

State v. Tester (2007-097)

2009 VT 3

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2009 VT 3

No. 2007-097

State of Vermont

v.

Paul Tester

Thomas J. Devine, J.

Supreme Court

On Appeal from  
District Court of Vermont,  
Unit No. 3, Orleans Circuit

May Term, 2008

Keith W. Flynn, Orleans County State's Attorney, and Alan C. Franklin, Deputy State's Attorney, Newport, for Plaintiff-Appellee.

Allison N. Fulcher of Martin & Associates, Barre, for Defendant-Appellant.

PRESENT: Reiber, C.J., Dooley, Johnson, Skoglund and Burgess, JJ.

¶ 1. **DOOLEY, J.** The issue on appeal is whether the trial court erred in admitting certain DNA evidence under Vermont Rule of Evidence 702 and the United States Supreme Court's decision in Daubert v. Merrill Dow Pharmaceuticals, 509 U.S. 579 (1993). Defendant contends on various grounds that the DNA test results offered into evidence in this case should not be admissible. Although we agree in part, we conclude that the improper admission of the DNA evidence was harmless beyond a reasonable doubt and affirm.

¶ 2. On September 27, 2005, defendant was arraigned on charges of felony sexual assault of a victim less than sixteen years of age, 13 V.S.A. § 3252(a)(3), [\[1\]](#) felony lewd and lascivious conduct with a child, 13 V.S.A. § 2602, and two counts of providing an alcoholic beverage to a minor, 7 V.S.A. § 658(a). These charges arose out of events that took place at the Willow Wood Campground on August 5, 2005.

¶ 3. The evidence presented at trial disclosed the following. The police first became aware of the incident on the evening of August 5, 2005, when they received a telephone call from a woman staying at the campground. The woman explained that two fourteen-year-old girls, M.M. and S.G., told her that they had sexual contact with defendant.

¶ 4. The girls described the events that took place at the campground as follows. According to S.G., M.M.'s mother brought the two girls to the campground. Both girls consumed beer and vodka before meeting defendant. Defendant, a thirty-three-year-old man, encountered the girls while he was picking raspberries and invited them back to his campsite, where he offered them more beer. For several hours, the three of them sat at a picnic table, drinking and talking. During this period of time, defendant asked the girls how old they were, and they answered that they were fourteen years old.

¶ 5. According to M.M., defendant kissed both girls and put his hands under M.M.'s clothing. At one point, defendant pulled down his pants. M.M. recalled stroking defendant's penis while defendant pulled S.G.'s head into his lap so that she could perform oral sex. M.M. testified that defendant invited both girls into his tent, and that she observed defendant lying on top of S.G. Partly because she was standing only a few feet away, she was certain that the two were having sexual intercourse while defendant was on top of S.G. On cross-examination, however, M.M. admitted that she could not see what was occurring in the tent because it was

dark inside. M.M. testified that she urged S.G. to leave defendant's tent afterwards and that the two girls then encountered the woman who had originally made the call to the police.

¶ 6. In some respects, S.G.'s testimony as to what had happened before the girls went inside the tent differed from M.M.'s. S.G. said that defendant attempted, but did not kiss her. She testified instead that she recalled seeing defendant kiss M.M. only when S.G. was returning from the bathroom. She denied that she performed oral sex on him. S.G. admitted to having been extremely intoxicated, so much so that at one point she lost her balance and fell off the picnic table. S.G. testified that defendant led both girls into his tent. Once inside, S.G. noticed that defendant was unclothed. She recalled defendant pulling off her pants and bathing suit bottom and then pulling her on top of him. While S.G. could not recall feeling defendant's penis enter her, S.G. testified that after a few minutes, defendant said he was going to "come." S.G. experienced pain in her vagina as defendant removed his penis.

¶ 7. The woman who came across the girls after their encounter with defendant also testified for the State. She saw the girls on their way back from defendant's campsite and noticed that S.G. had been crying. She asked the girls "if they were okay" and indicated the location of her campsite if they wanted to talk. After spending a short time at M.M.'s mother's campsite, the girls went to the bathroom and again encountered the woman. This time, the girls told her what had happened at defendant's campsite. The woman testified that the girls had seemed "shaken" and showed signs of intoxication.

¶ 8. All the remaining evidence presented by the State involved the rape test kit taken as part of the investigation. On October 5, 2006, defendant filed a motion in limine, seeking to exclude DNA evidence collected by the State from the rape test kit. In support of this motion, defendant presented the affidavit of Dr. Donald Riley, a biochemist and molecular biologist. In the motion, defendant argued that the State's methodology in testing the evidence was not "scientifically valid" and could not be "properly . . . applied to the facts in issue." In particular, defendant challenged: (1) a so-called 05-2-1 sample, taken from S.G.'s vagina; and (2) a 05-4-1 sample, taken from her "external genital area." In the motion, defendant argued that the DNA evidence should be excluded as unreliable because: (1) the 05-2-1 sample was a mixture; (2) the 05-2-1 sample, which was only .64 nanograms and a mixture of at least two people's DNA, was smaller than the one-nanogram minimum recommended by the manufacturer of the DNA testing equipment; (3) defendant's samples were improperly stored in porous cardboard boxes and were thus subject to cross-contamination; (4) defendant's "known" sample was tested in close proximity to the "unknown" samples, which created another opportunity for contamination or false matches; and (5) the lab offered no estimate of its error rate. Defendant also argued that the 05-2-1 sample DNA results were incomplete, because "two of the 13 DNA locations or loci were missing," which, in defendant's view, indicated that the amount of DNA was insufficient and that the analysis was not reproducible, itself an important signal of scientific unreliability. Finally, defendant mentioned several misidentifications of samples by lab technicians. In defendant's view, these errors demonstrated a "loss of concentration by the analyst during a critical phase of testing." Defendant contended that "[t]he method of correcting these mistakes was retrospective guesswork, generally not accepted as valid scientific procedure." Defendant requested an evidentiary hearing on the admissibility of the evidence.

