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Behavioural Change and Alcohol-Fuelled Violence: A Field Experiment

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Abstract

We conduct a field experiment to assess whether alcohol-induced behavioural changes explain participants' recent history of violence. We find that being in a drinking environment, rather than intoxication, reduces participants' cognitive ability but increases their overconfidence. Those who experience small reductions in ability or become much more overconfident tended to have been involved in more violent incidents. Since these behavioural changes were largely unanticipated, our results suggest that individuals underestimate their true likelihood of becoming involved in violence when making alcohol consumption decisions. This presents additional challenges when formulating policy designed to deter alcohol-fuelled violence.

Keywords: Intoxication, over-optimism, violence *JEL:* C93, D91, I18.

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1. Introduction

Alcohol-fuelled violence is never far from public conversation. Intoxication plays a role in 36 percent of all violent crime in the United States, and 40 percent of those in the United Kingdom (Bureau of Justice Statistics 2010; Office for National Statistics 2017). These incidents inflict a significant external cost on society. Victims suffer physical and emotional harm, resulting in lost labour productivity and large healthcare bills. Perpetrators must be prosecuted, incurring criminal justice costs. In the United Kingdom, the annual social cost is approximately £10 billion, equivalent to 20 percent of the country's national defence budget (Office for National Statistics 2017, 2018; Heeks et al. 2018). It is therefore unsurprising that understanding the causes of alcohol-fuelled violence is of interest to policymakers in both public health and law enforcement.

The correlation between alcohol consumption and violent behaviour is well established, and has been investigated across multiple disciplines. In medicine, for example, the effects of alcohol on likelihood of violence-related (as opposed to non-violent related) injury was examined among patients attending 32 Emergency Departments across fifteen countries (Cherpitel and Ye 2010). Findings indicated that, both within and across countries, violence-related injuries were significantly more likely when alcohol was consumed prior to injury compared to injuries from other causes. Indeed, alcohol consumption is considered a strong risk factor for both violent offending and victimisation (Shepherd et al. 2006).

Evidence of a direct causal relationship between alcohol consumption and aggression has been shown by psychologists in laboratory settings. In a series of experiments, participants delivered electric shocks to a fictitious opponent (Bushman and Cooper 1990). Those who consumed alcohol delivered more frequent, more intense shocks than either a control group, or those who had consumed a placebo alcoholic drink.

The economics methodology has attempted to establish causality by examining the cross-price effect of changes to the price of alcohol on violence. A negative relationship between the price of alcohol and measures of violence, confirmed by several reduced form type econometric studies for both the United States and the United Kingdom, indicates a one-way causation (Markowitz et al. 2012; Matthews et al. 2006; Page et al. 2017).

Whilst the claim that intoxicated individuals are more likely to be violent is not disputed, the precise mechanism by which alcohol consumption leads to violence is much less well understood. The state-of-the-art in economics argues that alcohol-fuelled violence is a fully rational decision (Markowitz and Grossman 2000; Markowitz 2000, Markowitz 2005).

Alcohol and violence are viewed as complementary consumption goods, and so individuals prefer drinking and fighting together. Under this framework, individuals fully understand what they are doing, and never have regrets.

Attempts in the medical and psychological literatures to explain the mechanism by which alcohol consumption leads to violence are much more wide-ranging[1] and can be divided into three broad avenues of investigation. The first argues that alcohol has a direct, psychopharmacological effect on the brain that causes behavioural changes. The chemical properties of alcohol are thought to boost courage or excitability, making individuals more confident of winning a fight, and hence more likely to engage in violent behaviour (Pernanen 1981; Fagan 1993). Alcohol is also believed to impair internal inhibitory processes giving way to naturally aggressive impulses (Bushman 1997). The second proposes that the drinking environment itself may induce changes in behaviour. Over-crowded venues, sexual competition (Graham and Homel 1997), high temperatures (Graham 1980), inaccessible bar and toilet facilities (Tomsen 1997), adverse noise levels (Quigley et al. 2003; Graham and Homel 1997) and competitive games (Graham and Wells 2001) are all thought to contribute to individuals becoming more prone to violence. The third notes that society tends to be more forgiving of abhorrent behaviour under the influence of alcohol, arguably because the individual is thought to not be fully in control of his actions (Fagan 1990; Gelles and Cornell 1990). This creates a self-fulfilling prophecy, by lowering the cost of violent when intoxicated.

Of course, these proposed mechanisms are not mutually exclusive. If, however, individuals are not fully aware of the behavioural changes they undergo when intoxicated in a drinking environment, policymakers face an additional dilemma. To illustrate, suppose that the severity of punishment faced by those convicted of alcohol-fuelled violence is increased. If an individual understood how alcohol consumption changed their behaviour, this would deter them from drinking and hence reduce alcohol-fuelled violence. If instead the individual was completely unaware of their behavioural changes they undergo – naive in the terminology of O'Donoghue and Rabin (1999) – then they argue as follows: "When I am sober, I would never become involved in a fight. Since my behaviour does not change when I become intoxicated, I would never become involved in a drunken fight. The increase in the severity of punishment only applies if I become involved in a drunken fight, so it is not relevant to my alcohol consumption decision. My decision does not change as a result of the new policy." Such an

[1] For a recent survey see Lipsey et al (2002)

individual would be just as likely to become involved in a drunken fight before and after the policy change. In this case, the policy would prove completely ineffective.

Recent laboratory experiments into economic decision-making and intoxication have cast doubt on whether the psychopharmacological effects of alcohol can explain alcohol-fuelled violence (Corazzini et al. 2015; Bregu et al. 2017). Across a broad range of decision-theoretic experiments, intoxication was found to result in no change in behaviour. The authors conjectured that the one thing that they could not vary in a lab setting – the drinking environment – may trigger the behavioural changes they were expecting to find.

We present the results of a field experiment designed to take a first step towards addressing two questions. Firstly, what role does the drinking environment, rather than intoxication, play in changing behaviour? Secondly, to what extent are individuals aware of the behavioural changes that they undergo as a result of alcohol consumption? Whilst the experimental design can be applied to a range of behaviours, we apply it to two of the proposed behavioural mechanisms causing alcohol-fuelled violence: changes in ability and overconfidence. We then use the results of our experiments to empirically assess the importance of these two channels in explaining our participants' recent histories of violence and whether individuals anticipate the changes that make them violent.

We recruited mildly intoxicated participants from a bar at the Cardiff University Students' Union. After completing a breath test to provide an objective measure of intoxication, they undertook an off-the-shelf, timed over-optimism test. Participants were asked to answer ten questions from a culture-free IQ test (Raven et al. 2003). They were provided with no feedback on their performance and were, instead, asked to guess how many questions they answered correctly. Their performance in the IQ test provided us with a proxy for their cognitive ability whilst intoxicated in a drinking environment. Comparing their guess to their actual performance provides a widely used measure of *over-optimism bias* (Moore and Healy 2008; Herz et al. 2014).

