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The Consequences of Providing Drinkers with Blood Alcohol Concentration Information on Assessments of Alcohol Impairment and Drunk-Driving Risk*

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Abstract

Objective—We examined the effect of providing drinkers with blood alcohol concentration (BAC) information on subjective assessments of alcohol impairment and drunk-driving risk.

Method—We sampled 959 drinking participants from a natural drinking environment and asked them to self-administer a personal saliva-based alcohol test. Participants then were asked to rate their alcohol impairment and to indicate whether they could drive legally under one of four BAC feedback conditions (assigned at random): (1) control condition (no BAC feedback provided before the ratings); (2) categorical BAC information (low, high, and highest risk) from the saliva test; (3) categorical BAC information corroborated by a calibrated police breath alcohol analyzer; and (4) precise (three-digit) BAC information from the breath alcohol analyzer.

Results—Both control participants and participants who received precise BAC feedback gave subjective impairment ratings that correlated with actual BACs. For participants who received categorical BAC information from the saliva test, subjective impairment did not correlate with the actual BAC. Providing drinkers with BAC information, however, did help them predict more accurately if their BAC was higher than the legal BAC driving limit.

Conclusions—Although BAC information can influence drinkers' assessments of alcohol impairment and drunk-driving risk, there is no strong evidence that personal saliva-based alcohol tests are particularly useful.

Widmark's (1932) pioneering work on quantifying the level of alcohol in blood allowed illegal impaired driving to be defined in terms of blood alcohol concentration (BAC); since that time, safety specialists have expressed concern about the absence of a method for a driver to measure his or her own BAC (Borkenstein et al., 1974). Those who oppose lower BAC limits argue that it is practically impossible for a drinker to determine his or her status with respect to the law. However, when both the driver's BAC and the legal driving limit for BAC are known, drivers presumably will make more rational choices when weighing the risks associated with driving after drinking.

Several studies have been conducted of drinkers' ability to estimate their own BAC levels (Beirness, 1984, 1987; Lansky et al., 1978a; Martin et al., 1991; Vogel-Sprott, 1974, 1975;).

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These studies suggest that individuals rely on internal sensations or on counting drinks to make their estimates, which often are different from their actual BAC levels. Beirness et al. (1993) found that drivers with BAC levels higher than the legal BAC limit overwhelmingly underestimated their actual BACs, suggesting that heavy-drinking individuals, if left to their own judgments, may be at high risk for assuming they can drive legally when they cannot. There is a reasonable argument that the drinking public could make more rational decisions about driving after drinking if they could accurately measure their BAC levels. Nevertheless, few studies have examined the effect of BAC estimation tools on impaired driving, and, to our knowledge, no research has investigated how BAC feedback affects drinkers' perceptions of their impairment and their risk of arrest for driving under the influence (DUI).

Tools for estimating BACs

Many attempts have been made to provide the public with informational materials and test devices to calculate or measure their own BAC levels. These have included "Know Your Limit" cards with matrixes with which drinkers can cross-index their weight and drink count to obtain an estimated BAC, and public use, coin-operated breath-test machines placed in drinking establishments (Breakspere, 1986; Haworth et al., 1997; Mackiewicz, 1989; Picton, 1979; Preece, 1995; Wundersitz, 2002). Small, handheld, electronic breath testers using semiconductors (earlier models) or fuel cells (such as modern police handheld breath alcohol analyzers) are available and can be accurate; however, they are expensive and require regular calibration to yield reliable results.

Recently, research on the use of saliva as a sample medium for detecting alcohol has yielded a variety of inexpensive, disposable, and portable personal alcohol testers. These tests, in general, include a paper test strip treated with a chemical that reacts with ethanol. Test-takers expose the test strip to saliva (often by holding the test strip on the tongue for several seconds), after which the strip changes color according to the level of ethanol in the saliva.

Saliva-based alcohol test strips typically have three or four different color-coded BAC categories, usually with meaningful category thresholds (e.g., .05–.08). After exposing the test strip to saliva, the test-taker then is required to "interpret" the results by matching the color of the test strip against a standard key (provided on the test package) that associates different test strip colors with different BAC ranges. Most commercially available saliva-based alcohol products have been tested for accuracy in laboratory settings, and some have received Department of Transportation certification for detecting presence versus absence of alcohol in the test subject's system.

