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Police officers' detection of breath odors from alcohol ingestion

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Abstract

Police officers frequently use the presence or absence of an alcohol breath odor for decisions on proceeding further into sobriety testing. Epidemiological studies report many false negative errors. The current study employed 20 experienced officers as observers to detect an alcohol odor from 14 subjects who were at blood alcohol concentrations (BACs) ranging from zero to 0.130 g/dl. Over a 4 h period, each officer had 24 opportunities to place his nose at the terminal end of a 6 in. tube through which subjects blew. Subjects were hidden behind screens with a slit for the tube to prevent any but odor cues. Under these optimum conditions, odor was detected only two-thirds of the time for BACs below 0.08 and 85% of the time for BACs at or above 0.08%. After food consumption, correct detections declined further. Officers were unable to recognize whether the alcohol beverage was beer, wine, bourbon or vodka. Odor strength estimates were unrelated to BAC levels. Estimates of BAC level failed to rise above random guesses. These results demonstrate that even under optimum laboratory conditions, breath odor detection is unreliable, which may account for the low detection rate found in roadside realistic conditions. © 1999 Elsevier Science Ltd. All rights reserved.

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1. Introduction

Alcohol breath odor is the most frequently cited observation by US police officers in alcohol related traffic offenses. Usually the strength of the odor is categorized as either slight, moderate or strong. Despite the frequent reliance on this clue in officers' investigation of drivers, little objective evidence is available on the probability of successfully detecting, identifying or measuring alcohol odors.

A computer literature search supplemented by examining references in various publications elicited only two studies examining the detectability of breath alcohol odor. The first study was found in a monograph published by Widmark (1932) (German Edition 1932, English Translation, 1981). Widmark was a professor at the University of Lund, Sweden and presented data obtained from behavioral testing of 562 drivers arrested for possible driving under the influence of alcohol. The behavioral testing occurred in police stations throughout Sweden, and were performed by more than 150 physicians. The seven behavioral tests included the odor of alcohol on the breath, the Romberg Test of body sway, walking a straight line and turning, finger to finger test, picking up small objects and slurred speech. Each of these items in the behavioral battery was administered to all subjects. Widmark noted that the examination occurred sometime after arrest at the police station and therefore the breath odor would have been during the post absorption stage. No subject whose blood alcohol concentration (BAC) was 0.06% or below had an alcohol breath odor detected by physicians. Between 0.061 and 0.08% BAC, 33% of the drivers were detected as having an odor; between 0.081 and 0.10% BAC, 63% of the drivers were detected; from 0.101 to 0.181% BAC, detections averaged 81%; between 0.181% and 0.260% BAC, detections averaged 92%; and it was only above 0.261% BAC that an alcoholic odor was 100% detected on the breath. It should be noted that all these drivers had been arrested for probable intoxicated driving and were exhibiting many other symptoms of alcohol presence which could have influenced the physician's perception. Despite this the probability of detecting alcohol on the breath re-

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mains surprisingly low and variable until very high BACs.

The other reference dealing with the issue was a National Highway Transportation Safety Administration, Department of Traffic (NHTSA/DOT) pilot study examining cues utilized by officers in detecting drivers under the influence of alcohol (DUI) (Compton, 1985). This was an experimental study where 75 male volunteer drivers were administered ethanol beverages sufficient to produce BACs of either zero or between 0.05 and 0.15%. Consumption was spaced over a 1.5–2 h period. After an additional half hour wait, subjects drove a car over a closed course to a check point, where an officer/observer conversed with the driver and noted among other symptoms whether an alcohol odor was presented. Other symptoms examined were face flushing, slurred speech, eye dilation, demeanor, disheveled hair, poor dexterity and clothes disheveled. The officers then made a determination whether the driver should be detained for further investigation.

Drivers with a zero BAC were correctly identified 93% of the time. There were 7% false-positives, i.e. identification of a zero BAC driver as having alcohol odor. Since officers were aware that they were participating in an alcohol study, a 7% false-positive rate is undoubtedly higher than would occur in actual traffic stops. An alcohol odor was detected in drivers with BACs between 0.05 and 0.09% only 39% of the time producing a false negative error rate of 61%. Conversely, 61% of drivers with BACs between 0.10 and 0.15% were detected as emitting an alcohol odor with 39% false negatives, i.e. drivers above 0.10%, not detected. Variability between officers in detecting odor was quite large.