¶ 9. The State filed a response on November 8, 2006, arguing that: (1) the defendant's expert's minimum sample size argument was contradicted by statements of the State's forensic examiner and has been rejected in other jurisdictions under similar circumstances, see State v. Hicks, 2003 WL 734232 \*4 (Wash. App. Div. 2); and (2) defendant's remaining contentions went to the weight, rather than the admissibility, of the evidence. The State also attached a supporting expert affidavit. On November 14, 2006, the court issued an order stating that defendant's motion in limine would be considered at trial. At trial, defendant also objected because there was no statistical match probability for the 05-2-1 sample and therefore the State "was not attaching any particular value of [the 05-2-1 sample] in relation to [defendant] or anyone else."

¶ 10. In ruling on the motion, the court began with whether the challenged methodology was unreliable insofar as it used a sample that was smaller than the minimum size recommended by the manufacturer. The court found as follows:

Now, for the Court to accept the defendant's argument, we'd have to be convinced that the literature and the generally accepted protocols within the scientific community categorically prohibit testing on genetic amounts of less than a nanogram. And we can't find that based on the competing affidavits of the chemists. We do note, and the State concedes, that the manufacturer of the particular test that the Vermont Forensic Lab used recommends amounts of one nanogram or above. But we have a proffer from the State's chemist that it can obtain accurate test results with samples as small as .3 nanogram[s] and there is a contention that there is no fixed recognition within the scientific community as to a required minimum sample size. The State will contend that the one nanogram recommendation of the manufacturer is a target value, it's an ideal, perhaps, to be strived towards, but a sample smaller than that is not categorically prohibited from effective or reliable testing.

As I say, that's an issue that the jury deserves to consider and decide based on the testimony presented.

The court turned next to defendant's remaining contentions. The court explained that most of defendant's arguments went to weight rather than admissibility. As for the misidentification errors recognized by defendant, the court described those mistakes as mere "transcription error[s]," that were not "so grave and fundamental [so as to] categorically preclude admissibility of the test results themselves." The court was not convinced by defendant's argument that the

05-2-1 sample should be excluded if not accompanied by statistical analysis. The court also addressed the possible jury confusion regarding the significance of the 05-2-1 sample, in light of the high statistical probability match of the 05-4-1 sample, stating:

I understand that the defense's concern is that with the potential for competing expert testimony, jurors being lay persons, might become confused and attach undue significance to the smaller [05-2-1] sample, which was not put into the statistical calculation, but we understand that the two experts who are expected to testify are both well-qualified in the field, they've had extensive training in the field and we are confident that they'll be able to explain to the jury how the statistical probabilities were done and the strengths and weaknesses of those probabilities.

Accordingly, the court denied defendant's motion.[\[2\]](#)

¶ 11. The case proceeded to trial. In addition to the testimony of S.G., M.M., and the woman from the campground, the State presented witnesses to trace the chain of custody of the rape test kit contents from collection to the Vermont Forensic Laboratory (the Lab) for analysis. The State also showed that it obtained a nontestimonial identification order to take saliva samples from defendant and that such samples were obtained on buccal swabs that were also delivered to the Lab.

¶ 12. A forensic chemist from the Lab testified that the two rape test kits were properly sealed and labeled when she recovered them. She tested the vaginal samples for blood and seminal fluid. The interior vaginal sample indicated the presence of both blood and seminal fluid, as did one of the swabs that had been labeled "foreign debris swab." Believing that these two samples were "biologically significant," the chemist separated these items from the others in the kit, placed them in a heat-sealed plastic bag, and stored them for future DNA testing.

¶ 13. A second chemist at the Lab performed DNA testing on the samples. As to the interior vaginal, or 05-2-1 sample, he testified that "it was a mixture of two individuals, one being male." The chemist testified that the DNA types of the 05-2-1 sample were "consistent with that of the suspect's," but "[i]t was a partial profile though." For this reason, he did not determine the statistical significance of the match, concluding only that defendant could not be excluded as a source of the DNA.

¶ 14. As to the labial, or 05-4-1 sample, the chemist testified that he was able to perform a full statistical evaluation. He explained that the probability of a randomly selected unrelated individual having the same DNA profile as the one generated was one in twenty-two quadrillion.

¶ 15. When questioned about the misidentification noted in defendant's motion in limine, the chemist stated that he had simply listed the sequence of samples incorrectly and had noticed the error immediately the next day. He claimed that this error was not a reflection of any aspect of the testing process. He also rejected any contention that contamination occurred at any time. As to defendant's claims about the proximity at which defendant's known and unknown samples were stored, he stated that this should not be a concern, because the samples were stored in sealed envelopes or plastic bags.

¶ 16. At the close of the State's case, defendant moved for a judgment of acquittal, which was denied. Defendant then went on to present his own expert witness, Dr. Riley, who reiterated the concerns about the 05-2-1 and 05-4-1 samples that we discuss below. On December 16, 2006, the jury returned guilty verdicts on each of the four charges against defendant. On December 22, defendant again moved for a judgment of acquittal, which the court denied by a written decision dated February 3, 2007, finding that there "was certainly enough evidence for the jury to consider and determine defendant guilty of a sexual assault, even without the additional DNA evidence." As to defendant's claims concerning the reliability of the evidence, the court noted:

The State's DNA testing tended not to exclude on one swab and to render a high probability of a match on the other. While defendant challenged chain of custody, the integrity of sample storage procedures, and protocols within the laboratories, we conclude the State established sufficient foundations of reliability on all of these important considerations.