Risks of providing BAC estimates in real-world settings

At face value, the benefits of providing drinkers with tools for estimating BACs (such as saliva-based alcohol tests) seem obvious. However, there are potential risks associated with BAC estimates that are not immediately clear (see Johnson and Voas, 2004, for a detailed discussion). For example, even if a BAC test device has demonstrated accuracy in laboratory settings, human error may lead to less accurate results when these devices are used in the field. Inaccurate test results might lead a drinker to assume that he or she can drive legally when that is not the case. Furthermore, personal alcohol tests may encourage drinkers to drive at BACs that are lower than the legal limit, yet they are unsafe. There is substantial evidence that impairment of many skills crucial to driving occurs at BACs much lower than the .08 limit (e.g., Harrison and Fillmore, 2005a; Holloway, 1995; Mitchell, 1985; Moskowitz and Fiorentino, 2000; Moskowitz and Robinson, 1988; Stapleton et al., 1986; Zador et al., 2000). It is reasonable to assume that people inclined to use these personal alcohol tests are those who are likely to drive after drinking and wish to avoid driving illegally (as opposed to those who elect to *not drink* if they plan to drive). Without access to BAC information, drinkers wary about the .08 limit

may choose to err on side of caution and moderate their drinking considerably. Conversely, by using a personal alcohol test, drinkers may maximize their alcohol consumption while still staying below a BAC level of .08, thus becoming dangerous, yet legal, drivers.

Ideally, tests providing accurate BAC information will discourage individuals from driving if their BACs are higher than the .08 BAC limit by making the risk of DUI arrest salient. There are potential risks to providing this information as well, and it is unclear how best to weigh the advantages against the disadvantages of this broad strategy of impaired-driving prevention. What is clear, however, is that the efficacy of this approach assumes that by providing accurate BAC information to drinkers, their perceptions of impairment and risk for DUI will change. There is no purpose in examining whether the potential disadvantages of providing BAC information outweigh the benefits without first determining that providing the information influences perceptions of drinking-and-driving risk. To date, there has been no research examining whether and to what extent receiving BAC information influences drinkers' subjective beliefs about impairment and driving risk.

Our research tested experimentally whether providing drinkers with BAC information in real-world drinking environments affected their subjective perceptions of alcohol impairment and driving risk. In this research, we contrasted the effect of categorical BAC results (such as those obtained from a saliva-based alcohol test) to "precise" BAC results (measured to three decimal places) similar to that obtained from a police-style breath alcohol analyzer (preliminary breath-test [PBT] unit). In addition, we examined the accuracy of the saliva-based test by comparing interpreted saliva-based test results with participants' real BAC category (as measured by a PBT).

Method

Procedure

Data were collected over 18 weekend nights, between April 2005 and February 2006, from a convenience sample of men and women recruited from the Gaslamp Quarter district of bars and restaurants in San Diego, CA. On survey nights, typically between 8 PM and 3 AM, teams of two to four survey staff approached individuals walking on the streets and sidewalks of the Gaslamp district and attempted to recruit them for participation. Survey staff did not enter any bars or restaurants to recruit participants.

Survey staff approached potential participants and asked them whether they would be interested in participating in a brief, voluntary, and anonymous study on drinking and safety. Potential participants were offered a small incentive (a \$3 food coupon) for taking part in the research. Individuals who expressed interest then were asked (1) if they were at least age 18 and (2) if they were planning to drive later that evening. Persons younger than age 18 and persons who indicated plans to drive later in the evening were not allowed to participate. Individuals who were eligible and interested in participating were asked to consent verbally, as written documentation of consent would not be anonymous. An outline of the research procedure is illustrated in Figure 1.

All conditions

After prescreening and obtaining informed consent, participants in all conditions were interviewed regarding their demographics. Next, participants were asked three questions on a 5-point scale concerning (1) how drunk they currently feel, (2) how impaired they feel their driving would be if they were to drive, and (3) their perceived likelihood of being stopped if they were to drive. Participants then were asked a fourth, dichotomous (yes or no) question

regarding whether they believed it would be legal for them to drive at their current level of intoxication. These four questions are described in detail under *Materials and apparatus*.

Following these questions, all participants were given a saliva-based personal alcohol test kit. Each participant was asked to examine the test package and to note that the test could be used to indicate whether his or her BAC was in the .000–.049, .050–.079, or .080 and higher category. Before administering the saliva test, participants were asked to estimate which BAC category they believed they would fall under and then were asked to provide a breath sample to be analyzed using a calibrated PBT unit (see *Materials and apparatus*). Participants were not given any feedback (BAC results) from the breath test at that time.

Finally, participants were asked to read the test instructions and self-administer the saliva-based personal alcohol test. Because we wanted all the alcohol test strips to produce valid results, survey staff corrected any test administration mistakes that participants might have made in the process.