We then invited the same cohort to attend a follow-up session one week later. This was conducted in a meeting room in the same building in the middle of the afternoon. The structure of the experiment was broadly similar. Participants completed another breath test, and took a second, timed over-optimism test. We also elicited their sober beliefs about their intoxicated behaviour, administered a short survey and paid them. This second session enabled us to disentangle the effects of the drinking environment from intoxication on cognitive ability and over-optimism. Whilst all participants experienced the same change in environment between sessions, the change in intoxication varied across individuals.

Our empirical contributions are three-fold. First, we provide evidence in favour of the conjecture put forward by the laboratory studies on economic decision-making and alcohol. Being in the drinking environment, rather than being intoxicated, triggers reductions in ability and increases in overconfidence. Second, of concern to policymakers, our participants appear relatively naive about these behavioural changes. They systematically underestimated the decline in their ability and did not predict any increase in overconfidence. Third, changes in ability resulting from being in the drinking environment are a robust, significant predictor of violence. Whilst changes in overconfidence are also associated with violence, the association is weaker.

The remainder of the paper is as follows. Section 2 outlines the experimental design and highlights some important ethical constraints relating to conducting field experiments with intoxicated participants. Section 3 discusses the data we collected and outlines our empirical strategy. Section 4 presents the main experimental findings and assesses whether the behavioural changes we identify predict our participants' recent history of violence. Section 5 concludes.

2. **Experimental Design**

Participant recruitment and first session

Participants were recruited directly from a bar at Cardiff University Students' Union on Thursday evenings during February and March 2018. Thursdays were chosen because they coincided with a regular pub quiz at the Union, which consistently saw around 200 participants. This provided us with a large pool of mildly intoxicated individuals from which to draw our sample.

Participants were provided with an information leaflet outlining the structure of the study and the payments they would receive, which they then discussed with the researcher. Each participant received £10 for taking part in the study, and up to another £10 based upon their performance in one randomly chosen stage of the experiment. The six stages of the experiment were explained, and that the payment stage would be chosen by the roll of a die at the end of the second session. Recent evidence from a meta-study suggests that paying participants for one randomly selected stage of an experiment has much the same effect on their incentives as paying them for every stage (Charness et al. 2016). Moreover, it is more likely to be incentive compatible (Yaron et al. 2018). Breakdowns of the potential payments were also provided immediately before participants began each stage. The study received ethical approval from the Cardiff Business School Ethics Committee on 17th July 2017.

Discussing the information leaflet served two purposed. First, it gave the participant a chance to ask questions about the study. Second, it allowed the researcher to determine whether the participant was able to give informed consent. If both parties were satisfied, the researcher talked them through a consent form, which the participant then completed and signed. Anyone considered by the researcher to be unable to provide informed consent (for example, due to intoxication) was excluded from the study. The consent form also asked for an email address, which constituted the only personal information participants provided while intoxicated. They were then led to the Students' Union foyer, just outside the bar, where several laptop computers had been set up. All stages of the experiment were conducted using a programme written in z-Tree (Fischbacher 2007).

First, participants undertook an alcohol breath test, which provided a commonly used measure of intoxication: the blood alcohol content (hereafter BAC) score, defined as the milligrams of alcohol per litre of breath expelled. So as not to bias their responses, participants were not told their score. Instead it was entered into the computer by the researcher.

The computer was then handed over to the participant. The research design relied upon our ability to link the results for the same participant across two separate sessions. However, to reduce the possibility of bias in participant responses, it was equally important to maintain their anonymity. Given that our participants were initially mildly intoxicated, we devised a system that was relatively simple, visual and did not rely on them remembering any information. Participants were asked to draw a raffle ticket from an urn, providing them with a unique identification number. Without showing the researcher, they entered this into the computer, which prompted them to double-check that the number they provided was correct. They then sealed the ticket in an envelope with their name on it, which was retained by the researcher on the promise that it would be returned at the second session. Envelopes for participants who did not attend the second session were destroyed at the conclusion of the study without being opened.

Participants then undertook an off-the-shelf over-optimism test, based on Raven's Standard Progressive Matrices (hereafter SPM, Raven et al. 2003). Each screen presented participants with a pattern, one piece of which had been removed. Immediately underneath, either six or eight candidates for the missing piece were shown, and the participant was asked to correctly identify which option completed the pattern. This test was chosen for several reasons. Its relatively simple structure reduced the probability that intoxicated participants would not understand what was expected of them. Its visual nature meant that participants did not need to read a lot in order to answer. Finally, the SPMs are designed not to become easier with practice, minimising the gains from learning across sessions. Responses were timed, to control for the possibility that participants might rush through the test in order to return to their pub-quiz team, i.e. because they had a relatively high opportunity cost of time.

We first presented two practice questions. After selecting an option, the correct answer was immediately displayed. Participants were then prompted to ask questions if they did not understand any aspect of the test. They were then told that they would have to answer ten questions and that, if this stage of the experiment was chosen for payment, each correct answer was worth £1. No feedback was given on their performance, and questions became increasingly difficult. Questions were selected from the full forty-question Raven's SPM culture-free IQ test based upon the work of Bilker et al. (2012), who identified the combination of ten questions which were the best predictor of a participant's overall score in the full test.[2]

Upon completing the SPM questions, participants were asked to predict how many questions they answered correctly. They were told that, if this stage of the experiment was chosen for payment, a correct prediction would pay £10; a prediction that was one question away would pay £9; two questions away would pay £8 etc. Again, no feedback was provided to minimise the opportunity for learning.

This concluded first session. Participants were thanked, given a lollipop, and told that they would be contacted shortly to organise attendance at the second session.

In laboratory work on intoxication, participants are only paid after enough time has elapsed following the end of the experiments for the effects of the alcohol that the researchers administered to wear off (Corazzini et al. 2015; Bregu et al. 2017). As this clearly is not an option in the field, research ethics dictated that payments were withheld until the follow-up session. Moreover, despite our determination that the individual was able to give informed consent, we did not ask any control questions at this stage. If a participant withdrew from the study after the first session, possibly because they did not believe that their consent had been sufficiently informed, they had not provided us with any personal details beyond their name and email address.

[2] Questions A11, B5, B12, C4, C12, D7, D12, E1, E5 and E7 were used in the first session.

Session Two

The follow-up session was held in a meeting room at the Students' Union on the Thursday afternoon after the first session. Participants were provided with another information sheet and asked to sign a second consent form. This reduced the possibility that the consent of each participant included in the study was influenced by alcohol consumption. They were then given a second alcohol breath test.

Participants were sat in front of a laptop and given their sealed envelope back. They were asked to open it and, without showing the researcher, re-enter the number on their raffle ticket into the computer. This enabled z-Tree to recall their responses from the first session. They were then told to take the ticket away with them, so that it would be impossible for the research team to link a set of responses back to them.

Participants then worked through the z-Tree programme independently. They were required to reflect upon their performance in session one. First, they were asked to recall their previous prediction regarding the number of correct answers they gave. This provided us with their sober beliefs about their intoxicated *beliefs*. Second, they were asked to provide a new prediction of their first session performance. This provided us with their sober beliefs about their intoxicated *performance*. If this stage was chosen for payment, a correct answer to each question would pay £5, falling in 50p intervals as their response became less accurate. This was designed to elicit whether the participant believed that alcohol consumption altered their perception of their own ability.