This appeal followed.

¶ 17. In this appeal, defendant challenges his conviction for sexually assaulting S.G. under 13 V.S.A. § 3252(a)(3), arguing that the trial court erred in admitting the DNA evidence. As the above discussion notes, there were two DNA samples admitted into evidence in this case; some of defendant's arguments appear to relate to both, and others to only one. Defendant also challenges a part of the jury charge. Finally, defendant argues that any error in the admission of DNA evidence is not harmless. Thus, the issues on appeal are:

- I. Issues Relating to Both DNA Samples
  - A. Whether the State has established an adequate chain of custody?
  - B. Whether the State has adequately protected the DNA samples from contamination?

- C. Whether the DNA samples are admissible without establishing an error rate for the lab?
- II. Issues Relating to the Interior Vaginal Sample
- A. Whether the sample size was adequate for DNA analysis?
  - B. Whether the fact that the sample contains DNA from two persons makes DNA analysis with respect to one possible?
  - C. Whether the DNA analysis of this sample is admissible without a statistical probability determination?
- III. Whether the charge to the jury was erroneous because it allowed the jury to determine whether defendant's expert witness was an expert?
- IV. Whether any error was harmless?

¶ 18. Defendant presents all arguments as involving Daubert. In fact, the first two issues itemized above—whether the State established a proper chain of custody for the DNA samples, and whether the State allowed contamination of the samples—do not involve Daubert at all, and the rest barely involve the standards articulated in that decision. It is best to look at most of the issues here as applications of the standards in Vermont Rule of Evidence 702, as amended in 2004 to reflect the Daubert decision and to conform the Vermont rule to the federal rule. Thus, the standards for admissibility of expert testimony are now: (1) whether “the testimony is based upon sufficient facts or data;” (2) whether it “is the product of reliable principles and methods;” and (3) whether “the witness has applied the principles and methods reliably to the facts of the case.” V.R.E. 702. Whether we view the issues under Daubert or under the standards in Rule 702, the standard of review is the same—we reverse only if the court has abused its discretion. USGen New England, Inc. v. Town of Rockingham, 2004 VT 90, ¶ 21, 177 Vt. 193, 862 A.2d 269. We also note that Daubert intended a more liberal approach to the admission of

expert evidence so that evidence that would have been readily admitted prior to Daubert should not now be excluded under Daubert. 985 Assocs., Ltd. v. Daewoo Elec. Am., Inc., 2008 VT 14, ¶ 10, \_\_ Vt. \_\_, 945 A.2d 381.

¶ 19. Before we address the specific issues, we recapitulate our earlier decisions on the admissibility of DNA evidence. The most important is State v. Streich, in which we held that based on the restriction fragment length polymorphism (RFLP) test, the technology of that time, DNA evidence could be admissible to identify the perpetrator of a crime under the standards in Rule 702 and Daubert. 163 Vt. 331, 346, 658 A.2d 38, 49 (1995). We reasoned:

The RFLP process is firmly rooted in “scientific knowledge,” and an application of the four Daubert factors confirms this conclusion. RFLP has been widely tested and has been the subject of a variety of learned articles. The process is not error-free, but adherence to accepted procedures and controls minimizes this error. Indeed, we cannot find any recent decision under any standard of admissibility which refuses to admit the DNA match result based on the invalidity or risk of error of the underlying technology.

Id. at 344, 658 A.2d at 47-48 (citations omitted). We were not, however, as supportive of the method then used to generate the probability statistics of the DNA match between a sample taken from the alleged perpetrator and one left at the scene. In Streich, the witness had found an effective match for three alleles and testified to a probability that the DNA found at the scene came from a random person in the population as the product of the probability for each of the alleles, 1 in 50,000.<sup>[3]</sup> We noted that there was controversy over whether the probability statistics for each allele were independent, and, as a result, we endorsed the “ceiling principle”—a method of calculating probability statistics that decreases the statistical significance of a DNA match. Id. at 345-46, 658 A.2d at 48-49. In doing so, however, we said:

We are also influenced by a practical consideration. The debate is not about whether to allow introduction of probability statistics. We agree with the courts that have held that evidence about the fact of one or more allele matches is not helpful without some evidence about the probability of a match in the population as a whole. The debate instead is about how conservative the probability statistic will be. Although use of the ceiling principle will increase the likelihood of a random match, the difference is unlikely to have any real effect on jury deliberations. We strongly doubt whether it will make much difference to a jury whether the probability of random selection of a person with the same alleles is 1 in 100,000 or 1 in 1,000,000.

Id. at 345, 658 A.2d at 48 (citations omitted). We emphasize our conclusion that the fact of allele matches is not helpful without some evidence about the probability of a match in the population as a whole.