Control condition

After self-administering the saliva test but before receiving or interpreting any test results, participants were asked to respond again to the same set of four questions regarding perceived driving impairment and the legality of driving in their current state (see *Materials and apparatus*). These items, asked at Time 2, served as the primary dependent measures in the study. After answering the questions, participants examined the saliva test strip, interpreted the test results, and reported which BAC category they believed that the test indicated. This condition was considered the “control” condition because participants made their Time 2 ratings on the dependent measures before receiving and interpreting the personal alcohol test results. Thus, BAC feedback could not play any role in differences between pre- and post-ratings.

Saliva alcohol test condition

After participants assigned to the *saliva alcohol test condition* finished self-administering the saliva test, they were asked to read and interpret the results indicated by the test strip. Then, *after* learning their BAC category from the test strip, they were asked to provide their Time 2 responses to the four dependent measure items. Thus, in the saliva alcohol test condition, unlike in the control condition, participants’ subjective ratings of impairment (the dependent measure) might be influenced by the results of the personal alcohol test.

Categorical BAC condition

In the previously described condition (saliva alcohol test), participants used the saliva test-strip results alone to estimate their actual BACs. In the categorical BAC condition, after participants administered and interpreted the personal saliva alcohol test, but before they responded to the dependent measures, the research interviewer told each participant his or her actual and accurate BAC category (.000–.049, .050–.079, or $\geq .080$) based on the PBT results. Thus, regardless of the validity of the saliva alcohol test, participants in the categorical BAC condition received accurate BAC categorical information (using the same categories as indicated by the saliva test) but not their exact (precise) BAC reading. Finally, after receiving categorical BAC information based on the PBT, participants were asked to respond to the three 5-point scale items and one dichotomous, dependent measure item.

Precise BAC condition

Participants assigned to the precise BAC condition received identical instructions and were exposed to the same procedures as in the categorical BAC condition. However, after providing

a breath sample to be analyzed using the calibrated PBT, participants were told their precise BACs (a three-digit reading), as opposed to their BAC categories. After receiving this precise BAC information, participants gave their Time 2 ratings on the four dependent measures.

Materials and apparatus

The survey instrument was programmed into Sony Clie CLIÉ handheld computers (Sony Corporation of America, New York, NY) using the HanDBase programming language (DDH Software, Wellington, FL). The survey program prompted interviewers with questions and procedures to administer to participants in the correct order according to the experimental condition. Participants' responses to questions were entered directly into the handheld computers, and survey data were downloaded the following day.

Four key questions (which served as the primary dependent measures) were asked at two time points during the study. The questions first were asked before participants self-administered the saliva-based alcohol test, and then questions were repeated after the participants took the saliva test. At Time 1, participants were asked to respond to the following questions: (1) "Given that you've had some drinks tonight, please describe how you feel right now on a 5-point scale. A '1' means that you feel completely sober and a '5' means that you feel completely drunk." (2) "If you were to drive right now, how would your driving ability be affected by alcohol? Again, use a 5-point scale where '1' means that your driving is not at all affected, and '5' means greatly affected." (3) "If you were to drive right now, what are the chances that police would stop you for driving while impaired? Use a 5-point scale where '1' means almost no chance, and '5' indicates very likely." (4) "Do you believe that it would be legal for you to operate a car right now (yes or no)?" An identical set of questions was asked at Time 2; however this line of questioning began: "Now that you've had a chance to test your own alcohol level, I'd like you again to describe how you feel right now on a 5-point scale...."

We conceptualized the first three questions as distinct from the fourth question; the former pertained to drinkers' perceptions of whether their driving skills were adversely affected by alcohol, and the latter concerned their perception of whether their BAC was above the legal limit. We considered these independent constructs because people might believe their BACs to be above .08 but nevertheless think that their driving skills were unimpaired. Conversely, a person could feel alcohol-impaired but below the .08 limit. This distinction is also important programmatically because strategies that target drinkers' perceived risk of crash might be differentially effective than strategies that target their perceived risk of arrest.

Breath samples were collected and analyzed using calibrated Intoxilyzer SD400 PBTs (CMI Inc., Owensboro, KY). These units were programmed by the manufacturer to not display participants' BACs but rather to store them internally to be downloaded and merged with survey data at a later date.

Participant characteristics

A total of 1,342 individuals participated in the research. Of these, 73 did not provide a PBT, and an additional 33 did not answer all of the dependent measure items. These individuals were excluded from analysis. Another 267 individuals had BAC readings of 0 (no evidence of alcohol in the system). Because we were interested in the ability of individuals to predict their alcohol impairment, we thought that these presumably unimpaired participants could contribute only error to the research, and thus, they were excluded as well. Finally, we eliminated participants within the highest 1% of BACs. These included 10 participants with BACs ranging from .227 to .383. Extremely high BACs often indicate the presence of mouth alcohol (rather than alcohol absorbed into the drinker's system); therefore, we removed the cases with the highest 1% of BACs to reduce this source of error.

