How intoxicated are you?

Investigating self and observer intoxication ratings in relation to BAC.

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Abstract

Introduction and Aims: The ability to accurately detect alcohol or other drug intoxication is an important skill for people who use these substances and for a variety of professions (e.g., policing, responsible service of alcohol). Previous studies have found that intoxicated people are generally poor at estimating their own level of intoxication (particularly at high Blood Alcohol Concentration; BACs) and the link between intoxication and BAC appears to drop-off at higher BAC levels. But studies of observer ratings of other's intoxication have yielded mixed results. The aim of this study was to investigate both self- and observer-ratings of intoxication against BAC levels to determine whether we see a similar drop-off in intoxication report for both self- and observer-rated intoxication.

Design and Methods: Participants were 388 students interviewed outside three university events. Participants provided demographics, a rating of how intoxicated they felt (0=not at all, 10=very), and provided a breath test. Interviewers recorded a rating of how intoxicated the participant appeared to be.

Results: We fitted our data with both polynomial and linear regressions. Polynomial regression provided a better fit when predicting both self-rated intoxication ($r^2=0.49$ vs. $r^2=0.40$, $p < 0.001$) and observer-rated intoxication from BAC ($r^2 = 0.58$ vs. $r^2 = 0.52$, $p < 0.001$), suggesting that there is a drop-off for both intoxication ratings.

Discussion and Conclusions: Both self-rated and observer-rated intoxication appeared to drop-off at higher levels of BAC. This may be due to either tolerance or a 'ceiling effect' for observable signs of intoxication.

Keywords: intoxication, alcohol, BAC, self-report, observer-report

Introduction

Excessive alcohol use continues to be a significant public health problem [1]. Alcohol-related impairment (e.g., to driving) is dangerous to both the intoxicated person and those around them. Thus, it is critical that impairment is accurately identified and addressed by both the person that has consumed the alcohol (e.g., accurately estimating their intoxication) and those interacting with the intoxicated person (e.g., responsible service of alcohol). Empirical research, however, provides an inconsistent picture about whether people can accurately judge the presence or level of intoxication in themselves or others. For example, for self-rated intoxication, people at lower levels of intoxication (i.e., Blood Alcohol Concentration, BAC ≤ 0.08) are either relatively accurate [2] or *overestimate* their intoxication [3, 4], whereas at the higher levels of intoxication (BAC ≥ 0.15) people typically substantially *underestimate* their intoxication [2-4]. Furthermore, in Kaestle et al. [2], the data best fit a polynomial, rather than linear, model suggesting that at a higher BAC self-rated intoxication is non-responsive to differences in BAC.

For observer-rated intoxication, the results are also mixed. For example, in a street intercept study [5], there was a modest association between surveyors' ratings of intoxication and BAC. Even professionals who regularly interact with alcohol-intoxicated people (e.g., police, bartenders, clinicians) can be surprisingly poor at correctly identifying presence or level of intoxication [6-10]. In Pagano and Taylor [8], police significantly underestimated BAC at both low ($\sim 0.04\%$) and high ($\sim 0.10\%$) levels of intoxication. In a study based in the emergency setting, clinicians missed approximately 23% of alcohol-intoxicated presentations [9]. Bias can also play a role: patients who appeared to be disheveled or of low SES were significantly more likely to be falsely suspected of intoxication [9]. Years of experience or receiving training may not always be enough to overcome these inaccuracies [6, 11]. Importantly, many of the signs commonly associated with alcohol intoxication can also be

present in non-intoxicated people (e.g., altered mood, slurred speech, poor motor coordination) which can create difficulties for detection accuracy [6].

Although several studies have investigated either self- or observer-rated intoxication in relation to BAC, few studies have investigated both ratings in their assessment of intoxication levels. Although Lubman et al. [12] did correlate self- and observer-rated intoxication assessments ($r=0.63$), this analysis did not take into consideration the potential non-linear relationship between BAC self-/observer-rated intoxication [e.g., see 2]. Here, we account for this relationship by using both linear and polynomial regressions, to determine if we see a similar drop-off in intoxication reports for both self- and observer-rated intoxication. We also examine whether any participant or observer characteristics (e.g., gender, ethnicity) were associated with different accuracy rates.

