polymarker testing was generally accepted in the scientific community. 151 N.J. at 169-76. The State's expert explained that the test was technologically and procedurally similar to the PCR/DQ Alpha test, which courts in New Jersey had already deemed scientifically reliable. Id. at 162, 172. In addition, the company that performed the DNA testing, which was not the company that manufactured the test kit, had conducted validation studies on the test in accordance with protocols established by the Technical Working Group on DNA Analysis

Methods (TWGDAM).[12] Id. at 172. Six other laboratories in the United States had also independently verified the accuracy of the test and it was used for casework or validation studies in approximately thirty to forty laboratories throughout the United States. Ibid.

The Court found that "[s]cholarly and scientific publications . . . approve[d] the polymarker test." Id. at 173. Three published articles opined the polymarker test "was reliable for casework." Ibid. In addition, " a list of forty-four presentations, posters, lectures, seminars, and workshops in which forensic scientists discussed issues regarding polymarker-related research, testing, and results." Ibid. No documents were produced suggesting the test was unreliable. Id. at 174.

At the time of the Rule 104 hearing in Harvey, there was only one New York case where polymarker evidence had been admitted. Id. at 175. However, since the defendant's trial, at least six courts in other jurisdictions had determined the test was admissible. Id. at 176. The Court was satisfied that the polymarker test was scientifically reliable and held that the trial court properly admitted the polymarker evidence. Ibid.

[12] TWGDAM was the predecessor to SWGDAM. History of SWGDAM, https://www.swgdam.org/about-us (last visited Jan. 18, 2022).

By any measure, the evidence for general acceptance was much stronger in Harvey than it is here. Whereas in Harvey, six laboratories had independently verified the accuracy of the polymarker test, the testimony here only established that OCME had done validation studies on its own LCN DNA testing technique. In addition, far more laboratories were using the polymarker test than performing the LCN DNA testing at issue here. Also, unlike in Harvey, where the defendant produced no scholarly articles disputing the accuracy of the polymarker test, Coyle testified to three articles and one letter critical of LCN DNA testing. Moreover, the State's experts referred to only one published article in support of LCN testing and that article was written by OCME personnel.

Finally, in Harvey, appellate courts in three other states and the Eighth Circuit Court of Appeals found the polymarker test was generally accepted in the scientific community. Id. at 176. Here, the State relies on questionable New York lower court decisions and an appellate decision from Maryland.

In sum, although there is some evidence supporting a finding of general acceptance, we conclude that the State has failed to "clearly establish" general acceptance of OCME's LCN DNA testing technique. Cassidy, 235 N.J. at 492 (quoting Johnson, 42 N.J. at 171). Accordingly, the LCN DNA evidence was not admissible. As discussed above, the error in admitting this evidence was

not harmless. Its use also "raise[s] a reasonable doubt as to whether [it] led the jury to a verdict it otherwise might not have reached." R.B., 183 N.J. at 330 (second alteration in original) (quoting Bankston, 63 N.J. at 273). For this additional reason, the conviction must be reversed and the retried.

III.

For sake of completeness, we next address defendant's argument that the affidavit submitted in support of the issuance of a search warrant for the Van Winkle Avenue property where the disputed DNA was found was insufficient to establish probable cause. The resulting search revealed evidence of blood, later determined to contain Vernieri's DNA.

The State contends that defendant's unusual conduct in visiting Vernieri two days before the murder, the disparities in his account of the visit, his assertion that he slept until 11:00 a.m. on the date of the murder even though cell phone records placed his phone behind Vernieri's home at 10:39 a.m., Logan's statement that he heard a shriek from downstairs between 10:10 and 10:30 a.m., and defendant's statement that he visited the Van Winkle property on the date of the murder, provided a sufficient basis for the search warrant.

In considering an application for a search warrant, "[t]he issuing authority 'must be satisfied that there is probable cause to believe that a crime has been committed, or is being committed, at a specific location or that

evidence of a crime is at the place sought to be searched.'" State v. Jones, 179 N.J. 377, 388 (2004) (quoting State v. Sullivan, 169 N.J. 204, 210 (2001)). "Probable cause for the issuance of a search warrant requires 'a fair probability that contraband or evidence of a crime will be found in a particular place.'" State v. Chippero, 201 N.J. 14, 28 (2009) (quoting United States v. Jones, 994 F.2d 1051, 1056 (3d Cir. 1993)). "[T]he probable cause determination must be . . . based on the information contained within the four corners of the supporting affidavit, as supplemented by sworn testimony before the issuing judge that is recorded contemporaneously." State v. Marshall, 199 N.J. 602, 611 (2009) (quoting Schneider v. Simonini, 163 N.J. 336, 363 (2000)).