¶ 20. The second case is State v. Brochu, in which we reaffirmed the holding in Streich. 2008 VT 21, ¶ 24, \_\_\_ Vt. \_\_\_, 949 A.2d 1035. Brochu also involved a different kind of DNA, called mitochondrial DNA (mtDNA), for which the probability of a match in the population as a whole is much greater. Thus, the mtDNA in Brochu showed characteristics for which the probability of a match in the general population was one in twelve. As in Streich, we held that this form of DNA met the admissibility standards of Rule 702 and Daubert, but that the weakness was in the probability statistics. Id. ¶ 48. The issue was whether evidence of a probability statistic as high as eight percent was admissible to show identity. We held that it was, under the broad relevancy standard of Rule 401. However, in response to defendant's argument that the match was misleading to the jury, we stated:

Defendant also challenges the evidentiary ruling as violative of V.R.E. 403, because the danger of unfair prejudice substantially outweighed the very limited probative value of the evidence. When applying this rule, the trial court's decision is highly discretionary and may be overturned only if the trial court withholds discretion or exercises it on grounds clearly unreasonable or untenable. Here, the trial judge exercised discretion and explained the rationale for her decision. She particularly noted that defendant could address the weight of the evidence by presenting his own expert witness and by cross-examining the State's expert. Because of the limited probative value of the evidence, we acknowledge that the Rule 403 determination is a somewhat close question. However, we cannot intervene simply because a different judge might have reached a different result. We conclude that the decision to admit the evidence was not an abuse of discretion.

Id. ¶ 51 (citations omitted).

¶ 21. The DNA match technology has advanced significantly since we described it in Streich. The analysis here was done by the polymerase chain reaction (PCR) method, a method that can be used on much smaller samples than the RFLP method discussed in Streich and for which the results are easier to interpret. Young v. State, 879 A.2d 44, 49-50 (Md. 2005); State v. Coy, 620 N.W.2d 888, 893 (Mich. Ct. App. 2000). If anything, the advancements have solidified the support for DNA analysis so that it is unanimously accepted. See generally, M. Berger, Expert Testimony in Criminal Proceedings: Questions Daubert Does Not Answer, 33 Seton Hall L. Rev. 1125, 1125-29 (2003) (chronicling growth of support for forensic DNA analysis as technology advanced).

¶ 22. With this background, we address the specific questions raised in the appeal, starting with defendant's challenges to both DNA samples. The first issue is whether there was an adequate chain of custody of the samples before they were analyzed. The State generally can meet its burden with respect to the chain of custody by demonstrating that "a sample is sealed and labeled upon collection and received by the technician performing the test in that condition." Dep't of Soc. Welfare v. Miller, 157 Vt. 92, 96, 595 A.2d 288, 290 (1991); see also State v. Comstock, 145 Vt. 503, 507, 494 A.2d 135, 137 (1985) (holding that a chain of custody is sufficient where the evidence arrived at the lab through the mail in the same condition as when the officer prepared it, with seal intact, and where there was "no evidence of tampering with, change in, or confusion of the sample during the mailing"). "The chain need not be perfectly established." State v. Stevens, 137 Vt. 473, 477, 408 A.2d 622, 625 (1979). Instead, the circumstances need establish only "reasonable assurance of the identity of the sample tested." State v. McAllister, 2008 VT 3, ¶ 10, \_\_\_ Vt. \_\_\_, 945 A.2d 863 (quotation omitted).

¶ 23. Defendant made two related arguments in the trial court. First, he argued that the nurse who collected the samples for the rape test kit failed to keep proper records of each step in collecting and storing the samples. We have never held that law-enforcement officers must provide written documentation to ensure an adequate chain of custody, and we see no reason to do so now. Indeed, presented with arguably more troubling circumstances in Stevens, we held that the State established an adequate chain of custody. 137 Vt. at 477, 408 A.2d at 625. In that case, the State produced a tube test kit allegedly containing a breathalyzer sample taken from defendant. The State presented the testimony of an officer who had sealed, labeled, and stored the evidence at the police station, and the State then showed that the evidence had arrived several days later at the state laboratory. There was no evidence of any tampering. In spite of a gap in the account of the sample's whereabouts, we held that a sufficient chain of custody had been established. Id.

¶ 24. Similarly, in State v. Auger, 124 Vt. 50, 196 A.2d 562 (1963), the sample in dispute arrived at the state lab apparently intact and labeled, with the seal unbroken. However, there were no witnesses to certain links in the chain of custody. Nor was there any testimony about who labeled the sample or how the labeling was completed. Nonetheless, we held that a sufficient chain of custody had been established. Id. at 58, 196 A.2d at 567.

¶ 25. Here, the nurse testified that she took the samples according to the rape kit instructions and protocols, air dried the swabs, labeled and sealed them, and handed them over to a state trooper. Through cross-examination of the nurse about actions she took over a year earlier, it was possible for defendant to raise questions and create doubt about the nature and number of the samples taken. Many of these questions could be avoided by better record keeping at the time of sample collection. However, the evidence met our standard and gave reasonable assurance of the identity of the samples. We see no abuse of discretion in the trial court's ruling that the questions defendant raised went to the weight of the evidence, and the State provided an adequate chain of custody for the samples.

¶ 26. We have a similar reaction to the defendant's second allegation of interference with the chain of custody. The Lab mislabeled one of the samples, and shortly thereafter noticed the error and corrected the mislabeling. There were also some typographical errors in the labeling. The

chemist's affidavit described the transcription error and its correction, noting that the correction was not dated because it occurred on the same day as the error and the error was obvious because the label was out of sequence. Again, the evidence met our standard and provided reasonable assurance of the identity of the sample for which the Lab results were given. There was no abuse of discretion in admitting those results.

¶ 27. We respond likewise to defendant's second major area of challenge, that the possibility of contamination of the samples made the results unreliable. Defendant's expert claimed that there was a risk of cross-contamination created by the processing of the swab samples at the same time as the processing of defendant's known sample, and by the storage of the samples in cardboard boxes. The Lab chemist responded in detail, explaining the exact sequence for analyzing the samples and stating that the evidentiary and reference samples were not extracted or analyzed at the same time. He also explained that the storage method, including the storage of cellular material in cardboard boxes, was appropriate and "a routine and generally accepted practice for the storage of swabs." Finally, he noted that he uses reagent blanks, which would indicate if there was contamination; in this case, the reagent blanks showed no contamination. The trial court accepted the Lab chemist's explanations. Again, we find no abuse of its discretion in doing so.