The remaining sample included 959 individuals. The majority of the sample was male (73.3%), non-Hispanic (87.0%), and white (78.0%). Only 5.1% were younger than age 21, and the median age was 23. The mean (SD) BAC was .080 (.046), with roughly comparable values for men and women (means = .081 [.045] and .078 [.048], respectively).

Our intent was to assign participants to conditions in roughly equal numbers; however, nearly 1.5 times as many participants were assigned to the precise BAC condition as to each of the other three (n 's = 198, 177, 237, and 347 for Conditions 1–4, respectively). The gender distribution was approximately equal across groups (68.2%, 74.0%, 75.1%, and 74.7% for the four conditions, respectively). The control and personal alcohol test conditions were conducted on 8 data-collection nights, the categorical BAC condition on 10 nights, and the precise BAC condition on 11 nights. Furthermore, between 22 and 25 participants were sampled per night for each of the first three conditions, whereas approximately 32 were sampled per night in the precise BAC condition. This contributed to a higher sample size in the precise BAC condition.

Results

All analyses were conducted using the univariate general linear model procedure in SPSS (Version 13.0; SPSS Inc., Chicago, IL). Preliminary analyses revealed that experimental groups did not differ significantly on age, race, ethnicity, BAC, or Time 1 ratings of impairment (all p 's > .27). Furthermore, the experimental condition variable did not significantly interact with any of the control variables (e.g., age, race) in predicting any other control variable (up to three-level interactions were tested). However, the correlation between BAC and Time 1 ratings did vary among conditions. This necessitated the inclusion of Time 1 ratings as a covariate in analyses predicting Time 2 impairment ratings from BACs.

Dependent measures

All participants were asked to indicate (at both Time 1 and Time 2) on a 5-point scale their subjective perceptions of their current sobriety, their driving impairment, and their perceived risk of being stopped for DUI (if they were to drive). Except for the control condition, Time 2 ratings were made *after* participants received BAC information. Reliability analysis of the three Time 1 variables yielded a Cronbach's α of .76. Reliability analysis of the three Time 2 variables yielded a Cronbach's α of .82. Both reliability measures were adequate, and thus, the two sets of three items were averaged to create before and after indices of subjective impairment. The association (η^2) between the subjective impairment index and the item concerning the perception of being higher than the legal BAC driving limit was moderate (.39 and .48 for Time 1 and Time 2, respectively) but was by no means redundant.

The mean score for each of the three 5-point dependent measures, and the proportion of participants who responded positively to the fourth question, stating that they believed they were legal to drive, are provided in Table 1. Separate values are given for each experimental condition and for Time 1 and Time 2 ratings.

Effect of BAC feedback information on subjective ratings of impairment

Although BAC and alcohol impairment are separate, independent constructs, research suggests that the relationship between the two is linear (Landauer and Howat, 1983; Laurell, 1977; Moskowitz and Sharma, 1974). People with higher BACs, on average, are relatively more impaired (on driving-related skills) than those with lower BACs. If people accurately assessed their own alcohol impairment, we would expect a strong positive linear relationship between participants' BACs and their subjective impairment ratings. To the extent that BAC and impairment are linearly related, such a correlation could be construed as evidence that people are relatively accurate in judging their alcohol impairment. Furthermore, to the extent that

drinkers are affected by “objective” BAC feedback (e.g., from a BAC estimation device), we would expect the correlation between BAC and subjective impairment ratings to be stronger than when no BAC information is provided (i.e., the control condition). If different types of BAC feedback (e.g., categorical information vs precise information) affect drinkers differently, then we would expect the magnitude of correlations between actual BACs and subjective impairment ratings to vary as well. Thus, in this study we anticipate an interaction between participants’ actual BACs and the experimental condition on Time 2 subjective impairment ratings.

Our statistical model included Time 1 subjective impairment (the average of three Time 1 dependent measure items) as a statistical covariate, along with the main effects of experimental condition and participants’ BAC (as measured by the calibrated PBT), and the Condition $\times$ BAC interaction as the primary effects of interest. Subjective impairment at Time 2 was the dependent measure. An initial analysis also included gender, race, ethnicity, and age as control variables (main effects only), but none of these related significantly to the outcome variable (all p ’s $> .26$), and they were excluded from further analyses.