The detection rates of the Widmark and Compton studies appear roughly comparable, although BACs in the Compton study between 0.10 and 0.15% were less well detected, possibly due to the outdoor field conditions under which the Compton study was performed. This in contrast to the Widmark study done in the enclosed space of a room in a police station. Another factor in the Widmark study was that the physicians knew that they were dealing with drivers arrested for probable DUI.

The study reported in this paper was performed to examine police officers ability to detect alcohol odors under optimum conditions, but without possible contamination by observation of other behavioral cues. Thus the study was conducted in a closed environment with subjects blowing through a short plastic tube to concentrate the breath stream and prevent odor dissipation. Officers placed their nostrils near the exit end of the tube. Subjects stood behind opaque screens with a slit for the tube. This insured that no other behavioral cue suggesting the presence of alcohol, which might have influenced judgments in the Widmark and Compton studies, would be present in the current study. The only cue presented to the officers would be odor. In addition to examining the detectability rate as a function of BAC, various types of beverages were consumed by the subjects and the role of beverage type on delectability was also examined.

2. Method

2.1. Design

The experiment was conducted as one double-blind session with four repeated trials over a 4-h period. The site was the Drug Recognition Expert Program facility of the Los Angeles Police Department (LAPD). Twenty officers who participated in the study were trained and experienced Drug Recognition Experts attending a mandatory recertification class.

2.2. Subjects

Eight males and six females, ages 21–35 years of age, participated as paid volunteer subjects. They were recruited with newspaper ads and then screened for physical and emotional illness and use of medication and drugs. Alcohol use was assessed with the Cahalan et al. (1969) quantity–frequency–variability scale.

Applicants who met screening criteria were enrolled in order of application. They were advised of the conditions of the study, including the maximum amount and the types of alcohol beverage they would drink, the duration of the drinking period, and the time the session would end. They were instructed to abstain from food for 4 h prior to the scheduled time for beginning the drinking. All subjects gave written informed consent to voluntary paid participation in the experiment. All aspects of the experiment and subjects' participation were approved by an institutional review board.

2.3. Alcohol treatment

The alcohol dosages and drinking times were varied so that at each of the four test sessions 12 subjects had BACs ranging from zero to roughly 0.12%. Each subject was assigned a target peak BAC, and the alcohol dose was calculated to produce that BAC taking into account gender, body weight, body composition and duration of the drinking and absorption periods. Subjects drank for 0.5, 1, or 1.5 h followed by an additional half hour absorption period prior to participation in testing. The alcohol beverages were 80 proof vodka (40% ethanol) mixed with orange juice, 86 proof bourbon (43% ethanol) mixed with 7-Up or

Cola, red wine (12% ethanol) and beer (approximately 4.75% ethanol by volume).

The mixed drinks and wine were served as three equal portions at equal time intervals. Twelve ounce cans of beer were given at equal time intervals in the number required for the target BAC. BAC measurements were obtained with three Intoximeters provided by the LAPD Scientific Investigation Division and operated by LAPD laboratory personnel.

2.4. Setting and apparatus:

The drinking session occurred in a large lounge area. Testing occurred in two separate large rooms in which opaque plastic curtains (76 in. high and 28 feet long) were installed wall to wall approximately six feet from one end of each room. The floor was marked on both sides of the curtain at equal intervals as positions 1 through 6. Slits were cut in the curtain at heights of 60, 66 and 72 in. to allow the insertion of plastic tubes. Drinking subjects used the slit positions most appropriate for their heights. The tubes were 6 in. lengths of hard plastic with a 2 1/4 in. external diameter and 1/4 in. wall thickness.