¶ 28. Defendant's third ground with respect to all the samples is that the Lab did not disclose its error rate. Defendant argues that the match probability should be adjusted to reflect the error rate. Thus, defendant argues, the jury cannot meaningfully evaluate the evidence without some numerical assessment of the Lab's performance. See, e.g., People v. Reeves, 109 Cal. Rptr. 2d 728, 751 (App. Ct. 2001) (evaluating same argument). We disagree.

¶ 29. Courts' analyses of the proper way to present match probability have been influenced greatly by two reports by the National Research Council (NRC) published in 1992 and 1996.<sup>[4]</sup> See Coy v. Renico, 414 F. Supp. 2d 744, 762 (E.D. Mich. 2006) (noting that courts have generally followed the statistical analysis of the NRC reports). The 1996 report addressed whether the laboratory error rate should be included in the match probability and determined that it should not. See NRC, The Evaluation of Forensic DNA Evidence 85-87 (1996) (hereinafter NRC Report II), available at [http://www.nap.edu/catalog.php?record\\_id=5141](http://www.nap.edu/catalog.php?record_id=5141). It based its recommendation on four reasons: (1) the relevant issue in a case is the risk of error in that particular case, not generally; (2) it would take an "unrealistically large number of proficiency trials" for a laboratory to generate an error rate; (3) it would be inappropriate to pool error rates across laboratories; and (4) each discovered error leads to a correction that lowers the error rate so it is impossible to accurately measure error rates. Id. at 85-86. Based on these reasons, the report concluded:

[W]e believe that a calculation that combines error rates with match probabilities is inappropriate. The risk of error is properly considered case by case, taking into account the record of the laboratory performing the tests, the extent of redundancy, and the overall quality of the results.

Id. at 87. The report added that the main answer to the possibility of error should be the retesting of samples, not using error rates as part of probability statistics. Id.

¶ 30. The courts have almost uniformly followed the recommendation of the National Research Council. See United States v. Trala, 162 F. Supp. 2d 36, 350 (D. Del. 2001), aff'd, 386 F.3d 536 (3d Cir. 2004); United States v. Shea, 957 F. Supp. 331, 340 (D.N.H. 1997), aff'd, 159 F.3d 37 (1st Cir. 1998); Roberts v. United States, 916 A.2d 922, 930 (D.C. Ct. App. 2007); Reeves, 109 Cal. Rptr. 2d at 751-52. We also note that the effect of adopting defendant's position in this case would not be to change the match probability statistic, but to prevent the introduction of any match probability statistics. The Lab chemist stated in response to the affidavit of defendant's expert that "[t]here is no error rate to report." Apparently, the Lab has not gone through the unreasonable number of proficiency trials discussed in the NRC report. In our view, reporting DNA matches with no probability statistics would be unhelpful and would mislead the jury.

¶ 31. We adopt the recommendation of the NRC report and hold that the laboratory error rate, to the extent it can be known, goes to the weight of the statistical match evidence and not to its admissibility. Defendant was free to cross-examine the Lab witness as to error rates.

¶ 32. We now turn to the issues related solely to the interior vaginal sample. Because the State's witness could give no statistical match probability for this sample, we conclude that it was error to admit it. For this reason, we do not reach the other challenges to the sample—that it was too small for reliable analysis and that it was a mixture of DNA profiles for which analysis is inherently unreliable.

¶ 33. On direct examination, the Lab chemist testified that the 05-2-1 sample contained a "male fraction," consisting of sperm, and a "female fraction," consisting of epithelial cells. He then explained as follows:

[I]n item 05-2-1, the male fraction . . . was a mixture of two individuals, one being male, and the DNA types were consistent with that of the suspect's. It was a partial profile though. The Cofiler kit didn't work optimally, so I didn't get all the alleles that I would expect to have found.

When asked what result was obtained by comparing the 05-2-1 sample with defendant's known sample, he stated that the 05-2-1 sample was "consistent with the suspect's profile." On re-direct, he testified as follows about a match between the 05-2-1 sample and defendant's DNA profile:

We were able to look at the allele[] types that resulted and determined that [defendant] could not be excluded as a contributor to those DNA types. An exclusion occurs if you have an allele that is different. There was nothing there that was different. We had some information that wasn't there, but there was nothing that was different to say that he wasn't a contributor.

¶ 34. Defendant argues that the expert testimony presented by the State—that defendant could not be excluded or that his DNA was consistent with the 05-2-1 sample—is not reliable or relevant under Rule 702 and Daubert. In Streich, we stated that we agreed “with the courts that have held that evidence about the fact of one or more allele matches is not helpful without some evidence about the probability of a match in the population as a whole.” 163 Vt. at 345, 658 A.2d at 48. While we did not directly hold that Rule 702 barred such evidence in Streich, we take that step now.

¶ 35. As with the earlier issue, the NRC reports are helpful. The 1992 report addressed this issue generally: “[t]o say that two patterns match, without providing any scientifically valid estimate (or, at least, an upper bound) of the frequency with which such matches might occur by chance, is meaningless.” NRC, DNA Technology in Forensic Science 74 (1992) (hereinafter NRC Report I), available at [http://www.nap.edu/catalog.php?record\\_id=1866](http://www.nap.edu/catalog.php?record_id=1866). The 1996 report also discussed the issue, but without a specific recommendation:

Certainly, a judge's or juror's untutored impression of how unusual a DNA profile is could be very wrong. This possibility militates in favor of going beyond a simple statement of a match, to give the trier of fact some expert guidance about its probative value. As noted above, however, there are a variety of procedures—qualitative as well as quantitative—that might accomplish this objective.