This analysis treated BAC and Time 1 ratings of impairment as continuous (score) variables and the experimental conditions as a four-level categorical variable. The analysis revealed statistically significant main effects of Time 1 ratings of impairment and for BAC, as well as a statistically significant Condition $\times$ BAC interaction ($F = 3.9$, 3/950 df, $p < .01$). Table 2 contains the variance components, test statistics, and effect sizes (partial η^2) of these effects. Note that according to Cohen (1977), partial η^2 of .01 is considered a small effect size, .06 is considered a medium effect size, and .14 or greater is considered a large effect size.

As anticipated, both initial subjective ratings of impairment and BAC were positively related to post-ratings of impairment. The statistically significant Condition $\times$ BAC interaction indicates that the slopes (predicting Time 2 subjective impairment ratings from BACs) differed among the four conditions. The unstandardized regression coefficients are depicted in Figure 2.

In addition, Table 3 contains several descriptive indicators of the relationship between BAC and subjective impairment rating as a function of experimental condition. First, it contains the standardized regression coefficients (betas) for each group; these within-condition standardized regression coefficients were derived using the error term from the full model and computed using the method outlined by Aiken and West (1991). Second, the table contains the partial correlations between BAC and Time 2 subjective impairment ratings (controlling for Time 1 impairment ratings). Third, the table contains the zero-order correlations between BAC and Time 1 subjective impairment ratings and between BAC and Time 2 subjective impairment ratings. Only in the precise BAC condition was the correlation between BAC and Time 2 ratings significantly greater than the correlation between BAC and Time 1 ratings. However, it is worth noting that, despite random assignment, baseline (Time 1) correlations varied significantly across conditions and were higher in the two categorical conditions.

Comparisons of the regression slopes between pairs of conditions (using the error term derived from the total model as the denominator) revealed that the relationship between actual BAC and Time 2 subjective impairment ratings (controlling for Time 1 impairment ratings) differed significantly only between the precise BAC and the saliva test conditions ($F = 9.34$, 1/519 df, $p < .01$; partial $\eta^2 = .010$) and between the precise BAC and categorical BAC conditions ($F = 6.13$, 1/579 df, $p < .01$; partial $\eta^2 = .018$). The difference between the precise BAC and the control conditions was not statistically significant.

One possible explanation for why the relationship between actual BAC and subjective impairment was weaker when categorical BAC information was provided is that categorical

information provides little detail about the extremely high BACs. Categorical BAC information that does not distinguish among BACs of .08 or greater may have relatively little effect on very heavy drinkers. If this were the case, we would anticipate that the advantage of precise BAC information over categorical BAC information would be greater at higher BAC levels.

To test this, we first combined the two categorical BAC feedback conditions (2 and 3) and then contrasted this combination with the precise BAC condition (the control condition was dropped). Second, we included a variable that indicated the participant's real BAC category (.000–.049, .050–.079, or $\geq .080$) based on the calibrated breath test, and we modeled a three-way Condition $\times$ BAC $\times$ Real BAC Category interaction (along with the necessary lower-level interactions). Essentially, this analysis tested the within-BAC category correlations between BAC and subjective impairment as a function of condition. However, the three-way interaction was not statistically significant ($p = .61$). Thus, the relative effect of precise BAC feedback compared with categorical BAC feedback did not differ significantly across the range of BACs. There is no evidence to suggest that categorical BAC feedback is particularly unpersuasive at higher BACs.

This analysis, however, did reveal a statistically significant two-way BAC $\times$ Real BAC Category interaction ($F = 4.0$, 2/753 df, $p < .05$; partial $\eta^2 = .010$). No other two-way interactions were statistically significant. The significant BAC $\times$ Real BAC Category interaction suggests that participants' sensitivity to their impairment (i.e., the extent to which their subjective impairment ratings correlate strongly with their actual BACs) does vary across the range of BACs. To better interpret this interaction, we computed the partial correlations (controlling for Time 1 impairment ratings) between BAC and Time 2 impairment ratings separately for the three actual BAC categories. Thus, we examined the within-BAC category correlations between BAC and impairment ratings. The partial correlations grew smaller as the BAC category increased ($r = .18$, .12, and .10 for low, higher, and highest BAC categories, respectively) suggesting that participants are less sensitive to their impairment at higher BACs.

Perception of whether participants are legal to drive

In addition to indicating their subjective impairment, participants also indicated whether they believed that they could drive legally at their current level of intoxication. This dichotomous item is distinct from the subjective impairment items in that it pertains solely to legal risk, and not to risk of crash. It does not assume that participants feel impaired. We used logistic regression to predict the likelihood that participants thought they were legally able to drive from condition, BAC, and the Condition $\times$ BAC interaction. We included Time 1 responses to the "legality" question as a control variable. Guided by the previous results indicating little difference between the saliva test condition and the categorical confirmation condition, we combined those conditions in the current analysis, leaving control, categorical BAC, and precise BAC as the three experimental conditions.