They then completed a second, timed over-optimism test under identical payment structures. They were given two practice SPMs again, and were then presented with ten new questions. These were also chosen following Bilker et al. (2012), who also identified the combination of ten questions, excluding those in session one, that best predicted a participant's score in the full Raven's SPM culture-free IQ test.[3] The full test is partitioned into five banks of ten questions, each bank more difficult than the last. In each session, the number of questions chosen from each bank was the same, providing a further attempt to keep the difficulty of the test as constant as possible. Participants were then asked to predict the number of correct responses.

Finally, participants were asked predict the difference in the amount of time they had spent on the SPM questions during each session. If this stage was chosen for payment, a

[3] Question A10, B4, B9, C6, C10, D5, D8, E2, E4 and E9 were used in the second session.

response within 30 seconds of the correct difference would pay £10, falling to £9 for predictions within 60 seconds, to £8 for predictions within 90 seconds etc. This was designed to elicit whether participants believed that alcohol consumption altered the amount of time they spent answering the questions.

After answering a series of control questions (including one about the number of violent incidents they had been involved in over the previous twelve months), participants were shown their results, and how they translated into payments. They were then prompted to inform the researcher that they were ready to determine how much they would be paid. At this point, they had completed six stages: (i) questions in session one; (ii) prediction in session one; (iii) reflection on performance in session one at the start of session two; (iv) questions in session two; (v) prediction in session two; and (vi) prediction about the amount of time taken in each session. They rolled a die to determine which session they would be paid for. This result was entered into the computer by the researcher, which then displayed the participant's total payment. Payments were made immediately in cash.

3. Data and Estimation

Data

[Table 1 here]

Over six weeks, we recruited 140 individuals, of whom 106 (76 percent) returned for the second session. This latter group forms our sample. As we did not ask control questions at the end of the first session due to concerns about informed consent, it is difficult to say the extent to which our study suffers from additional selection bias. We checked for difference in participant scores (overall and by question), BAC score and time taken (overall and by question) in session one between those who continued to session two and those who dropped out. The only significant difference between responses related to question nine, where those who continued were more likely to choose the correct answer. As such, we have no evidence to suggest that selection bias between those who continued to session two and those who did not is a serious concern.

Descriptive statistics for the sample are presented in Table 1. Most of our participants were white, male, single undergraduate students. Since the likelihood of being a victim of assault may be related to physical characteristics (Sivarajasingam et al. 2017), we asked participants to report their height and weight. These were 1.75m and 72kg on average. The BAC score derived from a breath test has been criticised for being more reflective of how much alcohol an individual has consumed than their level of intoxication. Two individuals with different body shapes could consume the same amount of alcohol and suffer different levels of intoxication. To control for this possibility, we use a ratio of height and weight to calculate a common measure of body shape, the body mass index (hereafter BMI). Those with a higher BMI tend to be stockier, and are likely to be less affected by alcohol on average than those with a lower BMI. The average BMI in our sample was 23, suggesting that our average participant was in a healthy weight range for their height.

The majority of our sample drink frequently (defined as at least three times per week), and report consuming an average of 8.88 units of alcohol per session. This is equivalent to one bottle of wine (ABV 12%) or nine single measures of whisky (ABV 40%). Around 25 percent were smokers.

The average number of violent incidents reported in the last twelve months was 0.25. Nineteen percent of our sample (20 participants) reported being involved in a violent incident. Conditional on involvement, the average number of incidents was 1.3, ranging between one and three.

At the first session, the average BAC score was 0.36 milligrams of alcohol per litre of breath expelled during the breath test. For comparison, it is illegal for anyone with a BAC score of 0.35 or over to drive in the UK. Forty-five percent of our sample fell into this category. Our average participant got 6.60 questions correct out of ten. They were, however, slightly overoptimistic, believing that they got 7.06 questions correct. The average participant took just over four minutes to complete the ten Raven's SPM questions.

At the second session, only two participants recorded positive BAC scores. Participants got an average of two more questions correct. They also predicted a higher average score than session one, suggesting that they understood that intoxication was likely to lower their ability. However, in contrast to session one, participants tended to be pessimistic about their performance.

Participants also reflected on their session one performance at the second session. They believed that their average score was 6.45 and that their average prediction at the time was 6.49 (it was 7.06).

Estimation of Behavioural Changes

Our experiment seeks to assess the determinants of changes in two behavioural variables. We proxy for the first, ability, with the participant's score in each session. Whilst this variable's interpretation requires care, our experiment is designed to control for alternatives. It could reflect differences in the difficulty of the two tests. Raven's SPMs are divided into five banks, labelled A to E, of increasing difficulty. Both tests draw one question from bank A, two each from banks B, C and D, and three from bank E. In addition to being identified as the questions that best predict performance in the full forty question test, this reduces the variation in difficulty between tests. Alternatively, differences in score could reflect learning between sessions. Whilst impossible to remove entirely, we take several steps to reduce the possible gains from learning. Firstly, participants receive no feedback until the end of session one. Secondly, we impose an interval of one week between sessions. Thirdly, we provide participants with practice questions at the start of each session, so they are familiar with the test format before they start. Fourthly, Raven's SPMs have a very simple structure and are designed not to become easier with practice. Differences could also reflect differences in the benefit or costs associated with the test. Each correct answer has a constant benefit of £1.

For the second, overconfidence, we make use of a common measure of over-optimism bias:

$$Over_{it} = Prediction_{it} - Score_{it},$$

where $i = 1, \ldots, 106$ denotes the individual and $t = 1, 2$ denotes the session. This has the following interpretation. If $Over_{it} > 0$, we say that a participant is *over-optimistic*. Their prediction of their performance in the Raven's SPM test exceeds their actual performance; they think they are more capable than they are. Conversely, if $Over_{it} < 0$, they are *under-optimistic*. Comparing across individuals i and j, if $Over_{it} > Over_{jt}$ then we say that i is more over-optimistic than j. Similarly, if $Over_{i1} > Over_{i2}$ then individual i was more over-optimistic at the first session than at the second.

There are, of course, alternative measures of over-optimism bias that we could have employed. For example, we could have considered the difference between a participant's prediction and score divided by their score, thereby measuring over-optimism as a percentage. We did not adopt this approach because participants tended to perform worse in the first session than the second. Suppose, for example that a participant predicted six correct answers in the first session, but only got five correct. In the second session, they predicted nine correct answers, but only got eight correct. According to our measure, they are equally over-optimistic in both sessions. However, using a percentage measure, their percentage over-optimism declines from 20 percent to 12.5 percent. Our measure is more restrictive, reducing the likelihood that we find any significant differences in over-optimism between sessions. Any differences we do find are not going to be driven by poorer performances in the test. We nevertheless re-ran our results employing this alternative measure as a robustness check. Whilst the coefficients changed, the overall pattern was the same.