2.5. Procedures

2.5.1. Subjects

Subjects were transported to the LAPD facility by taxi one hour prior to the start of drinking. Breath samples were obtained to confirm initial zero BACs. Subjects' blood pressures were checked and female subjects provided urine samples which were tested for pregnancy. Research staff monitored subjects throughout the drinking and absorption period. Subjects were allowed to eat lunch when a minimum of an hour had elapsed after the absorption period. Six subjects had lunch between test period 2 and 3, but other subjects had a delayed lunch because they began drinking later in the session. Lunch was a pizza, salad and corn chips.

At each test period six subjects were escorted to each of the two testing rooms. Research assistants assigned them to specific positions behind the curtain as determined by an incomplete Latin square design for each of the four testing periods. Once in their positions, the subjects placed their breath tubes half way through the slots and stood silently.

Although there were 14 subjects, only 12 participated at each test period. Subjects 1–12 participated in periods 1 through 3 but in period 4, subjects 2 and 3 were replaced by subjects 13 and 14. This change was required in order to continue to present a balanced distribution of BACs at all test periods. As the BACs of subjects who began drinking early declined, other subjects began drinking and were brought into the study. The number of subjects at zero BAC decreased in later periods.

2.5.2. Officers

Officers were informed of the experiment objective and were given data forms to record their examination of subjects, identified only by number. The data form requested judgments as to the presence or absence of alcohol odor, the strength of the odor, if present, the type of alcohol beverage and an estimate as to the subject's BAC. Officers were requested to work independently and not to converse with the subjects. The 20 officers were split into two groups which alternated as observers in different rooms at different test periods. At each test period the officers made judgments only on the six subjects in the room to which they were assigned for that test period.

After the 12 subjects were positioned by research assistants, the officers were summoned. The subjects were hidden from the officers' view by the opaque plastic screens. Each officer approached a marked curtain position and, when ready, asked a subject to blow through the test tube, e.g. 'Position 4, blow through your tube'. He completed the form for that subject and that test period based on the presence or absence of an odor of alcohol. He then moved to the next available unoccupied position in that room and repeated the procedure until all six subjects were examined. Since the order of smelling subjects was random, if there were a carry over effect from smelling one subject to another there would have been no systematic error. Upon completion, officers handed their test forms to the research assistant and left the room. The test periods began at 12:00 and were repeated at 13:00, 14:00 and 15:15 h.

3. Results

3.1. Measured BACs

Two successive Intoximeter BACs were taken before and after each test period. Table 1 presents the mean measured BAC for breath specimens for 14 subjects at four test times. The table indicates the beverages consumed by each subject. Alcohol was only administered to each subject at a single drinking period. Test periods for odor detection lasted no more than 15 min each, and the decline in BAC level during those periods averaged 0.005%.

3.2. Officers' detection rate for the odor from alcohol

Table 2 summarizes the accuracy of odor detection by the 20 officers for each of the four test periods for all detection attempts and by three BAC categories. There should be 120 detection attempts for each period (20 officers evaluating six subjects), but several data points were missing for the first three periods.

Table 1
Mean measured BACs for 14 subjects at four test times blood alcohol concentrations (%)

Subject	Test 1	Test 2	Test 3	Test 4	Beverage
1	0.000	0.000	0.000	0.000	None
2	0.000	0.000	0.000	–	None
3	0.000	0.000	0.000	–	None
4	0.000	0.000	0.000	0.098	Bourbon
5	0.000	0.080	0.120	0.082	Vodka
6	0.000	0.000	0.100	0.089	Bourbon
7	0.108	0.105	0.090	0.066	Vodka
8	0.130	0.114	0.099	0.079	Bourbon
9	0.089	0.081	0.064	0.050	Beer
10	0.104	0.082	0.061	0.033	Wine
11	0.049	0.038	0.021	0.004	Beer
12	0.017	0.006	0.001	0.000	Wine
13	–	–	–	0.118	Beer
14	–	–	–	0.087	Bourbon
Mean BAC	0.042	0.042	0.046	0.059	

Results for the first two periods will be discussed initially, as the consumption of the lunch clearly changed the probability of detection. Overall, successful classification of odors were 81 and 76% in the first two periods. Examination of the two positive BAC categories found 88 and 78% correct detections for BACs above 0.08%, but only 60 and 70% at or below 0.08%.

