Probabilistic Reasoning in *Navarette v. California*

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ABSTRACT

In *Navarette v. California*, the U.S. Supreme Court, in a 5–4 decision authored by Justice Thomas, rejected a Fourth Amendment challenge to an investigative traffic stop on the grounds that a prior 911 call, in which the caller reported that she had been run off the road by a pickup truck, gave rise to reasonable suspicion that the driver of the truck was intoxicated. Writing for the dissent, Justice Scalia argued that the majority could not infer from the 911 call that the driver was drunk, unless it had some basis in reality to believe that the proportion of reckless traffic violations attributable to drunk drivers is at least 1 in 20. In this Essay, I mark the extraordinary occasion of a U.S. Supreme Court Justice quantifying the reasonable suspicion standard by using the best available data to estimate the conditional probability that the driver of the truck was drunk, given the 911 call. I find that the probability is less than 1 in 20, and indeed closer to 1 in 100. After presenting my analysis, I highlight three important caveats and then close with a brief discussion of the controversial issue of quantification of standards of proof.

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62 UCLA L. Rev. Disc. 158 (2014)

TABLE OF CONTENTS

INTRODUCTION

On April 22, 2014, the U.S. Supreme Court decided *Navarette v. California*.[1]

Six years earlier, on Saturday, August 23, 2008, the police arrested the petitioners, Lorenzo and Jose Navarette, two brothers in their midtwenties,[2] following an investigative traffic stop. The question presented in the case was whether the police had reasonable suspicion of ongoing criminal activity sufficient to justify the stop.

A 911 call placed at 3:47 p.m. prompted the traffic stop. The caller reported that a Silver Ford 150 pickup truck, with license plate 8D94925, was traveling southbound on California Highway 1 and had run her off the road five minutes earlier at mile marker eighty-eight. The police located the truck thirteen minutes later near mile marker sixty-nine, followed it for five minutes, and then executed the stop at 4:05 p.m. As the police approached the truck, they smelled marijuana. A search of the truck bed uncovered thirty pounds of marijuana, and the police arrested both men for transportation of marijuana.

The petitioners argued that the traffic stop violated the Fourth Amendment because the police lacked reasonable suspicion of ongoing criminal activity. Both the trial court and the California appellate court disagreed. The California Supreme Court denied review.

In a 5–4 decision, the U.S. Supreme Court held that the traffic stop complied with the Fourth Amendment. Justice Thomas, writing for the majority, framed the central inquiry as "whether the 911 caller's report of being run off the roadway created reasonable suspicion of an ongoing crime such as drunk driving as opposed to an isolated episode of past recklessness."[3] The majority concluded that, in light of the 911 call, the police had reasonable suspicion that the driver of the truck, Lorenzo Navarette, was intoxicated.

Writing for the dissent, Justice Scalia reframed the central inquiry of the case in probabilistic terms.

> I fail to see how reasonable suspicion of a *discrete instance* of irregular or hazardous driving generates a reasonable suspicion of *ongoing in-*

1. 134 S. Ct. 1683 (2014). Unless noted otherwise, the opinion of the Court is the source of the facts and prior history of the case that I recite below.
2. The Court's opinion does not state the petitioners' ages at the time of their arrest. I ascertained this information through personal communication with the petitioners' counsel. Letter from Paul Kleven to author (May 2, 2014) (on file with author).
3. *Navarette*, 134 S. Ct. at 1690.

> *toxicated driving*. What proportion of the hundreds of thousands—perhaps millions—of careless, reckless, or intentional traffic violations committed each day is attributable to drunken drivers? I say 0.1 percent. I have no basis for that except my own guesswork. But unless the Court has some basis in reality to believe that the proportion is many orders of magnitude above that—say 1 in 10 or at least 1 in 20—it has no grounds for its unsupported assertion that the tipster's report in this case gave rise to a *reasonable suspicion* of drunken driving.[4]

For the sake of argument, let us assume that Justice Scalia is correct about the applicable legal standard. That is, let us assume that, as a matter of law, the 911 call could give rise to a reasonable suspicion of drunk driving only if the proportion of reckless traffic violations attributable to drunk drivers is at least 1 in 20. (Of course, quantifying a standard of proof such as reasonable suspicion is controversial; although it is not my focus, I include a few words about the quantification issue in my concluding remarks.) The key question, then, is whether there is a basis in reality to believe that the proportion of reckless traffic violations attributable to drunk drivers is at least 1 in 20.