The results revealed statistically significant effects for Time 1 perceptions of "driving legality," BAC, condition, and the Condition $\times$ BAC interaction. The statistical results, odds ratios, and regression coefficients for each condition are provided in Table 4. Overall, as BACs increased, the likelihood that a participant perceived that he or she was safe to drive decreased.

To help interpret the Condition $\times$ BAC interaction, we conducted separate logistic regressions for each condition. The results for the control condition revealed no relationship between BAC and perception of being legal to drive ($p = .28$), whereas the relationship was statistically significant in both the categorical and the precise BAC feedback conditions (both p 's $< .01$). When including only the categorical and precise BAC feedback conditions in the analysis, only the Condition $\times$ BAC interaction approached statistical significance ($p = .07$).

Because the legal BAC for driving varies by age (i.e., the legal BAC limit is .02 for drivers age 20 and younger), we reproduced the analysis excluding 49 participants age 20 and younger; therefore, there was a consistent legal driving limit for participants. The results of this analysis mirrored the previous results.

Analysis of the accuracy of saliva alcohol test strips

All participants self-administered the saliva-based test and interpreted the test results, identifying (according to the test) their BAC category. When compared with actual BAC categories (based on the PBT reading), only 43.8% of the time did a participant's interpreted BAC category correctly match his or her actual category. The mean BACs of the lower (.000–.049), higher (.050–.079), and highest ($\geq .080$) risk categories (based on participants' interpretations of the saliva alcohol test) were .061 ($\pm .004$), .086 ($\pm .004$), and .110 ($\pm .008$), respectively (95% confidence intervals in parentheses)—all significantly higher than the category as defined by the alcohol test.

Analyses were conducted to determine whether individual-level variables (gender, age, race, ethnicity, and BAC) predicted the accuracy versus the inaccuracy of the interpreted saliva alcohol test. We used logistic regression to predict the dichotomous outcome (test results were accurate versus not accurate) from the five individual-level variables (tested simultaneously), along with two-way interactions between BAC and each demographic variable. Main effects of age, race, and ethnicity of participants failed to significantly predict whether their interpretations of the saliva test accurately predicted the BAC category. However, gender (Wald = 4.9, 1 df, $p < .05$; odds ratio = 1.48) did predict test accuracy, along with the BAC $\times$ Age interaction (Wald = 4.05, 1 df, $p < .05$; odds ratio = 3.11). Men were more likely to draw inaccurate test interpretations than women, and individuals with higher BACs were more likely to produce inaccurate test results than were individuals with lower BACs, particularly as age increased. A younger drinker at a high BAC was less likely to inaccurately interpret the test results than an older drinker at the same BAC.

In a subsequent analysis, we tested to see whether the accuracy of the saliva test interpretations moderated the accuracy of participants' subjective impairment ratings. Using only those participants in the saliva alcohol test condition and controlling for Time 1 impairment ratings, we tested the interaction between saliva test accuracy (accurate vs inaccurate) and actual BAC as a predictor of Time 2 impairment ratings. When the saliva tests were interpreted correctly, the partial correlation between BAC and Time 2 impairment was .26. This correlation was lower (.09) when the saliva test results were not accurate. However, the Accuracy $\times$ BAC interaction was not statistically significant ($p = .43$); thus, we cannot conclude with confidence that the saliva alcohol test is necessarily more useful when its results are accurate.

Discussion

Several theoretical perspectives predict that people will be less likely to engage in a behavior to the extent they believe that behavior increases the risk of negative consequences. Drinkers who intend to drive are at risk both for crash and for arrest or citation; yet, it is not clear how well drinkers accurately assess this risk. Because the legal risk for drinking and driving is defined in terms of BAC and because BAC is related to driving impairment, it is theoretically consistent that drinking drivers with a high-level BAC ($\geq .08$) will become more aware of the risks they face if they learn their actual BAC level. Although research has examined drinkers' ability to estimate their own BAC and to monitor their alcohol consumption, to our knowledge (e.g., Lansky et al., 1978a, 1978b; Martin et al., 1991; Vogel-Sprott, 1974, 1975), no research has demonstrated the effect of receiving BAC information on subjective perceptions of driving impairment and risk.

In this study we interpreted the magnitude of the correlation between BAC and impairment ratings as an indicator of sensitivity to impairment. Research has demonstrated that BAC is linearly related to impairment in driving-related skills (Landauer and Howat, 1983; Laurell, 1977; Moskowitz and Sharma, 1974), and accordingly, we postulate that persons with relatively high BACs are relatively highly impaired and that persons with relatively low BACs are only slightly impaired. Our use of the phrase *sensitivity to impairment* to describe the correlation between BAC and subjective impairment ratings assumes that BAC reflects actual driving impairment, and logically follows this assumption.