Table 2
Number of responses total by test period and by BACs

Trial	1	2	3	4
Total				
Correct	95 (81%)	87 (76%)	67 (59%)	76 (63%)
False positive	5	6	10	5
False negative	10	11	20	27
Uncertain	8	10	16	12
Total	118	114	113	120
0.00% BAC				
Correct	48 (83%)	37 (77%)	21 (55%)	14 (70%)
False positive	5	6	10	5
Uncertain	5	5	7	1
Total	58	48	38	20
≤0.08% BAC				
Correct	12 (60%)	14 (70%)	28 (74%)	22 (55%)
False negative	7	3	5	13
Uncertain	1	3	5	5
Total	20	20	38	40
>0.08% BAC				
Correct	35 (88%)	36 (78%)	18 (49%)	40 (67%)
False negative	3	8	15	14
Uncertain	2	2	4	6
Total	40	46	37	60

Table 3
Strength of alcohol odor by BAC (number of ratings)

Odor rating	Slight	Moderate	Strong
BAC (g/dl)			
<0.04	8	6	0
0.04–0.08	15	19	3
>0.08	48	51	30
Total	71	76	33

Officers correctly assessed zero BACs 83 and 77% of the time.

The majority of subjects in the last two periods had consumed lunch and food odors interfered with detection of alcohol odor. Overall correct assessments declined in the third and fourth periods to 59 and 63% respectively. Detections were 49 and 67% above 0.08, and 74 and 55% at or below 0.08%. Correct judgments regarding zero BACs also dipped to 55 and 70% in the last two periods.

Each officer had 24 sniffing opportunities, but correct detection varied greatly from six to 22 with a mean of 16. The large inter-officer variability is consistent with the conclusion of the Compton (1985) study. Similarly, false negatives ranged from 1 to 10, with a mean of three, and uncertain responses from 0 to 16 with a mean of rwo. False positives were less frequent with a range from 0 to 4 but only a mean of one.

If officers reported the presence of an alcohol odor, they were asked to rate the strength of that odor as either slight, moderate or strong. Table 3 summarizes the number and percent of responses in the three response categories as a function of BAC level for all beverage types combined.

A trend towards correlation between BAC and odor strength estimate appears to exist, but a Chi square statistical test failed to reach significance at the 0.05% level. While no BAC below 0.04% was rated as producing a strong odor, BACs above 0.04% were rated at every strength level from slight to strong. Conversely, looking at the 'slight' odor strength rating column, the actual BACs of subjects ranged from the lowest level (0.019%) to the highest (0.138%). For a police officer, a 'strong' odor estimate should suggest that the subject is more likely than not to have a BAC above 0.08%. On the other hand, failing to detect any odor or detecting a 'weak' odor is no evidence that the driver is not above 0.08%.

Although somewhat confounded by differences between BACs, there also was little relationship between the type of beverage consumed and the estimate of the strength of the beverage. Officers, after rating odor strength, were asked to identify the beverage. It was a near unanimous statement of all officers that they were unable to determine the beverage type.

The difficulty in detecting alcohol breath odor or identifying the beverage type may run counter to subjective impressions. It should be noted that this study examined odor in nearly all cases after absorption was completed. Judgments made during drinking, or soon thereafter when the beverage remains in the oral mucous membranes or in the stomach, would likely increase odor detection and beverage identification.

If an officer reported the presence of an odor, he was requested to estimate the BAC of the subject using one of three response categories: 0.04% or below, 0.05–0.08%, and above 0.08%. The officers were correct 19, 35, 25 and 29% in test periods 1–4 respectively, which is roughly what is expected by random estimates. Errors were two times more likely to be underestimates rather than over estimates.