"A search that is executed pursuant to a warrant is 'presumptively valid,' and a defendant challenging the issuance of that warrant has the burden of proof to establish a lack of probable cause 'or that the search was otherwise unreasonable.'" State v. Boone, 232 N.J. 417, 427 (2017) (quoting State v. Watts, 223 N.J. 503, 513-14 (2015)). "Reviewing courts [should] 'accord substantial deference to the discretionary determination resulting in the issuance of the [search] warrant.'" Ibid. (second alteration in original) (quoting Jones, 179 N.J. at 388). However, "[c]ourts [must] consider the 'totality of the circumstances' and should sustain the validity of a search only if

the finding of probable cause relies on adequate facts." Ibid. (quoting Jones, 179 N.J. at 388-89).

Defendant's argument lacks sufficient merit to warrant extended discussion. R. 2:11-3(e)(2). Considering the totality of the circumstances, Boesch's affidavit contained adequate facts supported by the record that demonstrated probable cause that evidence of a crime would be found at the Van Winkle Avenue property.

Boesch averred that cell phone records showed that defendant's cell phone was in the area of Vernieri's house and the commercial parking lot behind it at 10:39 a.m. on September 14, 2012, which was close to the time that Sinan Logan reported hearing a disturbance from Vernieri's home. In statements given to the police, defendant claimed that he was asleep in his apartment at that time. Defendant also admitted in his second statement to police that he visited the Van Winkle property on the date of the murder. Vernieri's daughter reported that Vernieri had a "strange encounter" with defendant, who stopped by Vernieri's house unannounced on September 12, 2012, something he had never done before. She further reported that her mother told her that defendant asked her for a tour of the house and asked her about diamond jewelry. Shoe impressions of an Adidas athletic shoe were found at the crime scene.

The facts set forth in Boesch's affidavit established probable cause for the issuance of the search warrant. The seizure of evidence during the execution of the warrant did not violate defendant's constitutional rights.

IV.

Defendant further argues that the trial court erred in admitting the statements made by Vernieri to a friend under the present sense impression exception to the hearsay rule, N.J.R.E. 803(c)(1). DeMauro testified regarding comments made to her by Vernieri on September 12, 2012, following defendant's visit to Vernieri's home. Defendant contends that there is no evidence that DeMauro spoke with Vernieri "'while or immediately after' the event was taking place." He claims that DeMauro's testimony allowed the State to argue in summation that his visit to Vernieri's home was perceived by her as "strange," and led to the State's assertion that something bad was going to happen on September 12, 2012, but "the plan had to change when [Vernieri] opened the door on the phone."

The State argues that the trial court properly admitted DeMauro's testimony as a present sense impression because she spoke with Vernieri immediately after defendant left Vernieri's home. The State also contends that DeMauro's testimony that Vernieri said she was surprised by defendant's visit was admissible under the state of mind exception to the hearsay rule, N.J.R.E.

803(c)(3). The State further maintains that the testimony was not clearly capable of producing an unjust result because it was "largely cumulative" of testimony given by Murphy and defendant's father, and the statements given to police by defendant. It claims that there was ample evidence in the record to establish that Vernieri was surprised by defendant's visit and, therefore, the prosecutor's comments in summation about the strangeness of the visit were appropriate.

"We review evidentiary rulings under an abuse of discretion standard." State v. Jackson, 243 N.J. 52, 64 (2020) (citing State v. Nantambu, 221 N.J. 390, 402 (2015)). "Under that deferential standard, we review a trial court's evidentiary ruling only for a 'clear error of judgment.'" State v. Medina, 242 N.J. 397, 412 (2020) (quoting State v. Scott, 229 N.J. 469, 479 (2017)). When inadmissible evidence is heard by the jury, "an appellate court should not order a new trial unless the error was 'clearly capable of producing an unjust result.'" State v. Yough, 208 N.J. 385, 397-98 (2011) (quoting R. 2:10-2). As we are remanding for retrial, we provide the following guidance to the trial court.

The present sense impression exception to the hearsay rule applies to statements "describing or explaining an event or condition, made while or immediately after the declarant perceived it and without opportunity to deliberate or fabricate." N.J.R.E. 803(c)(1). There is no dispute that Vernieri

spoke to DeMauro after defendant's visit on September 12, 2012. Accordingly, the applicability of the exception turns on whether Vernieri's comments to DeMauro were made "immediately after" the visit.

In State ex rel. J.A., 195 N.J. 324, 336-40 (2008), the Court considered the meaning of the phrase "immediately after" under the present sense impression exception. The Court determined there was a distinction between delays measured in seconds as opposed to those measured in minutes. Id. at 339. The Court held that a witness statement taken by police ten minutes after a robbery occurred was not "immediately after" and the trial court abused its discretion by admitting the statement under the present sense impression exception. Id. at 340. Similarly, in Gonzales v. Hugelmeyer, 441 N.J. Super. 451, 458 (App. Div. 2015), we held that a statement by an eyewitness given to police who "arrived at least 'several minutes'" after an accident occurred was not admissible under the present sense impression exception.