NRC Report II, at 193.

¶ 36. The courts are divided on the issue, although the majority appears to favor requiring a qualitative or quantitative assessment of the significance of the match. The most thorough analysis of the case law is in People v. Coy, 620 N.W.2d at 896-99. The court in Coy concluded that “absent some analytic or interpretive evidence concerning the likelihood or significance of a DNA profile match, [the expert's] testimony concerning the potential match between defendant's DNA and the DNA in the mixed blood samples found [at the crime scene] was insufficient to assist the jury in determining whether defendant contributed DNA to the mixed sample.” Id. at 898. The decision that best expresses our concerns, in line with our analysis in Streich and Brochu, is Peters v. State, 18 P.3d 1224, 1227-28 (Alaska Ct. App. 2001):

Admitting a DNA profile match without evidence that properly interprets the significance of the DNA match could be very misleading. It is generally known that DNA testing often allows scientists to identify a particular individual from among millions. Because the potential precision of DNA testing is so well known, a jury might assume that any DNA profile match is extremely unlikely and therefore extremely probative. But as explained above, this is not always true. A jury might therefore give undue weight to a DNA profile match in a case where no evidence has been presented showing the significance of the match.

Furthermore, admitting a DNA profile match with improper interpretive evidence may be misleading. For instance, in [the defendant's] case, the expert witness testified that out of the 27,216 possible genotypes that the DNA test could distinguish, only 162 genotypes could not be excluded as sources of the DNA found on [the defendant]. Yet no evidence was introduced showing how common any of these genotypes is. . . . [T]he significance of a DNA profile match varies with the frequency that the genotypes are represented in the general population, not with the absolute number of genotypes.

. . . The State argues that evidence of physical characteristics such as eye color and hair color are routinely admitted in courts without any evidence of their frequency within the general population. But there is a fundamental difference between these physical characteristics and evidence of a DNA profile match. Because jurors can readily observe hair color and eye color within the general population, the jury is presumed to have a grasp of the frequency of these characteristics within the general population. DNA evidence is different. Because a juror is unable to observe a person's DNA, the juror has no idea of the frequency of a particular DNA profile.

See also United States v. Yee, 134 F.R.D. 161, 181 (N.D. Ohio 1991) (“Without the probability assessment, the jury does not know what to make of the fact that the patterns match: the jury does not know whether the patterns are as common as pictures with two eyes, or as unique as the Mona Lisa.”); State v. Carter, 524 N.W.2d 763, 783 (Neb. 1994) (holding that “evidence of a DNA match will not be admissible if it has not been accompanied by statistical probability evidence that has been calculated from a generally accepted method”), overruled on other grounds by State v. Freeman, 571 N.W.2d 276, 293 (Neb. 1997); State v. Cauthron, 846 P.2d 502, 516 (Wash. 1993) (“Testimony of a match in DNA samples, without the statistical background or probability estimates, is neither based on a generally accepted scientific theory

nor helpful to the trier of fact.”), overruled on other grounds by State v. Buckner, 941 P.2d 667, 668 (Wash. 1997). We endorse the analysis of Coy and Peters.

¶ 37. We recognize that in different circumstances some courts have admitted evidence of DNA matches without statistical probability estimates. We highlight these cases only to factually distinguish them from the case before us now, and not to endorse their holdings. We leave to another day whether we would follow them in similar circumstances.

¶ 38. First, consistent with the holding of Coy, some cases have admitted testimony of a match and its qualitative significance without a statistical probability statement. See State v. Hummert, 933 P.2d 1187, 1192-93 (Ariz. 1997) (upholding admission of expert testimony that a “random match would be very uncommon,” even though there was no testimony as to mathematical or statistical probability of a match). In the case before us, there is no testimony regarding the qualitative significance of the match.

¶ 39. Second, in some cases the probability of the identification of a different person is so statistically remote that courts have allowed testimony that the DNA found at the scene came from the defendant. See Young, 879 A.2d at 54-56 (“When the random match probability is sufficiently minuscule, the DNA profile may be deemed unique. In such circumstances, testimony of a match is admissible without accompanying contextual statistics. In place of the statistics . . . the expert may testify that in the absence of identical twins, it can be concluded to a reasonable scientific certainty that the evidence sample and the defendant sample came from the same person.”). The 1996 NRC Report concluded that there is no scientific basis to require statistical testimony in those circumstances. NRC Report II, at 194-95. Here, the risk of misidentification is not statistically remote.

¶ 40. Third, this is not a case in which the DNA evidence is being used to exclude an identification. See State v. Passino, 161 Vt. 515, 525, 640 A.2d 547, 552 (1994) (evaluating the defendant’s claim that exculpatory DNA evidence was wrongfully excluded by the trial court). Here, the State was not using the DNA evidence both to show a match with defendant and to show no match with alternative perpetrators. In such a case, one court allowed the introduction of testimony that two alternative perpetrators’ DNA was inconsistent with the sample and that the defendant’s DNA was consistent with the sample, without requiring testimony on the statistical probability that the defendant was the source of the sample. See State v. McNickles, 753 N.E.2d 131, 142-43 (Mass. 2001).

¶ 41. In summary, we conclude that in the circumstances of this case, the admission of DNA match evidence, without additional evidence of the frequency with which such matches might occur by chance, is error.

¶ 42. Before we examine whether the evidence admission error is harmless, we consider whether the court committed an error in the charge to the jury. On appeal, defendant challenges the following language in the instructions:

On the other hand, if the expert’s opinion is based upon one or more facts that are not supported by the evidence, or if the expert is

dishonest or biased or not qualified, then the expert's testimony may have little or no value.