Although comparisons between the four beverages types were hindered by difference in BACs, there is little evidence that beverage type was a significant influence in detecting the odor of alcohol. Table 4 presents the number of correct and incorrect detection for all subjects by test period, beverage and BAC. There is a slight tendency for beer and wine, at higher levels, to be more easily detected. Since the volume of beer is much greater than the volume of other beverages, it is possible that odor from unabsorbed stomach contents led to more detections. Rates of detection for vodka differed little from bourbon although the amount of congeners such as fusel alcohols in bourbon is perhaps a hundred times greater. Officers had no greater difficulty with vodka than other beverages despite the fact that vodka's content of almost pure ethanol renders it essentially odorless as a beverage. These results suggest that some common by-product of ethanol consumption underlies the odor production from fully absorbed beverages.

Table 4
Was there an odor? Decisions for positive BACs by beverage type and BAC

Beverage type	BAC range	Mean BAC	No. subjects	% Yes
Beer	<0.04	0.021	15	50
	0.04–0.08	0.054	30	67
	>0.08	0.097	27	85
Wine	<0.04	0.017	29	28
	0.04–0.08	0.061	9	44
	>0.08	0.093	18	83
Vodka	<0.04	0.006	10	60
	0.04–0.08	0.066	10	60
	>0.08	0.098	46	59
Bourbon	0.04–0.08	0.079	10	80
	>0.08	0.102	68	72

4. Conclusions and discussions

In a controlled setting, highly trained and experienced police officers were asked to determine if subjects had been drinking based solely on the odor emitted from the subjects' breath. The setting, which was unlike a roadside condition, was designed to maximize the opportunity to use odor as a cue. It is unlikely that in a normal roadside interaction police officers would have their nostrils close to a circumscribed, strong breath stream.

Under these laboratory circumstances, 78.5% of the officers decisions were correct during the first two trial periods when confounding food odors were not present. The majority of errors were false negatives, i.e. officers failed to perceive the odor of alcohol in drinking subjects. The false positive rate for officers, i.e. a report of alcohol odor in subjects at zero BAC, was considerably lower. In fact, considering their strong expectations of the presence of alcohol, the number of false positives was quite low, i.e. less than 6%. This suggests that under real life conditions officers are unlikely to report the odor of alcohol for an individual at zero BAC.

As expected, the probability of detecting a breath odor is correlated with BAC. At BACs of 0.08% and below, the probability appears close to 60%, but for BACs above 0.08% the probability rises to the 80% range when no food odors are present. Under more realistic field conditions, the probability of detecting alcohol odor would be much lower. Even when an odor is detected, officers may not take action because of underestimating BACs. Few of the estimates of levels were correct, and nearly all the errors were underestimations, which would lead to decisions to release individuals.

This laboratory situation created an optimum opportunity to use alcohol odor as a sole indication of the presence of alcohol and for estimation of its strength. Clearly, estimates of strength, even in this situation, were invalid as were identifications of the beverage consumed. Also, even these extremely experienced officers were capable of detecting the presence of alcohol relatively reliably only in the region of 0.08% and higher.

The finding that there were only small differences in the intensity of the odor as a function of the type of beverage is of scientific interest. It suggests the fusel oils and other chemical constituents of many alcoholic beverages are not the prime determinant of odor after the beverage is fully absorbed. Note that although vodka has only a few parts per million of these chemicals and bourbon contains several thousand parts per million, there was little difference in the detection of the odors from these two substances. This suggests that what is detected in the breath may be a constituent of the metabolization of alcohol.

In this controlled environment study, it was demonstrated that officers were able to derive only limited information from alcohol odor. These findings are consistent with the Widmark (1932) police station study and the Compton (1985) open air roadside studies. Both previous studies found small likelihood of detecting breath alcohol odors for BACs below 0.08–0.10% and detection failures even above 0.10%.

Given the difficulty of detecting the odor of alcohol under roadside conditions and the likelihood of underestimating BAC from the strength of the odor, it would seem prudent for an officer who detects any odor of alcohol on a drivers breath, (assuming that the driver hasn't drunk in the last 15 or 20 min), to administer field sobriety tests or an alcohol breath sensor.

Furthermore, given the low probability of detecting an alcohol breath odor, it might be prudent for officers to use a breath testing device whenever a driver exhibits behaviors frequently associated with alcohol use. Equally prudent might be the use of a passive alcohol sensing device whenever an officer contacts a driver after a collision or traffic infraction.

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