However, we admit that our use of BAC as a proxy for impairment is far from perfect, and we acknowledge that there may be alternative ways to interpret the results. There is considerable variation in people's tolerance to the impairing effects of alcohol on driving skills (e.g., Harrison and Fillmore, 2005b; Vogel-Sprott, 1992), and our research does not account for any potential individual differences. Furthermore, the research demonstrating the relationship between BAC and driving impairment (Landauer and Howat, 1983; Laurell, 1977; Moskowitz and Sharma, 1974) may have defined "impairment" differently than did our participants and may have focused on different driving-related skills than participants typically consider when thinking about driving. It is possible that the relationship between BAC and impairment, as defined by our participants, is not linear, and the observed correlation between BACs and subjective impairment ratings may reflect something other than sensitivity to impairment. Thus, although our discussion of the research is consistent with the empirical results, other plausible interpretations may exist.

Our research demonstrated statistically significant, moderate correlations between actual BACs and subjective impairment ratings. Although the results are not particularly strong, they do indicate that drinkers who consumed relatively more alcohol feel more impaired in their driving skills than those who consumed relatively less alcohol. Our analyses also revealed that drinkers were less sensitive to their presumed impairment at higher BACs.

In our primary analysis, we examined whether participants were more sensitive to their presumed impairment (as indicated by a stronger correlation between BAC and impairment ratings) when they received BAC feedback. We also examined whether this sensitivity varied as a function of the type of BAC information received. The results indicated that drinkers who were given precise BAC feedback rated their impairment more closely in line with their actual BAC than did participants who were given categorical feedback and that the presumed sensitivity increased significantly beyond baseline only for participants who received precise BAC feedback. However, no strong evidence indicated that providing precise BAC feedback increased sensitivity relative to control participants (who received no BAC feedback). These patterns suggest that the saliva-based alcohol tests might actually have hindered participants' subjective estimates of presumed impairment. Overall, we cannot conclude with confidence that BAC feedback helps drinkers accurately assess their driving impairment; rather, under some conditions, categorical BAC feedback attenuates drinkers' natural ability to assess their driving impairment.

On the other hand, BAC feedback did predict participants' estimates regarding whether it was legal for them to drive. For control participants (who did not receive BAC feedback), BAC did not significantly predict the perception of their legal status. For those who received BAC feedback before completing the dependent measure, BAC did significantly predict perceptions of legality, but in this case no significant differences were found in the efficacy of categorical versus precise BAC feedback.

Saliva-based personal alcohol test

The saliva test used in this study was not particularly accurate. For nearly half of the participants, the saliva test underestimated actual BACs. Women taking and interpreting the saliva test tended to produce more accurate results than did men, and persons with lower BACs—particularly younger people with lower BACs—taking and interpreting the test tended to produce more accurate results than persons with higher BACs. BAC and gender were analyzed in the same model; therefore, the fact that women interpreted the saliva test more accurately than men is independent of BAC level. It is possible that female participants were more carefully administered and more carefully read and interpreted the test strips.

Limitations

Although the correlation between BAC and subjective impairment ratings increased significantly for participants who received precise BAC information, the comparison of correlations among conditions could be clouded by differences in baseline sensitivity ratings. Although including Time 1 sensitivity ratings helped place experimental conditions on equal footing, we cannot rule out the possibility of a “ceiling effect.” High baseline sensitivity to impairment in the two categorical BAC feedback conditions may have limited the potential effect of BAC feedback.

Furthermore, it would have been beneficial had we collected data on the drinking history and possible alcohol dependence of our participants. Research suggests that persons with alcohol dependence are less capable of assessing the BACs than nonalcoholic social drinkers (Lansky, et al., 1978a,b; Silverstein et al., 1974) and that persons with family history of alcohol dependence report subjective symptoms of intoxication differently than those without a family history of dependence (e.g., O’Malley and Maisto, 1985; Schuckit, 1980). Alcohol dependence may have proved to be an important moderating variable in this research, with BAC feedback being more impactful for alcohol-dependent persons.

Conclusions

Drinkers who self-administered and interpreted a saliva-based personal alcohol test more accurately determined whether they were legally able to drive than did drinkers who did not receive any BAC information. However, the categorical BAC information did not appear to influence perceptions of presumed impairment and safety risk for driving. In fact, the sample correlation between BAC and subjective impairment ratings was smaller in the saliva alcohol test condition than in the other experimental conditions.