In what follows, I argue that the answer is no. Indeed, I argue that there is reason to believe that the proportion is less than 1 in 20, and closer to 1 in 100. After presenting my baseline analysis, I highlight three important caveats, two of which run counter to my answer, but the other of which runs decidedly in favor.

I. BASELINE ANALYSIS

Let R denote the event of a reckless traffic violation. Let D denote the event of a drunk driver. The proportion of reckless traffic violations attributable to drunk drivers is

$$\frac{P(R \cap D)}{P(R)},$$

where $P(R \cap D)$ denotes the joint probability of R and D (the probability of a reckless traffic violation and a drunk driver) and $P(R)$ denotes the probability of R (the probability of a reckless traffic violation).

4. *Id.* at 1695 (Scalia, J., dissenting) (emphasis in original).

By the definition of conditional probability,

$$\frac{P(R \cap D)}{P(R)} = P(D|R),$$

where $P(D|R)$ denotes the conditional probability of D given R (the probability of a drunk driver given a reckless traffic violation). This is what we are after—we want to know the probability that the driver of the pickup truck was drunk given that the truck was involved in a reckless traffic violation.

According to Bayes' theorem,

$$P(D|R) = \frac{P(R|D)P(D)}{P(R|D)P(D) + P(R|{\sim}D)P({\sim}D)},$$

where $P(R|D)$ is the conditional probability of R given D (the probability of a reckless traffic violation given a drunk driver), $P(R|{\sim}D)$ is the conditional probability of R given not D (the probability of a reckless traffic violation given a sober driver), $P(D)$ is the probability of D (the probability of a drunk driver), and $P({\sim}D)$ is the probability of not D (the probability of a sober driver).

Dividing the numerator and denominator by $P(R|{\sim}D)P(D)$, we have

$$P(D|R) = \frac{\dfrac{P(R|D)}{P(R|{\sim}D)}}{\dfrac{P(R|D)}{P(R|{\sim}D)} + \dfrac{P({\sim}D)}{P(D)}}.$$

The term $P(R|D)/P(R|{\sim}D)$ is the relative risk of a reckless traffic violation given a drunk driver. That is, it is the risk of a reckless traffic violation given a drunk driver relative to the risk of a reckless traffic violation given a sober driver. The term $P({\sim}D)/P(D)$ is the reciprocal odds of a drunk driver, or the odds of a sober driver.[5]

The events in *Navarette* took place in California. Under California law, both today and in 2008, a driver of a noncommercial motor vehicle who is twenty-one years old or older is legally drunk if his blood alcohol concentration (BAC)

5. The odds of an event are the probability of the event divided by the probability of its complement. For example, the probability of drawing an ace from a deck of cards is $^1/_{13}$, and the probability of its complement, not drawing an ace, is $^{12}/_{13}$. Hence, the odds of drawing an ace are $^1/_{12}$.

equals or exceeds 0.08 grams per deciliter (g/dL).[6] For our purposes, therefore, a driver is drunk if his BAC is 0.08 g/dL or higher.

