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RAPID COMMUNICATION

Predicting Alcohol Impairment: Perceived Intoxication Versus BAC

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The purpose of this study was to report the relationship among perceived intoxication, performance impairment, and actual blood alcohol concentration (BAC) levels. Fifteen subjects, aged 21 to 40, completed both single- and double-dose sessions of alcohol consumption. BACs, reaction and anticipation time, and perceived intoxication data were collected during both sessions. Analysis of data showed that perceived intoxication was significantly related to performance impairment, but the actual BAC was not.

Key Words: Perceived Intoxication, Impairment Predictors.

EXPERIMENTAL DATA have indicated that alcohol impairs driving-related skills such as divided attention, vision, perception, tracking, information processing, etc.[1] While the degree of alcohol intoxication is an important clinical, social, and educational matter, what may be more important is the individual's perceived extent of impairment that, in turn, would likely alter a driver's willingness to drive after drinking.

Several researchers have investigated self-perceived levels of intoxication in relation to actual BAC levels.[2-11] In general they have found positive linear relationships between perceived intoxication measured by questionnaire response and actual BAC changes. For example, in a laboratory setting, Mills and Bisgrove[8] demonstrated a linear relationship between subjects' estimates of impairment while intoxicated and BAC. In the field, however, with data collected from two fraternity parties, the same authors found no apparent relationship between intoxicated subjects' perceived estimate of impairment and their BAC ($r = 0.14$).

Acute tolerance to alcohol, usually demonstrated by showing a greater effect on the ascending limb of the BAC curve than at the same BAC level on the descending limb, was first reported by Mellanby in 1919.[12] Numerous studies have since been conducted confirming acute tolerance effects on physiological and behavioral measures.[13-15] Radlow and Hurst[16] investigated the relationship between self-perceived alcohol effect and acute tolerance, and discovered that the peak subjective alcohol effect occurred 24 min before peak BAC. Portans et al.[17] reported similar findings and suggested that during and immediately after a drinking bout, perceived level of intoxication was poorly correlated with BAC. The authors concluded that one's perceived level of intoxication may be a better indicator of behavioral impairment than BAC. Although the phenomenon of acute tolerance is not a focus of this study per se, there does seem to be a consistency between peak alcohol effect and impairment, whether measured by actual BAC or an individual's perceived level of intoxication.

This study was designed to investigate the relationship between perceived levels of intoxication, BAC, and psychomotor skills. Psychomotor skills were determined by measuring reaction time (RT) and anticipation time (AT). In an earlier study to measure variability in behavior impairment at specific levels of the rising and falling BAC curve, we[18] found, as did Schmidt,[19] and Wilson and Plomin,[6] that RT and AT time tasks were free of practice effects, and we therefore chose to use these tests as a measure of psychomotor skills. Nicholson et al.,[18] in a previous alcohol intoxication study of RT and AT, conducted a nonalcohol follow-up procedure using an identical test protocol. Results indicated that there were no significant improvements in performance due to practice in the nonalcohol group.

Reaction time and anticipation time measures are common in research on psychomotor skills because they are components of many real-life tasks.[19] They represent the skills of eye-hand coordination, perception of motion, motion prediction, and visual estimation of speed.

METHODS

Sixteen (eight males and eight females) paid volunteer subjects, aged 21 to 40, participated in the study. Each potential subject was interviewed by the investigators to determine eligibility for the study, and each completed the Khavari Alcohol Test,[20] a screening tool to quantify their current and previous drinking experiences. Subjects were excluded for the following reasons: family history of alcoholism; drinking practices of more than 1.5 times the national average of 27.8 ml of alcohol per day,

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or drinking less than twice per week; apparent overweight; oral contraceptive use; pregnancy; or physical illness. Only moderate drinkers, as determined by the Khavari Test criteria, were included in the study. All selected subjects received a complete written and verbal explanation of the study including all testing procedures, and signed an informed consent. Once selected, qualifying volunteers each received a complete physical examination by a physician before participating in this study. Payment of $35.00 was made to each subject at the end of the study.

Each subject took part in two experimental sessions, one single-dose and the other double-dose. The majority of alcohol studies examining behavioral impairment have used dosages that would produce a peak BAC of 0.10 or above. Less attention has been given to impairment at a peak of 0.08 or below. The rationale for using both single- and double-dose conditions was to examine performance impairment at different intoxication levels, including those below 0.10. The order of the two drinking sessions was counterbalanced, and there was a time interval between the two sessions of approximately 20 to 30 days.

Procedures

Prior to each session, subjects had been instructed to refrain from eating or drinking, except water, from 10:00 PM the night before, and to consume no alcohol or other drugs for 24 hr prior to the time of their testing. Testing sessions started at approximately 10:00 AM. Four subjects were tested per day.