Method

We conducted interviews and breathalyzed young people attending concerts during the University of Otago's Orientation Week, a period with a number of social events typified by alcohol use and higher BACs [13, 14]. Researchers worked in teams of 2-3 outside the entrance to each event. Potential participants were approached, provided with a brief overview of the purpose of the study, and invited to take part in a 3-5 minute interview (for additional information on the methods see [13]). All study procedures were approved by the University of Otago ethics committee (16/007).

Measures

Demographics/descriptives. Gender, ethnicity, age, and number of standard drinks in the current session (New Zealand standard drinks).

BAC. BAC was measured using an Australian Standards breathalyser (Lifeloc® FC10) which provided Breath Alcohol Consumption (ug/L).

Self-rated intoxication. Participants rated their current intoxication from 0 (not intoxicated) to 10 (very intoxicated).

Observer rated intoxication. Researchers rated how intoxicated they believed the participant was based from 0 (not intoxicated) to 10 (very intoxicated). This item was based on a measure from Lubman et al. [12] and intoxication ratings were based on signs of intoxication (e.g., loss of coordination, slurred speech; observers received no formal training and were asked to use their best judgment).

Analysis strategy

We included 388 participants who had consumed at least one drink, had complete data for self- and observer-rated intoxication, and could provide a reliable breath test. To measure the relationship between BAC and self/observer-rated intoxication, we used a similar strategy to Kaestle et al. [2] and depicted the link between BAC and intoxication graphically with 1) linear regressions and 2) polynomial regressions to determine which model fit the data better and whether there was a non-linear relationship between BAC and intoxication. Next, we added individual predictors to a multiple regression to determine whether any factors were associated with intoxication (age, gender, ethnicity [Pākehā/NZ European, 0 = other]).

Results

Participants

We approached 902 participants and 388 met our inclusion criteria (for full attrition see [13]), 48% were men, most were Pākehā/New Zealand European (79%), and 18 years of age (median=18; SD=1.7; Range=17-32). Participants reported consuming an average of 7.1 (median= 6.6; SD= 4.4) standard drinks before the interview. For our sample, the average BAC was 346ug/L (median= 340, SD= 231), self-reported intoxication was 4.3 (median= 5.0, SD= 2.5), and observer-rated intoxication was 4.4 (median= 5.0, SD= 2.4). Note, there was a

strong correlation between self- and observer-rated intoxication ($r = .802$, $p < .001$; see supplementary material for figure).

Link between BAC and self/observer-intoxication

As shown in Figure 1a, the polynomial regression provided a better fit when predicting self-rated intoxication from BAC ($r^2 = 0.49$ vs. $r^2 = 0.40$; $F = 75.493$, $p < 0.001$). Similarly, when predicting observer-rated intoxication from BAC, the polynomial regression provided a better fit ($r^2 = 0.58$ vs. $r^2 = 0.52$; $F = 51.186$, $p < 0.001$). These findings suggest that the relationship between BAC and both self- and observer-related intoxication is non-linear and appears to flatten out at higher BAC.

Additional predictors (age, gender, ethnicity)

Neither gender (estimate = -0.1 , $p = .57$) nor age (estimate = $.07$, $p = .15$) accounted for any additional variance in the models. However, when using a binary estimate of ethnicity, ethnicity accounted for additional variance (estimate = $-.24$, $p = .048$), suggesting that NZ European/Pākehā tended to under-estimate their intoxication compared to other ethnicities. In contrast, in the models predicting observer-rated intoxication, neither participant gender nor ethnicity accounted for any additional variance, but age emerged as a significant predictor (estimate = -0.13 ; $p = .006$; $r^2 = .581$), suggesting that observers underestimated the intoxication of older participants.