The 911 call gave the police two relevant facts: (1) the incident took place in the daytime and (2) the vehicle was a pickup truck. According to data from the 2007 National Roadside Survey (NRS), a national field survey of alcohol- and drug-involved driving sponsored by the National Highway Traffic Safety Administration (NHTSA) and conducted by the Pacific Institute for Research and Evaluation (PIRE), 0.1 percent of daytime drivers of pickup trucks have a BAC of 0.08 g/dL or higher and are, therefore, legally drunk.[7] Taking this as our estimate of the probability of a drunk driver, we have

$$P(D) = \frac{1}{1000} \qquad \text{and} \qquad P(\sim D) = \frac{999}{1000}.$$

Thus, I estimate that the odds of a sober driver are 999 to 1:

$$\frac{P(\sim D)}{P(D)} = 999.$$

According to estimates from a PIRE study that links the 2007 NRS weekend nighttime data to 2006–2007 weekend nighttime data from the Fatality Analysis Reporting System (FARS), an annual nationwide census of fatal motor vehicle traffic crashes compiled by NHTSA, the relative risk of a fatal two-vehicle crash given a driver with a positive BAC (BAC ≥ 0.005 g/dL) is given by

$$RR(\text{BACR}) = e^{0.022 \times \text{BACR}},$$

where BACR is merely BAC rescaled to milligrams per deciliter (BACR = BAC x 1000).[8] Note that *RR*(BACR) gives the risk relative to a driver of the same gender and age with a zero BAC (BAC < 0.005 g/dL).

6. CAL. VEH. CODE § 23152 (2014), *available at* http://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=VEH&sectionNum=23152.

7. JOHN H. LACEY ET AL., 2007 NATIONAL ROADSIDE SURVEY OF ALCOHOL AND DRUG USE BY DRIVERS: ALCOHOL RESULTS 51 tbl.51 (2009), *available at* http://ntl.bts.gov/lib/31000/31600/31643/811248.pdf.

8. Robert B. Voas et al., *Alcohol-Related Risk of Driver Fatalities: An Update Using 2007 Data*, 73 J. STUD. ON ALCOHOL & DRUGS 341, 345 tbl.2 (2012), *available at* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3316710/pdf/jsad341.pdf.

Assuming that the relative risk of a weekend daytime nonfatal two-vehicle near-crash (the reckless traffic violation in *Navarette*) is proportional to the relative risk of a weekend nighttime fatal two-vehicle crash (*RR*(BACR)),[9] we have

$$\frac{P(R|D)}{P(R|\sim D)} = \frac{\int_{80}^{150} e^{0.022\times\mathrm{BACR}}\, dF(\mathrm{BACR})/[F(150)-F(80)]}{\int_{0}^{80} e^{0.022\times\mathrm{BACR}}\, dF(\mathrm{BACR})/[F(80)-F(0)]},$$

where F is the unknown cumulative distribution function of BACR,[10] and it is assumed that a driver's maximum BAC is 0.15 g/dL.

I assume that a driver's maximum BAC is 0.15 g/dL for two reasons. First and foremost, according to the 2007 NRS daytime data, virtually no daytime drivers have a BAC of 0.15 g/dL or higher.[11] Second, according to the 2007 NRS nighttime data, which PIRE uses to estimate *RR*(BACR), fewer than 0.5 percent of nighttime drivers have a BAC of 0.15 g/dL or higher; hence, integrating over BAC levels in excess of 0.15 g/dL would involve extrapolation beyond the range of the data used to estimate *RR*(BACR), which would bias our estimate of $P(R|D)/P(R|\sim D)$ if *RR*(BACR) does not hold outside that range.

Let us assume that F is the lognormal cumulative distribution function.[12] That is, let us assume that the logarithm of BAC follows a normal distribution. This is a natural assumption because BAC is nonnegative and positively skewed.[13]

We can use data from the 2007 NRS to calibrate F. According to the 2007 NRS data, 99.4 percent of daytime drivers of pickup trucks have a BAC lower than 0.005 g/dL and, as noted previously, 0.1 percent have a BAC of 0.08 g/dL or higher.[14] We can use these two data points to calculate the two unknown parameters that characterize F, namely the mean μ and standard deviation σ. Set