Upon arriving at the laboratory for the first session, each subject again received an explanation of the testing procedures. The following tests were administered prior to alcohol consumption to establish a baseline, and at specified intervals throughout the testing at both sessions:

1. Simple reaction time (RT) and anticipation time (AT). Following five practice trials of RT and AT, 10 recording trials were measured. The RT and AT were measured using the modified Bassin Anticipation Timer (Model 50575). The system consisted of a solid-state control unit, a start and finish (L.E.D.) lighted runway 30-inches long, and a response button. When the trial started, a stimulus light following a varied foreperiod (1.5–4 seconds) came on, and the subject responded to the stimulus as quickly as possible by pressing a hand-held button. The light then traveled down the runway at a velocity of 4 miles per hr, and the subject was to anticipate the arrival of the light at the target location at the end of the runway. Only the mean values of the 10 trials were used for data analysis. The RT and AT measures were used for several reasons: they are most common in psychomotor research, they are components of many real-life tasks[21] and they appear to be consistent regardless of practice effects.[18] Both simple RT and AT represent the attentional state and neuromuscular speed of individuals.

2. Breath ethanol measurements were taken to control for zero levels preceding the drinking test sessions, and at 5-min intervals thereafter, continuing through the peak BAC and falling curve until BACs were less than 15 mg/dl. At no time during the testing were subjects aware of their BAC readings.

3. Immediately following each BAC measurement, subjects were asked to estimate their perceived degree of intoxication on a scale where 0 represented completely sober and 10 represented "very high" or drunk.

For the single-dose session, each subject was served an alcoholic beverage consisting of 1 ounce of ethanol (approximately 2.3 ounces of 86 proof vodka) and orange juice in the ratio of 4 parts juice to 1 part ethanol. For double-dose sessions, subjects drank two drinks (approximately 4.6 ounces of 86 proof vodka). Subjects were instructed to finish drinking in approximately 20 min for the single-dose session and 40 min for the double-dose session.

RESULTS

Of the 16 subjects participating in this study, 15 retained both double- and single-dose ethanol beverages and completed all behavioral tests. The subsequent analyses were based on these 15 subjects.

For the convenience of comparison, all scores were transformed into Z-scores. The RT and AT performance scores were used as the impairment criteria. Pearson correlation coefficients between perceived intoxication and performance, and between BAC and performance were computed. Tables 1 and 2 present the correlation coefficients between performance scores and BAC levels, and perceived intoxication for the single dose and double dose, respectively.

As shown in Table 1, significant relationships were found in the single-dose condition for all reports of perceived intoxication and RT/AT performances, with the exception of RT at 140 min. Conversely, only one correlation showed significance (BAC and RT at 40 min) for the BAC and performance measures.

In the double-dose condition (see Table 2), similar results were found. While all correlations between perceived intoxication and performance scores (RT and AT) were significant, no BAC-performance score was.

Table 3 presents the Z-score values for correlation coefficients between perceived intoxication, performance, and BAC levels during both single-dose and double-dose sessions. These data clearly indicate that the subjects' self-perceived intoxication levels correlate more highly with

Table 1. Correlation Coefficients Between BAC and Performances, and Between Perceived Intoxication (PI) and Performances for the Single Dose Condition Across All Subjects ($n = 15$)

	Minutes following drinking						
	20	40	60	80	100	120	140
BAC and RT	0.34	0.42*	0.38	0.33	0.34	0.36	0.32
PI and RT	0.54*	0.55*	0.49*	0.50*	0.48*	0.43*	0.40
BAC and AT	0.36	0.41	0.34	0.31	0.33	0.32	0.33
PI and AT	0.55*	0.56*	0.51*	0.50*	0.50*	0.44*	0.45*

* $p < 0.05$, one-tailed.

Table 2. Correlation Coefficients Between BAC and Performances, and Between Perceived Intoxication (PI) and Performances for the Double Dose Condition Across All Subjects ($n = 15$)

	Minutes following drinking						
	20	40	60	80	100	120	140
BAC and RT	0.35	0.40	0.40	0.37	0.35	0.34	0.35
PI and RT	0.61*	0.60*	0.55*	0.53*	0.49*	0.53*	0.48*
BAC and AT	0.37	0.35	0.38	0.38	0.32	0.32	0.30
PI and AT	0.56*	0.53*	0.54*	0.52*	0.55*	0.48*	0.49*

* $p < 0.05$, one-tailed.

Table 3. Z-Scores for Differences in Correlation Coefficients Between Perceived Intoxication (PI) and Performances, and BAC and Performances Across All Subjects ($n = 15$)

	Minutes following drinking						
	20	40	60	80	100	120	140
Double-dose							
BAC and RT vs. PI and RT	2.35	2.21	1.98	2.02	2.00	2.12	NS*
BAC and AT vs. PI and AT	2.13	2.10	2.02	1.97	NS	2.00	2.08
Single-dose							
BAC and RT vs. PI and RT	2.18	1.99	NS	1.98	2.00	2.12	2.10
BAC AND RT VS. PI AND AT	2.12	1.97	2.05	2.08	2.00	NS	NS

NOTE: Z-SCORE GREATER THAN 1.96 IS SIGNIFICANT AT 0.05 LEVEL.
* NS, not significant.