We aim to understand how alcohol consumption and being in a drinking environment affect our two variables of interest: participants' score and their over-optimism bias. For each $y_{it} \in \{Score_{it}, Over_{it}\}$, suppose that the data generating process has the following form:

$$y_{it} = \beta_0 + \beta_1\, bar_{it} + \beta_2\, BAC_{it} + x_i'\gamma + \varepsilon_{it}, \quad (1)$$

where bar_{it} is an indicator variable which takes value 1 when the participant is in a drinking environment and zero otherwise, BAC_{it} is the participant's blood-alcohol content score, x_i is a vector of individual controls and ε_{it} is an i.i.d. error. This is a similar structure to that employed by previous studies, but incorporates their conjecture that the drinking environment plays a role in altering an individual's perceptions.

We attempt to identify the effect of being in the drinking environment and intoxicated on our behavioural variables of interest by employing three separate strategies. First, we run pooled OLS regressions to estimate (1). Second, to correct potential omitted variable bias, we include individual fixed effects. Since most of our control variables are individual characteristics, they are subsumed into the fixed effects. We consequently include interaction terms where appropriate. Third, we employ a difference estimator, regressing:

$$\Delta y_i = \beta_1\, \Delta bar_i + \beta_2\, \Delta BAC_i + \Delta\varepsilon_i,$$

Where $\Delta z_i = z_{i1} - z_{i2}$ is the increase in the variable when consuming alcohol in a drinking environment relative to daytime. Since all participants are recruited in the Students' Union bar and then undertake session two in a different room in the Students' Union during the middle of the day, $\Delta bar_i = 1$ for all i. Our baseline regression equation thus simplifies to:

$$\Delta y_i = \beta_1 + \beta_2\, \Delta BAC_i + \Delta\varepsilon_i, \tag{2}$$

The effect of the drinking environment is thus the expected change in our behavioural variables, conditional of intoxication. We subsequently include controls to rule out alternative explanations for the change in behaviour:

$$\Delta y_i = \beta_1 + \beta_2\, \Delta BAC_i + x_i'\zeta + \Delta\varepsilon_i, \tag{3}$$

effectively interacting our controls with bar_{it}.

The key to this identification strategy is to exploit the variation in levels of intoxication across participants. Clearly, bar_{it} and BAC_{it} are correlated – most participants were more intoxicated during session one than in session two. We should therefore be concerned about multicollinearity. Fortunately, the extent of their intoxication varied substantially. Seven percent of participants were always sober, whilst two percent were mildly intoxicated in both sessions. Moreover, bar_{it} only explains around half of the variation in BAC_{it} (regressing BAC_{it} on bar_{it} and a constant yields an R^2 of 53 percent and a variance inflation factor of 2.13). This suggests that, whilst the two are indeed correlated, multicollinearity between our two key explanatory variables of interest is not an issue.

Estimation of Alcohol-Fuelled Violence

The second part of our empirical analysis determines the role our two behavioural channels – changes in ability and overconfidence – play in alcohol-fuelled violence. In particular, we seek to explain the self-reported number of violent incidents our participants were involved in over the previous twelve months.

Only 19 percent of our sample reported being involved in violence. Of those who were, the maximum number of incidents was three. Given both the low frequency of incidents and the low numbers per victim, we adopt a Poisson regression to explore the relationship.

In the introduction, we noted that whether individuals understood the behavioural changes that occurred when intoxicated in the drinking environment had important implications for policy. A sophisticated individual, for example, would be deterred from going out drinking by the introduction of a more severe punishment, because they understand that they may get into a fight. A naive individual, in contrast, would reason that, since they would never fight when sober, the introduction of a more severe punishment should not influence their drinking behaviour.

We exploit the sober beliefs about our participants' intoxicated selves that we elicited during session two to decompose our behavioural changes into anticipated and unanticipated components. For each $y_{it} \in \{Score_{it}, Over_{it}\}$, we can split Δy_i into:

$$\Delta y_i = Anticipated\ \Delta y_i + Unanticipated\ \Delta y_i \tag{4}$$

A completely sophisticated individual fully understands the effect that intoxication and the drinking environment has on their behaviour: $\Delta y_i = Anticipated\ \Delta y_i$. Conversely, a purely naive individual does not anticipate any behavioural changes: $Anticipated\ \Delta y_i = 0$ and so $\Delta y_i = Unanticipated\ \Delta y_i$. In practice most individuals fall somewhere in between. By constructing this decomposition and using it to explain the number of violent incidents our participants were involved in, we can begin to assess whether policymakers should be concerned about naivety when attempting to deter alcohol-fuelled violence.

We constructed the anticipated components of our two behavioural changes as follows. The unanticipated component was then derived by taking the difference between the true change and the anticipated change. When sober, our participants believed that they got $Prediction_{i2}$ questions correct. They also believed that their intoxicated selves would have got $E_{i2}[Score_{i1}]$ questions correct. They thus anticipated a change in ability of:

$$Anticipated\ \Delta Score_i = E_{i2}[Score_{i1}] - Prediction_{i2} \tag{5}$$

Similarly, when sober, our participants believed that their intoxicated selves thought they had got $E_{i2}[\ Prediction_{i1}]$ questions correct. They anticipated an increase in over-optimism relative to session 2 of:

$$\begin{aligned} Anticipated\ \Delta Over_i &= \{E_{i2}[\ Prediction_{i1}] - Score_{i1}\} - \{E_{i2}[Score_{i1}] - Score_{i1}\} \\ &= E_{i2}[\ Prediction_{i1}] - E_{i2}[Score_{i1}] \end{aligned} \tag{6}$$

The first term in parentheses represents the participant's perceived over-optimism bias in session one, measured at session two. The second term represents their residual over-optimism bias. Of course, our participant does not know $Score_{i1}$ at the point at which we ask about their beliefs. However, since we define over-optimism bias linearly, the two $Score_{i1}$ terms cancel to yield that the participant's anticipated change in over-optimism bias is simply the difference between their how many questions their sober self thought they got correct whilst intoxicated and their sober self's estimate of their intoxicated self's prediction.

In all cases, we employed a negative binomial regression as a robustness check. The results were largely unchanged, and the estimated α's were not significant.

4. Results

We now present the results of our empirical analysis. We begin by considering how intoxication and the drinking environment affect our two behavioural variables of interest: ability and over-optimism bias. We then link our experimental findings to participants' self-reported recent history of violence, to assess the importance of each behavioural channel in determining alcohol-fuelled violence.

Ability, intoxication and the drinking environment

[Table 2 here]

Table 2 presents pooled OLS results. Column 1 reports the baseline specification. Column 2 incorporates BMI to better approximate participants' intoxication. Column 3 attempts to control for experience, by including whether the participant already has a degree. Column 4 incorporates lifestyle characteristics, namely whether the participant is single or smokes. Column 5 controls for their drinking behaviour, as those who drink more frequently or consume more alcohol when they drink may be less affected by intoxication.