$$F(5;\ \mu,\sigma) = 0.994 \text{ and } F(80;\ \mu,\sigma) = 0.999.$$

9. This is a reasonable assumption provided that (1) the effects of alcohol on driving skills are roughly the same in daytime and nighttime and (2) when driving skills are impaired the percentage increases in the risks of nonfatal near crashes and fatal crashes are roughly the same, both of which are quite plausible.
10. A cumulative distribution function, $F(x)$, describes the probability that a variable (like BACR) takes on a value less than or equal to any given number x.
11. LACEY ET AL., *supra* note 7, at 47 tbl.46.
12. The lognormal cumulative distribution function is given by
$F(x;\mu,\sigma) = \frac{1}{2}\left[1+\mathrm{erf}\left(\frac{\ln x-\mu}{\sqrt{2}\sigma}\right)\right]$, where $\mathrm{erf}(z) = \frac{2}{\sqrt{\pi}}\int_0^z e^{-t^2}\,dt$.
13. *See infra* Table 1 and accompanying text.
14. LACEY ET AL., *supra* note 7, at 51 tbl.51.

This is a system of two equations in two unknowns. Solving the system,[15] we find

$$\mu = -10.4391 \text{ and } \sigma = 4.7961.$$

Table 1 shows how well our calibrated F fits the 2007 NRS data.

TABLE 1. Fit of Calibrated *F*

	Percent of Daytime Drivers of Pickup Trucks, by BAC		
	Less than 0.005 g/dL	Between 0.005 g/dL and 0.08 g/dL	Greater than 0.08 g/dL
2007 NRS data	99.4	0.5	0.1
Calibrated F	99.4	0.5	0.1

Using our calibrated F, we have

$$\frac{P(R|D)}{P(R|{\sim}D)} = 12.0949.$$

In other words, I estimate that the relative risk of a reckless traffic violation, consistent with the facts of the 911 call, given a legally drunk driver is approximately 12 to 1.

Given my estimates of the odds of a sober driver and of the relative risk of a reckless traffic violation given a drunk driver, I can now estimate the primary object of interest—the conditional probability of a drunk driver given a reckless traffic violation, again consistent with the facts of the 911 call.

$$P(D|R) = \frac{\frac{P(R|D)}{P(R|{\sim}D)}}{\frac{P(R|D)}{P(R|{\sim}D)} + \frac{P({\sim}D)}{P(D)}} = \frac{12.0949}{12.0949 + 999} = 0.0120.$$

In sum, I estimate that, given the 911 call, the conditional probability that the driver of the pickup truck was legally drunk was 1.2 percent, or approximately 1 in 83. This is less than Justice Scalia's proposed standard of 1 in 20.

It is important to note that my baseline estimate of $P(D|R)$ is subject to the statistical uncertainty in the data that I use to estimate $P({\sim}D)/P(D)$ and calibrate

15. I used MATLAB to perform all computations. My MATLAB program code is available upon request.

F and in the data that PIRE uses to estimate RR(BACR). I cannot account for the former,[16] but I can account for the latter as the PIRE study reports the standard error of the coefficient on BACR.[17] Using this information to compute a 95 percent confidence interval for $P(D|R)$, I find that the upper bound is 0.0238, which is also less than 1 in 20.

II. THREE CAVEATS

There are three important caveats of my baseline analysis.

The first caveat is that my baseline analysis does not take into account two additional relevant facts that we know about Lorenzo Navarette, the driver of the pickup truck. Specifically, we know that Lorenzo is male and that he was in his midtwenties at the time. My baseline analysis does not take these facts into account because the 911 call did not relate them to the police. But the police may have learned these facts before they executed the traffic stop, perhaps from matching the truck's license plate to the truck's owner or through visual observation of Lorenzo during the five minutes that they followed the truck. Taking these facts into account increases my estimate of $P(D|R)$.