Table 4. Means and Standard Deviations (in Parenthesis) of BAC, Perceived Intoxication (PI), RT, and AT Scores Across Time for Single Dose

	Baseline	Time (min)						
		20	40	60	80	100	120	140
BAC (%)	0	0.045	0.066	0.062	0.057	0.044	0.038	0.028
		(0.015)	(0.016)	(0.017)	(0.013)	(0.014)	(0.011)	(0.009)
PI	n/a	5.7	6.5	6.0	5.2	4.2	3.1	2.0
		(1.6)	(1.8)	(1.4)	(1.3)	(1.3)	(0.8)	(0.4)
RT (ms)	205.1	218.5	216.9	208.4	210.1	212.0	202.5	195.7
	(14.8)	(15.5)	(13.1)	(15.7)	(14.3)	(15.7)	(12.4)	(10.7)
AT (ms)	50.0	57.5	53.8	54.8	48.3	40.2	37.0	40.1
	(12.5)	(13.2)	(13.4)	(13.0)	(12.2)	(11.9)	(12.4)	(11.3)

Table 5. Means and Standard Deviations (in Parenthesis) of BAC, Perceived Intoxication (PI), RT, and AT Scores Across Time for Single Dose

	Baseline	Time (min)							
		20	40	60	80	100	120	140	
BAC (%)	0	0.061	0.098	0.092	0.087	0.077	0.061	0.043	0.026
		(0.018)	(0.021)	(0.016)	(0.017)	(0.015)	(0.013)	(0.008)	(0.005)
PI	n/a	7.6	8.2	7.6	6.2	5.5	4.1	3.2	2.1
		(1.5)	(1.7)	(1.3)	(1.2)	(1.1)	(0.9)	(0.3)	(0.3)
RT (ms)	213.5	223.4	222.7	222.6	218.3	215.8	210.1	196.0	198.4
		(14.8)	(13.7)	(15.1)	(14.8)	(15.0)	(14.7)	(12.7)	(13.5)
AT (ms)	49.7	58.7	68.8	57.4	59.1	44.7	37.2	39.9	38.5
	(13.4)	(15.5)	(14.4)	(13.8)	(13.2)	(12.9)	(12.5)	(11.2)	(12.0)

their performance than do their BAC levels. Furthermore, the differences were significant in the majority of cases.

Tables 4 and 5 show means and standard deviations for BAC and perceived intoxication (PI), RT, and AT scores across time, for both the single- and double-dose sessions. These results appear to reinforce findings of earlier studies that show that self-perceived levels of intoxication rise more rapidly initially than BAC levels.[2,3,5,17]

DISCUSSION

Few research designs have called for simultaneous collection of time course data involving BAC, perceived intoxication, and psychomotor performance for a given dose and regimen of alcohol. As expected, the results of this study supported previous research findings involving acute tolerance effects in that impairment was greater on the rising limb than on the falling limb. Perceived intoxication was significantly correlated with RT and AT, with one exception, across the entire time course of alcohol absorption, for both double- and single-dose sessions.

The positive, but not significant, correlation coefficients between BACs and RT and AT seem to be consistent with previous studies.[2–4,7] The findings from this study as well as the previous studies suggest that there is a link between BACs and psychomotor performance, and between perceived intoxication and psychomotor performance. Subjects' perceived intoxication, however, correlated more closely with performance than did the BACs (see Table 3). This might be due to biological variability among subjects and/or time-related differences of BACs, which makes it difficult to use the BAC to predict performance impairment.[22]

In assessing their own intoxication level, drinkers may be able to use factors such as confidence, previous drinking experience, temporary changes in mood, feelings of anxiety, and psychophysiological behaviors to estimate their impairment. These speculations are worth further investigation since no studies appear to have examined such specific criteria as reliable indicators of intoxication. If, as researchers have indicated,[1] the impaired psychomotor performance under the influence of alcohol is indeed one of the major factors associated with automobile accidents, and if an awareness of self-perceived intoxication is correlated with psychomotor performance, then it behooves drinkers to pay attention to their perceptions of level of intoxication. In addition, if specific criteria can be identified as indicators of the feeling of intoxication, then those indicators can be described to others.

It follows that educational efforts toward prevention of alcohol abuse and prevention of alcohol-related injury, particularly involving motor vehicles, could incorporate knowledge of those indicators. These results show that for alcohol education, self-perceived intoxication should be given greater attention to facilitate individual drinking-driving decision-making processes. In reality, few who have consumed alcohol are apt to have access to their BAC level, and self-perceived intoxication may be the only information that individuals have available to judge the degree of their alcohol impairment.

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