Across all specifications, being in a drinking environment significantly lowers participants' ability by around 1.8 correct answers. Whilst the coefficient on BAC is also always negative, it is never significantly different from zero. The effect is robust after BMI is controlled for, suggesting that levels of intoxication have no significant impact upon ability. This is in line with the results from previous laboratory experiments.

We attempt to refine our estimates by controlling for several individual and lifestyle characteristics that may impact upon ability. Having a degree appears negatively correlated with the score achieved in the test, as does being single and drinking large quantities of alcohol on nights out. Inclusion of none of these additional controls substantially alters the magnitude or the significance of the effect of the drinking environment and intoxication on ability.

[Table 3 here]

Table 3 presents the results when we control for individual fixed effects. Since none of our individual or lifestyle characteristics vary across sessions, they are all subsumed into the fixed effects. Nevertheless, this allows us to control for potential omitted variable bias. Once again, the drinking environment has a significant negative effect on ability, reducing the number of correct answers our participants provided by around 1.8 questions on average. Intoxication, as measured by BAC has no significant effects. In column 4, we allow for the possibility that differences in BMI alter the effect of BAC at the margin, replacing BAC with an interaction term. This does not appear to be the case. Finally, column 5 includes both BAC and the BAC-BMI interaction. Unfortunately, these terms appear highly collinear, creating problems with multicollinearity.

[Table 4 here]

Finally, Table 4 presents difference regressions, which show the effect of being intoxicated and in a drinking environment relative to a daytime, sober baseline. Column 1 includes our two variables of interest. Column 3 controls for differing opportunity costs of time by including the difference in the log of the time participants took to complete the test. Column 3 replaces ΔBAC_i with $\Delta BAC_i \times BMI_i$, allowing for the possibility that the same BAC can lead to different levels of intoxication for participants with different body shapes. We reproduced all our results using this alternative measure of intoxication, and nothing changed. Column 4 controls for whether the participant has a degree. Note, however, that the interpretation of the coefficient is different to that of Table 2. This is the effect of having a degree on the change in score between sessions, rather than on the score itself. Columns 5 and 6 control for smoking and regular drinking behaviour.

The same pattern emerges. Moreover, the R^2 for each of these regressions are substantially larger than those reported previously. This suggests that the drinking environment explains a large proportion of the within-individual variation in ability, if not the across-individuals variation.

Table 4 also sheds light on the perhaps surprising result in Table 2 that having a degree is associated with lower ability. It appears that those with a degree did significantly worse in the drinking environment relative to their baseline. Whilst their score during session two was slightly higher than those without a degree, they worse performance in the bar resulted in an overall negative coefficient in Table 2.

[Table 5 here]

Tables 2, 3 and 4 present a consistent picture. Whilst the drinking environment appears to significantly lower ability, small increases in intoxication (as measured by changes in BAC) do not alter participants' performance in our test. Of course, it is possible that intoxication still has an effect on ability, but that this effect is nonlinear. For example, feeling intoxicated could have a level effect, reducing ability without altering it at the margin. Indeed, if this were the case, it is possible that this effect, rather than a direct effect of the drinking environment is being captured by the coefficient on bar_{it}. To control for this possibility, we replaced participants' BAC scores with a series of indicators showing different levels of intoxication. A representative set of results are provided in Table 5.

Table 5 replaces participants' BAC score with an indicator that takes a value of one if the participants' BAC is over the UK drink-drive limit of 0.35, and zero otherwise. This captured around 42 percent of our sample in session one. Whilst we find some evidence that intoxication does reduce ability. Nevertheless, the drinking environment has both a more significant and a much larger effect on ability.

As a further robustness check, we performed similar regressions with a more flexible version of the empirical model:

$$Score_{i1} = \beta_0 + \beta_1\, \Delta bar_i + \beta_2\, \Delta BAC_i + \beta_3\, Score_{i2} + x_i'\gamma + \varepsilon_{it}.$$

This nests our previous specification, under which we restricted $\beta_3 = 1$. The results were broadly similar.

Over-optimism bias, intoxication and the drinking environment

[Table 6 here]

Table 6 presents pooled OLS results for over-optimism bias, controlling for the same characteristics as Table 2. Across all specifications, being in the drinking environment appears to significantly increase participants' overconfidence in their own abilities. Their prediction increases by roughly 1.1 relative to the number of questions they actually answer correctly. Whilst the coefficient on BAC is always positive, associated with greater over-optimism, it is never significant. At the margin, intoxication appears to have no effect on how overconfident our participants feel. Again, this is in line with the existing laboratory evidence. Controlling for body shape (BMI) does not affect the results. Similar, whilst having a degree and being single both appear to significantly increase over-optimism, they have a negligible effect on our main coefficients of interest.

[Table 7 here]

Table 7 presents results incorporating individual fixed effects. They broadly support those of the pooled OLS regressions. After controlling for potential omitted variable bias relating to personal and lifestyle characteristics, being in a drinking environment appears to increase over-optimism bias by around one; for a given score, participants' prediction increased by one in the bar. In contrast, intoxication has no effect at the margin, even after controlling for the differing effects of alcohol consumption due to differences in BMI.

[Table 8 here]

Table 8 reports difference regressions that exploit within individual variation in over-optimism, environment and intoxication. Whilst the pattern is broadly similar, the magnitude of the effect of the drinking environment on over-optimism declines when having a degree is controlled for. Although not individually significant, having a degree does appear to have a small positive effect on over-optimism in the drinking environment. This reflects the fact that participants in our sample with degrees suffered a significantly larger drop in ability when in the drinking environment, as reported in Tables 4 and 5. Lifestyle characteristics, such as smoking, frequent drinking and heavy drinking do not appear to have any significant effect on how over-optimism changes as a result of the environment.

[Table 9 here]

Finally, Table 9 replaces BAC with an indicator representing being over the UK drink-driving limit, in a similar spirit to Table 5. In contrast to Table 5, being intoxicated appears to have no significant effect on participants' over-optimism bias – it is driven purely by other factors associated with the drinking environment. Again, controlling for participants being graduates does reduce the magnitude of the coefficient on Δbar_i. Its sign and significance are not affected.

Alcohol-Fuelled Violence and Behavioural Change

We now turn to the second part of our empirical analysis. The above results suggest that, principally as a result of being in a (broadly defined) drinking environment, individuals' cognitive ability declines and they become more overconfident. Intoxication plays a more minor role in causing these behavioural changes. Both channels have been suggested as explanations for participation in alcohol-fuelled violence. Declines in cognitive ability are thought to be associated with a higher cost of participating in a protracted argument, whereas declines in physical ability/motor skills are thought to increase the cost of engaging in a fight. Increases in overconfidence make fighting more likely, as the individual becomes more convinced that they can win the fight relatively unscathed.