Murphy testified that he was on the phone with Vernieri at about 9:00 p.m. when defendant arrived at her home on September 12, 2012. In his statements to police, defendant said he arrived at Vernieri's home at around 7:20 p.m. and stayed for approximately one hour. DeMauro testified that she spoke to Vernieri at around 9:30 or 10:00 p.m. that night. Despite the conflicting evidence of the time defendant arrived and left, the trial court

found "defendant rang her doorbell at approximately 8:30 p.m." and the statements "were made at 10 p.m. on September 12, 2012, immediately after the defendant left her home." The record does not establish that the statements to DeMauro were made within seconds rather than minutes of perceiving the event "and without opportunity to deliberate or fabricate." N.J.R.E. 803(c)(1). Therefore, the statements are not admissible as present sense impressions.

We also consider whether Vernieri's statements to DeMauro are admissible under the state of mind hearsay exception, which provides an exception for "[a] statement made in good faith of the declarant's then-existing state of mind, emotion, sensation or physical condition (such as intent, plan, motive, design, mental feeling, pain or bodily health), but not including a statement of memory or belief to prove the fact remembered or believed . . . ." N.J.R.E. 803(c)(3).

"Simply stated, the 'state of mind' exception to the hearsay rule allows admission of extrajudicial statements to show the state of mind of the declarant when it is at issue in a case." State v. McGuire, 419 N.J. Super. 88, 136 (App. Div. 2011) (quoting State v. Benedetto, 120 N.J. 250, 255–56 (1990)). "Such state-of-mind testimony may properly be used only for evaluating the victim's actions or the likelihood of him or her acting in a certain way." State v. Scharf, 225 N.J. 547, 581 (2016) (emphasis in original). "[T]he evidence may

not be used as evidence of the defendant's actions or intent." Ibid. Moreover, a limiting instruction should be provided to the jury regarding "the permissible and prohibited purposes of the evidence." Ibid.

The statement that Vernieri was surprised by defendant's visit was not offered to evaluate any actions of Vernieri or the likelihood of her acting in a certain way. Rather, it was used to show that defendant's behavior was unusual or odd. Therefore, the statement was not admissible under the state of mind hearsay exception.

While this evidentiary error was not clearly capable of producing an unjust result, Vernieri's statements to DeMauro shall not be admitted into evidence during the retrial.

V.

Finally, we address defendant's argument that the trial court erred by instructing the jury that it could consider his conduct at the time of his arrest as evidence of his consciousness of guilt. He contends that his conduct was not "relevant to any material issue disputed at trial" and points out that he was acquitted of resisting arrest. He maintains that he did not attempt to flee and that his conduct was entirely "consistent with utter panic."

Relying on State v. Williams, 190 N.J. 114, 125 (2007), as well as cases from foreign jurisdictions, the State argues that evidence of resisting arrest is

admissible "to prove defendant's consciousness of guilt of the underlying crime." It claims that count fourteen of the indictment, which charged defendant with third degree resisting arrest, was dismissed only because testimony failed to establish the element of physical force. The State notes that the trial court found that the testimony could constitute disorderly-persons resisting arrest, N.J.S.A. 2C:29-2(a)(1). The State also contends that the court's limiting instruction properly protected defendant's rights.

Both McMorrow and Boesch testified, without objection, that defendant ignored numerous commands to turn off and exit his vehicle, that he refused to submit to handcuffs after being forcibly removed from the vehicle, and that he was taken to the ground by officers and restrained. Defendant has not argued on appeal that McMorrow's or Boesch's testimony was improperly admitted. We deem that issue waived. See Sklodowsky v. Lushis, 417 N.J. Super. 648, 657 (App. Div. 2011) ("An issue not briefed on appeal is deemed waived."). We therefore focus on the jury instruction.

In summation, defense counsel disputed that defendant's conduct at the time of his arrest showed consciousness of guilt. Counsel pointed out that defendant voluntarily stopped his vehicle and placed the car in park. Counsel suggested that defendant's failure to immediately follow resulted from his need to process what was happening. Counsel's arguments provided the jurors with

an alternative explanation for defendant's conduct, which the jurors, in accordance with the court's instruction, were free to either accept or reject.

Defendant objected to the jury instruction regarding consciousness of guilt. "In reviewing instructions to the jury, a court must not isolate the language challenged but must examine the remark in the context of the entire charge." State v. DiFrisco, 137 N.J. 434, 491 (1994). The effect of the challenged "charge must be evaluated in light of the totality of the circumstances." Ibid.

The instruction properly informed jurors of the "permitted and prohibited purposes of the evidence." State v. Cofield, 127 N.J. 328, 341 (1992) (quoting State v. Stevens, 115 N.J. 289, 304 (1989)). Jurors were instructed that they could use the evidence that defendant ignored police commands to exit his vehicle and submit to being handcuffed only for the purpose of deciding whether the evidence demonstrated consciousness of guilt. Jurors were also told they could decide the evidence did not demonstrate defendant's consciousness of guilt, and in that case, they must disregard the evidence. The court properly instructed the jurors regarding the permitted use of this evidence that was admitted without objection.

Reversed and remanded for retrial. We do not retain jurisdiction.

I hereby certify that the foregoing
is a true copy of the original on
file in my office.

CLERK OF THE APPELLATE DIVISION