For persons concerned only with their BACs relative to the .08 legal limit, categorical BAC feedback from the saliva test may be informative and may aid their decision making about whether to drive. For such individuals, however, driving at legal but nevertheless risky BACs (e.g., .07) may be acceptable. These drinkers may use personal alcohol tests to help gauge how much alcohol they can consume and still stay below the .08 limit. Conversely, for individuals who are concerned about driving safely, categorical BAC information (e.g., provided by saliva-based tests) may not be particularly useful. Individuals who are cognizant about the risk of driving while impaired may be more inclined to limit their drinking in the first place if they plan to drive, regardless of the available of BAC estimation tools.

One limitation of this research is our assumption that BAC accurately reflects actual alcohol impairment in driving-related skills. We had no objective measure of driving impairment in this research. Additional research is needed to further clarify any potential benefit or role for personal alcohol devices as a tool to reduce drinking and driving.

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Figure 1.

Diagram of experimental procedures. BAC = blood alcohol concentration; PBT = preliminary breath test

Figure 2.
The relationship between blood alcohol concentration (BAC) and subjective impairment ratings, by experimental condition

Table 1

Means/proportions (and standard deviations) of each dependent variable by condition and time

	Time 1				Time 2			
	Sober	Impair	Stop	Legal	Sober	Impair	Stop	Legal
Control (<i>n</i> = 198)	2.66 (0.9)	2.61 (1.1)	2.22 (1.3)	0.34 (0.03)	2.53 (1.0)	2.58 (1.1)	2.34 (1.3)	0.36 (0.03)
Saliva test (<i>n</i> = 177)	2.81 (1.0)	2.77 (1.3)	2.36 (1.4)	0.34 (0.04)	2.75 (1.1)	2.74 (1.3)	2.32 (1.3)	0.38 (0.4)
Categorical (<i>n</i> = 237)	2.68 (0.9)	2.70 (1.3)	2.36 (1.4)	0.32 (0.03)	2.62 (1.1)	2.63 (1.3)	2.40 (1.3)	0.39 (0.03)
Precise (<i>n</i> = 347)	2.76 (0.9)	2.75 (1.2)	2.47 (1.4)	0.31 (0.02)	2.76 (1.0)	2.73 (1.2)	2.53 (1.4)	0.43 (0.03)
Total (<i>N</i> = 959)	2.73 (0.9)	2.71 (1.2)	2.37 (1.4)	0.32 (0.02)	2.68 (1.1)	2.68 (1.2)	2.42 (1.3)	0.40 (0.02)

Table 2

Variance components, statistical tests, and effect sizes for predicting subjective impairment ratings from blood alcohol concentration (BAC) and condition

Effect	SS	Statistical test	Partial ²
Time 1 rating	467.02	$F = 1,322.6, 1/950 \text{ df}, p < .01$	.582
BAC	16.36	$F = 46.3, 1/950 \text{ df}, p < .01$	.047
Condition	1.89	$F = 1.78, 3/950 \text{ df}, p = .15$	.006
BAC $\times$ Condition	4.16	$F = 3.91, 3/950 \text{ df}, p < .01$	.012
Error	335.5	–	–

Note: SS = Sums of Squares

Table 3
The relationship between blood alcohol concentration as subjective impairment ratings as a function of condition

	Standardized coefficients β	Partial correlations	Zero-order Time 1 correlations	Zero-order Time 2 correlations	Test of difference between Time 2 and Time 1 correlations
Control	.165	.21	.334	.428	$z = 1.62, p = .11$
Saliva test	.079	.11 (NS)	.430	.401	$z = -0.47, p = .64$
Categorical	.121	.17	.511	.493	$z = -0.41, p = .68$
Precise	.217	.34	.384	.495	$z = 2.76, p < .01$

Note. NS = not significant.

Table 4

Statistical tests and odds ratios for predicting participants' beliefs regarding whether they could legally drive as a function of blood alcohol concentration (BAC) and condition

Effect	Statistical test	Odds ratio
Time1 rating	Wald = 120.20, 1 df, $p < .01$	1.17
BAC	Wald = 36.92, 1 df, $p < .01$	0.047
Condition	Wald = 11.02, 2 df, $p < .01$	0.006
BAC $\times$ Condition	Wald = 7.0, 2 df, $p < .05$	See below
Condition	Odds ratio for BAC ^a	Unstandardized coefficients
Control	7.83×10^{-3}	-4.85
Categorical BAC	1.66×10^{-7}	-15.61
Precise BAC	3.96×10^{-10}	-21.65

^aNote that it is natural for odds ratios involving BAC as the predictor to be extremely small because it is measured on an extremely small scale, and the range of actual BACs is much less than "1."