According to the 2007 NRS data, 98.71 percent of males age 21–34 driving pickup trucks in the daytime have a BAC lower than 0.005 g/dL and 0.65 percent have a BAC of 0.08 g/dL or higher.[18] Using these points to reestimate $P({\sim}D)/P(D)$ and $P(R|D)/P(R|{\sim}D)$, and after recalibrating F, I find that $P(D|R) = 0.0756$, or roughly 1 in 13. This is greater than Justice Scalia's proposed standard of 1 in 20. It is important to note, however, that the lower bound of the 95 percent confidence interval is 0.0393, or roughly 1 in 25. Hence, we cannot reject the hypothesis that $P(D|R)$ is less than 1 in 20 at the five percent level of significance.[19]

The second caveat goes to the suitability of 2007 NRS daytime data. Each daytime survey in the 2007 NRS was administered during work hours on a Friday, whereas the events in *Navarette* took place in the afternoon on a Saturday, when we might expect a greater frequency of drunk driving. Thus, it is

16. LACEY ET AL., *supra* note 7, do not report standard errors for the BAC distribution among daytime drivers of pickup trucks.
17. The standard error is 0.003. Voas et al., *supra* note 8.
18. The report by LACEY ET AL., *supra* note 7, does not provide this information. I ascertained this information through personal communication with the report's lead author. Letter from John H. Lacey to author (June 4, 2014) (on file with author).
19. I hasten to add that the size of the reestimation sample is small (N=49) relative to the size of the baseline sample (N=367), and thus the reestimate of $P(D|R)$ is subject to greater statistical uncertainty.

possible that I have overestimated $P(\sim D)/P(D)$ and underestimated $P(R|D)/P(R|\sim D)$, and thereby underestimated $P(D|R)$.[20] Although I do not have data on the frequency of drunk driving on weekend afternoons, I have the 2007 NRS data for weekend nights, when the frequency of drunk driving is the greatest. Using these weekend nighttime data—specifically, the data for males age 21–34 driving pickup trucks—I can estimate an upper bound on $P(D|R)$. I estimate that it is 0.2591, or roughly 1 in 4. It is important to note, however, that this upper bound is not tight—the true $P(D|R)$ is surely lower, as the frequency of drunk driving on a weekend afternoon is surely lower than it is on a weekend night.[21]

While the first and second caveats run counter to my conclusion that $P(D|R)$ is less than 1 in 20, the third caveat runs decidedly in favor.

There is an important fact, previously not taken into account, which suggests that even my baseline estimate of $P(D|R)$ overstates the probability that Lorenzo Navarette was legally drunk. Recall that after receiving the 911 call but before executing the traffic stop, the police followed the pickup truck for five minutes. During that time, "Lorenzo's driving was irreproachable."[22] Given this fact, the probability that Lorenzo Navarette was legally drunk was surely less than the probability for the average daytime driver of a pickup truck; indeed, it ostensibly was all but zero. After all, a person's "ability to drive a motor vehicle is severely impaired" when he is legally drunk.[23] In particular, a drunk driver predictably has difficulty steering, controlling his speed, and maintaining his lane position.[24] Indeed, research indicates that a driver's tracking ability, meaning his ability to control and maintain position relative to changes in the driving environment, is quite sensitive to alcohol. Drinking impairs a driver's tracking ability at BAC levels as low as 0.0018 g/dL and consistently at BAC levels of 0.05 g/dL and higher.[25]

20. Observe that $P(D|R)$ is decreasing in $P(\sim D)/P(D)$ and increasing in $P(R|D)/P(R|\sim D)$.

21. An upper bound on a set of numbers is tight if it is the smallest number that is greater than or equal to every number in the set. For example, whereas 1 and 2 are both upper bounds on the set of all fractions, 1 is tight and 2 is not.

22. Navarette v. California, 134 S. Ct. 1683, 1696 (2014) (Scalia, J., dissenting).

23. *Id.* at 1697 (citing AMITAVA DASGUPTA, THE SCIENCE OF DRINKING: HOW ALCOHOL AFFECTS YOUR BODY AND MIND 39 (2011)); *see also* NAT'L INST. ON ALCOHOL ABUSE AND ALCOHOLISM, ALCOHOL OVERDOSE: THE DANGERS OF DRINKING TOO MUCH 2 (2013), *available at* http://pubs.niaaa.nih.gov/publications/AlcoholOverdoseFactsheet/Overdosefact.htm.