[Table 10 here]

Table 10 presents results based upon participants' behaviour when intoxicated and in the drinking environment (i.e. in session one). Since these are the results of a Poisson regression, the coefficients cannot be interpreted as marginal effects. Nevertheless, their sign and significance is instructive. Column 1 presents the baseline specification. Column 2 controls for frequent drinking. Those who are in a drinking environment more frequently are likely to be involved in more fight just by chance. It also controls for the self-reported average alcohol intake of participants during a drinking session. This acts as a proxy for other behavioural explanations related to intoxication besides the two that we investigate. Column 3 incorporates obvious physical characteristics that assailants may use when targeting a victim. Column 4 includes gender and changes in the amount of time taken to complete the tests as a proxy for the opportunity cost of participants' time.

The results of Table 10 do not provide strong evidence that the behavioural changes our experiment identifies contribute to our participants' proclivity for violence. In only the final two specifications is their score whilst in the drinking environment a significant predictor of the number of incidents that they have been involved in during the previous twelve months. Moreover, across all specifications, the coefficient is positive. This suggests that, in contrast to the previous literature, those with higher cognitive ability when in a drinking environment are involved in *more* fights on average. Similarly, overconfidence in the drinking environment does not appear to significantly affect the number of fights our participants were involved in.

Drinking frequently and consuming relatively large amounts of alcohol when drinking are both highly significant. As expected, those who go out drinking more often and those who become severely intoxicated tend to get into more fights.

[Table 11 here]

Table 11 attempts to shed light on the perplexing results of Table 10. We replace the participants' cognitive ability and overconfidence in the drinking environment with the increase in ability and overconfidence relative to the baseline session (session two).

A smaller decline in ability is associated with significantly more violent incidents across all specifications. The coefficient is also relatively stable, ranging between 0.33 and 0.40. After controlling for observable characteristics that could influence whether a participant becomes the victim of a fight (height and weight), increases in over-optimism whilst in a drinking environment also significantly increase the number incidents they are involved in. Changes in behaviour do appear to predict violence. Drinking behaviour continues to play a significant role in alcohol-fuelled violence, however, suggesting that our two behavioural channels do not represent the whole picture.

Taken together, these results provide nuanced evidence on the causes of alcohol-fuelled violence. Whilst Table 10 suggests that ability and over-optimism in the drinking environment are not related to violent incidents, Table 11 suggests that the changes in these variables are. Those who feel that their decision-making has not been badly impaired – either because they suffered a smaller-than-average decline in ability or because they have become much more overconfident – tend to be involved in more fights on average. After controlling for observable characteristics, those who experience a smaller-than-average perceived decline in ability may feel relatively confident of winning a fight, and of escaping with relatively minor injuries. In contrast, those who experience a larger perceived decline in ability may believe that the expected cost of engaging in a fight is prohibitive.

This fits with previous evidence that suggests that the relationship between alcohol consumption and the probability of being involved in violence is an inverted U (Morgan et al, 2009). Those who consume moderate amounts of alcohol are the most likely to get into fights. The evidence in Table 11 suggests that our participants' average alcohol consumption puts them on the downward-sloping section of this curve.

[Table 12 here]

Finally, we attempt to investigate the extent to whether participants are sophisticated about their chances of becoming involved in a fight. As a first step, Table 12 presents the results of several *t*-tests designed to look for evidence of sophistication. The first two rows provide evidence of partial sophistication relating to changes in ability. First, we check whether participants anticipate any change in ability using (5). Second, we see whether any anticipated change is an accurate reflection of the true change in ability using (4). Participants predict a reduction in their cognitive ability resulting from intoxication and the drinking environment. At the follow-up session, they predicted that their average score during session one was 6.45, whereas they predicted an average score after completing the second test of 7.80 (a perceived fall of 1.35 marks on average). This underestimates the true reduction in cognitive ability. During session one, participants' average score was 6.60, whereas at the follow-up session it was 8.56 (a fall of 1.95 marks on average). We conclude that they are partially sophisticated about this first channel.

The next two rows perform identical tests for over-optimism. Participants do not anticipate any change in over-optimism. The average of the anticipated increase in over-optimism given by (6) is not significantly different from zero. Since over-optimism does increase, our participants appear naive about this second channel. The unanticipated increase in over-optimism is positive and significant. During session two, participants believed that their session one prediction was 6.49 correct answers on average, but that they had only achieved 6.45 correct answers. This represents belief that their over-optimism bias increased relative to session two by 0.04. In reality, participants' average over-optimism bias during session one was 0.46. This bias to -0.76 during session two. Their over-optimism bias was 1.22 higher in session one relative to session two. Since this relatively large change was almost entirely unanticipated, we conclude that they are naive about the effect of the drinking environment on overconfidence.

[Table 13 here]

Table 13 decomposes ability and over-optimism in Table 11 into anticipated and unanticipated changes using (4). The results suggest that both the anticipated and unanticipated changes in ability are significant factors influencing participation in violence. Once again, those who either anticipate, or fail to anticipate but nevertheless experience, a small drop in ability tend to be involved in significantly more violent incidents. Both coefficients are relatively robust across specifications.

In contrast, changes in over-optimism play a much less important role in alcohol-fuelled violence. Similar to Table 11, changes in over-optimism only have a significant effect after height and weight are controlled for. Perhaps unsurprisingly, it is the unanticipated change in perception that has an effect. Those who become more overconfident when in a drinking environment tend to be involved in more fights.

These results raise two concerns for policymakers. Firstly, punitive measures are likely to be less effective than would be predicted if individuals were fully rational. Since individuals systematically underestimate the impact on their behaviour of being drinking environment when they decide whether to go out drinking, they will also underestimate the likelihood of their becoming involved in violence. Changes in the punishment associated with alcohol-fuelled violence are thus likely to be largely ignored when an individual chooses whether to enter a drinking environment.

Secondly, a multiple-selves framework may be more appropriate when developing policy. In the classical multiple-selves framework (O'Donohue and Rabin 1999) individuals have time-inconsistent preferences. If an individual does not understand that their preferences change over time, then can therefore inflict an externality on their future self. For example, they may choose to spend their income today believing (incorrectly) that they will start saving for retirement tomorrow. When tomorrow arrives, they postpone saving until the day after until eventually they reach retirement with relatively few savings.

A similar argument can be made when dealing with the effects of intoxication. Since the sober individual is forced to deal with the consequences of their intoxicated self's behaviour

– be it through injuries or punitive measures – they are being held responsible for actions that they would never have chosen to undertake. Of course, if they were fully aware of the effect of the drinking environment on their preferences and perceptions, they would take these possibilities into account when deciding whether to enter the environment. They would be culpable. Our evidence, however, suggests that this is not the case. Punishments inflicted on the sober self therefore represent an externality inflicted by the intoxicated self. As a result, society may be correct to make allowances for acts committed under the influence.

5. Conclusions

Alcohol-fuelled violence is a blight on society. Whilst the statistical link between consumption of alcohol and violent behaviour has long been understood, the underlying causal mechanism is still elusive. Economists have argued that alcohol-fuelled violence reflects a rational decision. Researchers in medicine and psychology, in contrast, have proposed numerous behavioural and social explanations. Alcohol is known to have several psychopharmacological effects, which alter an individuals' perceptions and potentially make them more prone to violence. The drinking environment may also play a role, acting as a psychological trigger that alters behaviour. Society, in turn, is more forgiving of abhorrent conduct when those involved are under the influence of alcohol.