Defendant argues that the trial court determines whether a witness is qualified as an expert, and that it was inappropriate to allow the jury to reach a contrary conclusion. Because the prosecutor called defendant's expert witness a "hired gun," defendant argues that there was a real risk that the jury acted under the instructions to ignore the witness's testimony. Defendant did not object to this charge prior to the jury deliberations.

¶ 43. Vermont Rule of Criminal Procedure 30 requires that a party object to language in the jury charge "before the jury retires to consider its verdict," as a precondition of challenging the language on appeal. In the absence of a contemporaneous objection, we can review only for plain error. See *State v. Deyo*, 2006 VT 120, ¶ 7, 181 Vt. 89, 915 A.2d 249. We find plain error only in extraordinary circumstances where the error affects defendant's constitutional rights or results in a miscarriage of justice. *Id.*

¶ 44. We are unable to find plain error here. Under Vermont Rule of Evidence 702, the trial court found defendant's witness on DNA, Dr. Riley, to be an expert and allowed him to give an opinion on the Lab's handling of DNA samples and analysis of those samples. There was no contest that his education, knowledge, and experience allowed him to give those opinions. The State did not claim that the witness was unqualified, but instead labeled him a hired gun because he routinely testifies for the defense in criminal cases and was paid a significant amount of money for his testimony in this case. The weight to be accorded evidence, including the testimony of an expert witness, is determined by the jury, and we have noted that "expert testimony has no greater probative weight because of the expertise." Reporter's Notes, V.R.E. 702. We see no reason why the jury cannot consider the qualifications of the expert in determining the weight of the expert's testimony. Moreover, even if the instruction were error, we fail to see how it could rise to the level of plain error. The jury heard no dispute over Dr. Riley's qualification to give the opinions he did; the State's argument went to his bias and credibility, and not to his qualifications. There was no plain error.

¶ 45. We return to the error in the admission of the DNA analysis of the interior vaginal sample. We must examine whether the error was harmless, as claimed by the State. *Streich*, 163 Vt. at 346; 658 A.2d at 49; see also V.R.Cr.P. 52(a). In doing so, we must look to what a reasonable jury might have done without the offending evidence, not what we would have done in the fact finder's place. *Lipka*, 174 Vt. at 385, 817 A.2d at 34. Our standard for harmless error is the same whether the error is constitutional or not—the error must be harmless beyond a reasonable doubt. *State v. Lemay*, 2006 VT 76, ¶ 10, 180 Vt. 133, 908 A.2d 430. Where the error is the erroneous admission of evidence, we must apply this standard by imagining a trial in which the evidence is not admitted. *State v. Lynds*, 158 Vt. 37, 42, 605 A.2d 501, 503 (1991). In assessing harm, we use four factors: the importance of the evidence in the prosecution's case, the cumulativeness of the evidence, the extent of cross-examination, and the overall strength of the prosecution's case. *Id.* at 42, 605 A.2d at 503 (citing *Delaware v. Van Arsdall*, 475 U.S. 673, 684 (1986)).

¶ 46. We begin with the importance of the evidence to the prosecution’s case. To establish defendant’s guilt, the State had to show that he had “engage[d] in a sexual act with another person” and that “[t]he other person [wa]s under the age of 16.” 13 V.S.A. § 3252(a), (a)(3). A “sexual act” is defined as:

conduct between persons consisting of contact between the penis and the vulva, . . . or any intrusion, however slight, by any part of a person’s body or any object into the genital or anal opening of another.

13 V.S.A. § 3251(1). The interior vaginal sample was offered to prove some form of intrusion or penetration. The exterior labia sample, which had a very high statistical correlation as a match, showed contact between defendant’s penis and S.G.’s labia but did not show “any intrusion . . . into [her] genital or anal opening.” *Id.*

¶ 47. There was other important laboratory and medical evidence at the trial. The hospital nurse indicated that she did an examination of S.G.’s vagina and found that the bottom part of the vagina was “red” and that the vaginal wall was “very red and tender.” She testified that this “bruising” was an indication of “forced sexual activity.” The Lab determined that the interior vaginal swab had male semen on it, showing the presence of semen in S.G.’s vagina.

¶ 48. The State’s primary evidence was the testimony of M.M. and S.G. S.G. testified that defendant pulled her on top of him, that he said he was going to “come,” and that she experienced pain as he withdrew his penis from her vagina. For her part, M.M. testified that she had seen defendant having sex with S.G. inside of his tent. Both girls testified to having been extremely intoxicated, and as noted above, some of their testimony proved to be inherently contradictory. Defendant did not testify, so this case does not involve a direct credibility contest between the two girls and the defendant.

¶ 49. We would judge the interior vaginal DNA evidence of some significance in the prosecution’s case, but not of critical significance. This weighting is apparent from the State’s closing argument to the jury. The State mentioned the match of the interior vaginal sample once briefly in its closing argument. The prosecutor relied much more on the other scientific evidence and on the testimony of the two girls and the other woman at the campsite.

¶ 50. With respect to the next harmless error factor, the match evidence was generally not cumulative for the purpose it was offered. Analysis of the other swab showed defendant’s DNA on S.G.’s exterior labia, but not internally where it would have been present as a result of penetration. The presence of semen showed penetration, but not necessarily by defendant.

¶ 51. With respect to the third harmless error factor, defendant was able to use cross-examination to show the limited significance of the match. In defense counsel’s closing argument, he noted that the State could not place defendant’s DNA inside S.G.’s vagina.