24. *Impaired Driving: Effects of Blood Alcohol Concentration*, CTR. FOR DISEASE CONTROL AND PREVENTION, http://www.cdc.gov/Motorvehiclesafety/Impaired_Driving/bac.html (last updated Feb. 11, 2011).

25. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., A REVIEW OF THE LITERATURE ON THE EFFECTS OF LOW DOSES OF ALCOHOL ON DRIVING-RELATED SKILLS § 3.2.5 (2000), *available at* http://www.nhtsa.gov/people/injury/research/pub/hs809028/title.htm.

This point was not lost on Justice Scalia.

> It gets worse. Not only, it turns out, did the police have no good reason *at first* to believe that Lorenzo was driving drunk, they had very good reason *at last* to know that he was not. The Court concludes that the tip . . . produced reasonable suspicion that the truck not only had been *but still was* barreling dangerously and drunkenly down Highway 1. In fact, alas, it was not, and the officers knew it. They followed the truck for five minutes, presumably to see if it was being operated recklessly. . . . But . . . for the five minutes that the truck was being followed (five minutes is a *long* time), Lorenzo's driving was irreproachable. . . . Consequently, the tip's suggestion of ongoing drunken driving (if it could be deemed to suggest that) not only went uncorroborated; it was affirmatively undermined.
>
> [T]he officer's observation *discredited* the informant's accusation: The crime was supposedly occurring (and would continue to occur) in plain view, but the police saw nothing. . . . The tip's implication of continuing criminality, already weak, grew even weaker.[26]

CONCLUDING REMARKS

In closing, let me say a few words about the issue of quantifying standards of proof. The U.S. Supreme Court has consistently resisted quantification of standards such as reasonable suspicion and probable cause,[27] and the lower courts have followed suit.[28] Meanwhile, legal scholars have continued to debate the pros and cons of quantification.[29] I do not take a stand on quantification in this Essay. Instead, I mark the extraordinary occasion of a U.S. Supreme Court Justice quantifying the reasonable suspicion standard by using the best available data to attempt

26. *Navarette*, 134 S. Ct. at 1696 (Scalia, J., dissenting) (emphasis in original) (citations omitted).
27. *See, e.g.*, Florida v. Harris, 133 S. Ct. 1050, 1055 (2013); Maryland v. Pringle, 540 U.S. 366, 370–72 (2003); Ornelas v. United States, 517 U.S. 609, 695–96 (1996); Illinois v. Gates, 462 U.S. 213, 231 (1989); Brinegar v. United States, 338 U.S. 160, 175–76 (1949).
28. *See, e.g.*, United States v. Ludwig, 641 F.3d 1243, 1251–52 (10th Cir. 2011); United States v. Humphries, 372 F.3d 653, 657–58 (4th Cir. 2004); United States v. McCrae, No. 07-CR-772 (JG), 2008 WL 115383, at *3 (E.D.N.Y. Jan. 11, 2008). *But see* United States v. Copeland, 369 F. Supp. 2d 275, 286–88 (E.D.N.Y. 2005) (quantifying the reasonable probability standard for prejudice in a deportation hearing).
29. *Compare, e.g.*, Orin S. Kerr, *Why Courts Should Not Quantify Probable Cause*, *in* THE POLITICAL HEART OF CRIMINAL PROCEDURE: ESSAYS ON THEMES OF WILLIAM J. STUNTZ (Michael Klarman, David Skeel & Carol Steiker eds., 2012), *with* Peter Tillers & Jonathan Gottfried, *Case Comment*—United States v. Copeland, *369 F. Supp. 2d 275 (E.D.N.Y. 2005): A Collateral Attack on the Legal Maxim that Proof Beyond a Reasonable Doubt is Unquantifiable?*, 5 LAW, PROBABILITY & RISK 135 (2006).

to answer whether the proposed standard is met under the facts of the case. If nothing else, I believe it is an instructive exercise that illustrates the nature of legal analysis under a quantified standard of proof: rigorous and transparent but necessarily subject to assumptions and data limitations.