We conducted a field experiment to assess the relative importance of two behavioural channels previously identified by the literature as contributing to alcohol-fuelled violence: increased overconfidence and reduced cognitive ability. Our participants undertook a standard, off-the-shelf over-optimism test on two separate occasions: during a night out in a bar, and then in a meeting room during the day. Whilst all participants experienced the same change in environment, the changes in level of intoxication varied greatly, enabling us to simultaneously identify the effect of the environment and intoxication on changes in behaviour. This experimental design had several additional benefits. Not only did it allow us to control for a range of individual characteristics by looking at within individual variation in ability and over-optimism, but also enabled us to ascertain participants' sober beliefs about their intoxicated selves.

We find that the broadly-defined drinking environment, rather than intoxication, plays a large role in changing individual behaviour. Participants performed significantly worse on average during the first session (in the bar) than the second. They were also significantly more over-optimistic about their performance. However, neither of these changes were associated with intoxication, either at the margin (measured by a blood alcohol content score) or overall (measured by being over the UK drink-driving limit).

We also asked participants to report how many violent incidents they had been involved in during the previous twelve months. Poisson regression results suggest that those who experience small declines in ability are involved in significantly more incidents on average. Whilst we also found evidence that increased overconfidence led to more involvement in violence, these results were less robust.

Our finding are consistent with a world in which individuals do not perfectly observe the effect that alcohol has on the ability of those around them. Those who believe that they experience relatively small declines (either because they do, or because they become more overconfident) reason that they are likely to win a fight against a random opponent and are unlikely to suffer serious injury. In contrast, those who believe that they suffer a relatively large decline in ability reason that they are unlikely to win against a random opponent and are more likely to get hurt. For the former group, being in a drinking environment increases the relative payoff from a fight. For the latter group it declines.

Participants appeared largely unaware of the effects of intoxication and the drinking environment on their over-optimism bias, and significantly underestimated their cognitive decline. Moreover, these unanticipated changes appear to have a significant effect on violent behaviour. This has important policy implications. First, it suggests that punitive measures to deter alcohol-fuelled violence may be relatively unsuccessful, as individuals do not see them as relevant when making alcohol consumption decisions – they underestimate the true probability becoming involved in a fight. Second, it suggests that individuals cannot be held entirely responsible for their behaviour whilst under the influence of alcohol. In a sense, their intoxicated selves inflict an externality on the future, sober self who suffers the consequences of their actions.

Our analysis suffers several shortcomings. First is the size of our sample reflecting the pilot study nature of our experiments, which places clear constraints on our econometric results. Second, whilst we identify the drinking environment as important, we are unable to say which aspects of that environment drive the changes in behaviour without more details on our participants' drinking habits. Third, is the external validity of our findings. Whilst we were surprised that such a large proportion of our participants had been involved in violence, the majority of alcohol-fuelled violence is not carried out by undergraduate students. As such, there is a question mark over how generalizable our findings are for, say, policymakers. We hope to address all these concerns in future work.

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Tables

Table 1: Descriptive statistics

	Mean	Std. Dev.	Min.	Max.
Personal characteristics				
Age (years)	20.67	2.54	18	31
Female	0.34	0.48	0	1
Height (cm)	174.69	11.38	144.5	194.5
Weight (kg)	72.07	13.46	54.5	114.5
Body Mass Index	23.41	3.74	10.01	38.62
White	0.87	0.34	0	1
Holds a degree	0.34	0.48	0	1
Lifestyle				
Single	0.57	0.50	0	1
Drinks frequently (three or more times per week)	0.42	0.50	0	1
Units of alcohol per session	8.88	5.76	2	35
Smokes	0.25	0.44	0	1
Number of violent incidents in last 12 months	0.25	0.57	0	3
Experimental results				
Session 1				
BAC	0.36	0.24	0	1.42
Score	6.60	1.69	1	10
Prediction	7.06	1.55	2	10
Time (seconds)	251.25	100.13	85.88	721.28
Session 2				
BAC	0.00	0.00	0.00	0.19
Score	8.56	1.37	4	10
Prediction	7.80	1.38	4	10
Time (seconds)	236.02	86.76	100.31	500.23
Prediction of session 1 score	6.45	1.91	2	10
Prediction of session 1 prediction	6.49	1.84	2	10

Table 2: Pooled OLS regressions of score on intoxication and an environment dummy

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: $Score_i$			
bar_i	-1.781***	-1.836***	-1.818***	-1.797***	-1.812***	-1.811***
	(0.325)	(0.323)	(0.313)	(0.325)	(0.315)	(0.327)
BAC_i	-0.478	-0.324	-0.373	-0.433	-0.390	-0.392
	(0.657)	(0.657)	(0.630)	(0.660)	(0.621)	(0.655)
BMI_i		0.029	0.031	0.032	0.037	0.040
		(0.029)	(0.028)	(0.029)	(0.027)	(0.028)
Has degree			-0.434*	-0.512**	-0.547**	-0.627**
			(0.237)	(0.243)	(0.251)	(0.258)
Single				-0.389*		-0.395*
				(0.215)		(0.213)
Smokes				0.035		0.167
				(0.237)		(0.250)
Drinks					-0.131	-0.156
frequently					(0.226)	(0.237)
Units					-0.033*	-0.035*
					(0.017)	(0.017)
Constant	8.558***	7.899***	8.003***	8.220***	8.238***	8.429***
	(0.133)	(0.683)	(0.666)	(0.696)	(0.658)	(0.679)
N	212	206	206	206	206	206
R^2	0.292	0.300	0.313	0.324	0.326	0.339
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-390.514	-375.961	-374.014	-372.329	-372.092	-370.095

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Fixed effect regressions of score on intoxication and an environment dummy

	(1)	(2)	(3)	(4)	(5)
			Dependent variable: $Score_i$		
bar_i	-1.953***		-1.706***	-1.726***	-1.728***
	(0.159)		(0.293)	(0.286)	(0.295)
BAC_i		-3.998***	-0.687		0.050
		(0.520)	(0.698)		(2.239)
$BAC_i \times BMI_i$				-0.027	-0.029
				(0.029)	(0.092)
Constant	8.557***	8.312***	8.559***	8.584***	8.584***
	(0.079)	(0.095)	(0.079)	(0.081)	(0.081)
N	212	212	212	206	206
R^2	0.592	0.460	0.596	0.590	0.590
p-value	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-256.362	-286.129	-255.291	-250.369	-250.368

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Difference regressions of score on intoxication and an environment dummy

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: $\Delta Score_i$					
Δbar_i	-1.683***	-1.724***	-1.769***	-1.431***	-1.449***	-1.491***
	(0.294)	(0.303)	(0.297)	(0.329)	(0.337)	(0.420)
ΔBAC_i	-0.750	-0.733		-0.798	-0.780	-0.798
	(0.702)	(0.719)		(0.756)	(0.755)	(0.745)
$\Delta \ln T_i$		0.665	0.751	0.636	0.626	0.626
		(0.440)	(0.461)	(0.424)	(0.426)	(0.422)
$\Delta BAC_i \times BMI_i$			-0.027			
			(0.030)			
Has degree				-0.790**	-0.787**	-0.756**
				(0.332)	(0.333)	(0.341)
Smokes					0.043	-0.064
					(0.359	(0.362)
Drinks frequently						0.490
						(0.320)
Units						-0.016
						(0.023)
N	106	106	103	106	106	106
R^2	0.597	0.605	0.602	0.627	0.627	0.636
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-201.019	-199.857	-195.096	-196.867	-196.860	-195.651

Robust standard errors in parentheses
* p<0.10, ** p < 0.05, *** p < 0.01.