¶ 52. The final harmless error factor is the overall strength of the State’s case without the offending DNA evidence. We conclude that the State had a strong case without the improperly admitted DNA evidence. While there were conflicts in the testimony of the two girls, both testified that there was penetration. S.G.’s immediate reporting of the incident to the woman at the campground supported her story. More importantly, the nurse’s examination and report of forced penetration was significant support for the testimony that there was penetration. S.G.’s testimony was supported by the presence of semen in her vagina; there was no evidence indicating that there had been an alternative source of semen. S.G.’s testimony was also supported by the presence of DNA on her labia matched to defendant by a very high probability statistic.

¶ 53. The most similar Vermont case to the one before us is State v. Oscarson, 2004 VT 4, 176 Vt. 176, 845 A.2d 337, also a case in which the trial court improperly admitted evidence. In Oscarson, a child sexual-assault case, we held that the evidentiary error was harmless as to one sibling victim, but not as to the other. 2004 VT 4, ¶¶ 35, 42. The erroneous evidence was the testimony of the child victim, for whose assault we reversed the conviction. In reaching our decision, we noted that the most important factors are the strength of the State’s evidence without the erroneously admitted evidence and the strength of the erroneously admitted evidence. Id. ¶ 32. With regards to the conviction we reversed, we concluded that these factors pointed in opposite directions: while the strength of the State’s evidence without the offending evidence was strong, the strength of the erroneously admitted evidence was also strong because it was a graphic, detailed description of the assaults by the victim. Id. ¶¶ 41, 42. Because of the strength of the erroneously admitted evidence, we found that its admission was not harmless. Id. ¶ 43 (“Given the explicit, highly detailed and graphic nature of [the victim’s] hearsay statements, we find this evidence simply too damaging and too explicit to say that it was ignored by the jury in favor of [his sibling’s] barebones affirmance of the abuse, or the limited circumstantial evidence.”).

¶ 54. Turning to out-of-state cases, in State v. Carter, the trial court had admitted DNA evidence with a statistical probability analysis, but the Supreme Court of Nebraska rejected that admission because of the methodology employed. 524 N.W.2d at 783. The State’s witness testified that approximately ten percent of the African American population had DNA that matched the sperm sample found in a stain on the victim’s clothing. In reversing the conviction, the Court held that the DNA match was not admissible without statistical frequency evidence and that the statistical frequency evidence testified to was inadmissible because the calculation method was not generally accepted in the relevant scientific community. Id. The State argued that the error was harmless given the non-DNA evidence against defendant. In rejecting this argument, the Court noted that defendant had presented no expert testimony “to contest or question the procedures or findings of the prosecution’s DNA witness.” Id. Because of this unusual circumstance and “the highly prejudicial nature of DNA evidence,” the Court held that it could not conclude that the admission of the evidence was harmless beyond a reasonable doubt. Id.

¶ 55. We acknowledge that the question of whether the error was harmless in this case is close, exactly because we cannot know whether the jury placed undue significance on the erroneously admitted DNA evidence, the main concern in Carter. Nevertheless, for a number of

reasons, we conclude that the admission of the evidence was harmless in this case. First, we believe that the State's case without the erroneously admitted evidence is stronger here than in either Oscarson or Carter. The testimony of the girls and the corroborative witness at the campground, together with the results of the physical examination and the properly admitted lab results gave the State an independently convincing case. Further, the credibility of the girls and the corroborative witness went unchallenged as the defendant did not testify.

¶ 56. Second, and unlike in Oscarson, the strength of the erroneously admitted evidence is limited. While the State relied upon the evidence, it did so only secondarily to the other evidence in the case. The State's position reduced the risk that the jury would give the evidence undue weight.

¶ 57. Finally, and unlike in Carter, defendant vigorously attacked the DNA evidence through an expert witness. The jury heard strong testimony that it should rely on the DNA evidence cautiously, if at all. Again, the presence of this testimony reduced the risk that the jury would give undue weight to the erroneously admitted evidence.

¶ 58. Necessarily, every evaluation of whether we can conclude beyond a reasonable doubt that the erroneous admission of evidence is harmless requires a specific evaluation of the facts before us. When we do so in this case, we conclude that the relevant standard of harmlessness has been met.

Affirmed.

FOR THE COURT:

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Associate Justice

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[1] Defendant was charged under former § 3252(a)(3). This subsection was amended and moved to § 3252(c) by 2005, No. 192 (Adj. Sess.), § 10, effective May 26, 2006.

[2] The day before trial, defendant also filed a motion in limine seeking to exclude the testimony of the woman as to statements made to her by S.G. and M.M. as inadmissible hearsay. The court denied this motion, concluding that the statements were admissible as excited utterances. Because defendant does not challenge this ruling here, we do not consider it further.

[3] As explained in Streich, “[t]he DNA molecule is composed of 3 billion ‘base pairs’ of four different chemicals, and the particular order or pattern of these base pairs dictates genetic characteristics. Because 99% of the DNA molecule is the same for all humans, DNA profiling focuses on those areas of the DNA molecule where there is significant differentiation of the base pair pattern. These areas of significant differentiation are called ‘polymorphic,’ and base pair patterns in polymorphic areas are called ‘alleles.’ ” 163 Vt. at 337, A.2d at 43.

[4] The National Research Council functions under the National Academy of Sciences, the National Academy of Engineering and the Institute of Medicine, pursuant to Congressional charter. See <http://sites.nationalacademies.org/nrc/index.htm>. Its mission “is to improve government decision making and public policy, increase public education and understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health.” Id. The 1996 NRC report was drafted by the Committee on DNA Forensic Science, made up primarily of academics, including law professors. See <http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=5141>.