Insert Figure 1 here

Discussion

We found that both self and observer ratings of intoxication are underestimated at higher levels of BAC and observed a non-linear association between intoxication ratings and BAC. While intoxication ratings were reasonably accurate for lower to moderate levels of BAC,

there was a ‘drop-off’ for both self- and observer-rated intoxication at relatively high BAC (e.g., 3 times the legal drinking limit). Furthermore, for self-rated intoxication, ethnicity was significantly related to subjective intoxication ratings, with NZ European/Pākehā more likely to under-estimate their intoxication relative to BAC; for observer-rated intoxication, observers were significantly more likely to underestimate the intoxication of older participants.

The observed ‘drop-off’ in self-rated intoxication is consistent with previous research [e.g., 2]. Explanations from other studies suggested that cognitive impairment may occur at the higher intoxication levels, meaning that people can no longer interpret internal signals of intoxication. However, as we observed this ‘drop-off’ effect at the higher intoxication levels for observer-rated intoxication as well, the ‘cognitive impairment’ explanation does not apply here (as the observers were not intoxicated); thus, it is possible that another explanation is needed for both effects. One potential explanation is that, in the context of the current study, there is a ‘ceiling effect’ for observable signs of intoxication. That is, participants in the current study, at minimum, had to walk a moderate distance to the event which eliminates the possibility of observing participants displaying behaviors associated with severe levels of intoxication (e.g., unconsciousness). In addition, given this is a relatively young sample, tolerance and experience with alcohol likely varies dramatically, which in turn may influence the relationship between behavior and BAC. Furthermore, acute tolerance (or the ‘Mellanby effect’) may provide another explanation for the apparent drop-off effect, such that intoxication levels decrease quickly after acute alcohol exposure [15, 16]. However, we believe it is an unlikely, given that acute tolerance is associated with the descending limb and most participants were entering the event and at the beginning of their drinking session [16].

Limitations. Slightly lower BAC levels were observed in this sample in comparison to other studies [2], which is likely due to the nature of the sample (younger, less experience

with alcohol). Furthermore, the ‘observers’ in this study were ‘untrained’, so results should be replicated in other cohorts that have training/experience (e.g., responsible service of alcohol, police).

Conclusion. In the current paper we provide evidence that both self- and observer-intoxication ratings appear to drop-off at greater BAC. Although this finding suggests that additional training may be necessary to identify those at higher levels of intoxication, it is important to note that this drop-off occurred at relatively high BACs (~3 times the legal drinking limit). The fact that this effect was present for both self and observer ratings suggests explanations beyond cognitive impairment are needed to understand the mechanisms behind these results.

DECLARATIONS

Conflicting interests

PH has received funding from the Lambert Cannabis Initiative at the University of Sydney to undertake clinical trials of cannabinoid treatment for alcohol withdrawal syndrome. PH has served on industry advisory boards for Indivior, AbbVie and Gilead and has been an investigator on clinical trials supported by Camurus. He has also served on an International Advisory Board for Lundbeck in relation to nalmefene. All other authors have nothing to declare. The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Ethical approval:

The ethics committee of the University of Otago approved this study (REC number: 16/007).

Guarantor:

DS

Contributorship

LM provided scope and co-wrote the first draft of the manuscript. BCR co-wrote the first draft of the manuscript, contributed to the study design, managed the data collection, and contributed to the statistical analyses. JAMF contributed to the study design, collected data and revised the first draft of the manuscript. TSC contributed to the study design, contributed to the writing of the manuscript, and contributed to the statistical analyses. DS and PH contributed to the study design, provided funding for the study, oversaw and contributed to the writing of the manuscript.

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Figure 1. Linear (dotted line) and polynomial (solid black line) regression models with 95% confidence intervals predicting observer-rated or self-rated intoxication. Additional points of

reference are added at the mid-point of intoxication (5) and at the legal drink-driving limit (250ug/L).

Supplementary Figure 1. Relationship between Self-rated and RA-rated intoxication.