Table 5: Difference regressions of score on intoxication and environment dummies

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: $\Delta Score_i$					
Δbar_i	-1.741***	-1.785***	-1.818***	-1.417***	-1.412***	-1.467***
	(0.213)	(0.215)	(0.217)	(0.239)	(0.239)	(0.356)
$\Delta DrinkDrive_i$	-0.467	-0.445		-0.591*	-0.594**	-0.566*
	(0.316)	(0.315)		(0.305)	(0.297)	(0.301)
$\Delta \ln T_i$		0.644	0.728	0.603	0.606	0.606
		(0.442)	(0.462)	(0.422)	(0.427)	(0.424)
$\Delta DrinkDrive_i \times BMI_i$			-0.016			
			(0.014)			
Has degree				-0.881***	-0.882***	-0.849**
				(0.326)	(0.325)	(0.332)
Smokes					-0.016	-0.103
					(0.359)	(0.368)
Drinks frequently						0.446
						(0.322)
Units						-0.015
						(0.023)
N	106	106	103	106	106	106
R^2	0.600	0.608	0.604	0.635	0.635	0.642
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-200.554	-199.457	-194.804	-195.790	-195.789	-194.767

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Pooled OLS regressions of over-optimism on intoxication and an environment dummy

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: $Over_i$			
bar_i	1.176***	1.173***	1.148***	1.079***	1.144***	1.080***
	(0.328)	(0.334)	(0.331)	(0.327)	(0.335)	(0.328)
BAC_i	0.088	0.060	0.128	0.322	0.139	0.319
	(0.669)	(0.671)	(0.674)	(0.678)	(0.677)	(0.674)
BMI_i		0.001	-0.002	-0.002	-0.006	-0.007
		(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
Has degree			0.605**	0.765***	0.664**	0.820***
			(0.253)	(0.243)	(0.257)	(0.249)
Single				0.726***		0.735***
				(0.223)		(0.223)
Smokes				0.114		0.078
				(0.264)		(0.277)
Drinks frequently					-0.053	-0.086
					(0.33	(0.230)
Units					0.025	0.026
					(0.019)	(0.019)
Constant	-0.755***	-0.755	-0.901	-1.383	-1.019	-1.485
	(0.131)	(0.950)	(0.965)	(0.949)	(0.920)	(0.907)
N	212	206	206	206	206	206
R^2	0.117	0.116	0.143	0.184	0.149	0.190
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-408.560	-395.207	-392.053	-387.005	-391.356	-386.204

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Fixed effect regressions of over-optimism bias on intoxication and an environment dummy

	(1)	(2)	(3)	(4)
		Dependent variable: $Over_i$		
bar_i	1.208***		0.994***	0.990***
	(0.189)		(0.264)	(0.273)
BAC_i		2.524***	0.595	
		(0.442)	(0.553)	
$BAC_i \times BMI_i$				0.024
				(0.026)
Constant	-0.755***	-0.613***	-0.757***	-0.739***
	(0.095)	(0.081)	(0.095)	(0.098)
N	212	212	212	206
R^2	0.280	0.227	0.284	0.274
p-value	0.000	0.000	0.000	0.000
Log-likelihood	-293.956	-301.550	-293.394	-287.705

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Difference regressions of over-optimism on intoxication and an environment dummy

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: $\Delta Over_i$			
Δbar_i	0.979***	1.015***	1.039***	0.756***	0.763**	0.826*
	(0.265)	(0.270)	(0.280)	(0.279)	(0.312)	(0.493)
ΔBAC_i	0.637	0.622		0.679	0.673	0.697
	(0.550)	(0.565)		(0.558)	(0.556)	(0.558)
$\Delta \ln T_i$		-0.595	-0.651	-0.569	-0.566	-0.566
		(0.548)	(0.576)	(0.541)	(0.541)	(0.533)
$\Delta BAC_i \times BMI_i$			0.023			
			(0.027)			
Has degree				0.697	0.696	0.655
				(0.431)	(0.434)	(0.454)
Smokes					-0.016	0.113
					(0.421)	(0.434)
Drinks frequently						-0.568
						(0.373)
Units						0.016
						(0.032)
N	106	106	103	106	106	106
R^2	0.284	0.293	0.285	0.314	0.314	0.328
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-220.131	-219.486	-214.508	-217.896	-217.896	-216.818

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Difference regressions of over-optimism on intoxication and environment dummies

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: $\Delta Over_i$			
Δbar_i	1.069***	1.108***	1.112***	0.792***	0.789***	0.870*
	(0.247)	(0.249)	(0.257)	(0.265)	(0.299)	(0.494)
$\Delta DrinkDrive_i$	0.306	0.286		0.412	0.414	0.380
	(0.383)	(0.380)		(0.373)	(0.375)	(0.373)
$\Delta \ln T_i$		-0.584	-0.641	-0.548	-0.550	-0.550
		(0.544)	(0.574)	(0.535)	(0.536)	(0.528)
$\Delta DrinkDrive_i \times BMI_i$			0.011			
			(0.018)			
Has degree				0.758*	0.759*	0.715
				(0.430)	(0.432)	(0.453)
Smokes					0.009	0.117
					(0.414)	(0.427)
Drinks frequently						-0.536
						(0.373)
Units						0.016
						(0.032)
N	106	106	103	106	106	106
R^2	0.284	0.293	0.285	0.317	0.317	0.329
p-value	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-220.123	-219.503	-214.509	-217.673	-217.673	-216.708

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Poisson regressions of incidents on score and over-optimism bias in the drinking environment

	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: $Incidents_i$					
$Score_{i1}$	0.160	0.203	0.184	0.218	0.206*	0.246**
	(0.182)	(0.131)	(0.191)	(0.142)	(0.124)	(0.124)
$Over_{i1}$	0.038	0.088	0.051	0.116	0.075	0.115
	(0.125)	(0.119)	(0.131)	(0.114)	(0.129)	(0.120)
Drinks frequently		1.125**		1.078*	1.204**	1.114**
		(0.494)		(0.560)	(0.564)	(0.556)
Units		0.059**		0.060***	0.063***	0.064***
		(0.025)		(0.023)	(0.022)	(0.022)
Height			0.061	0.054		0.059*
			(0.040)	(0.045)		(0.034)
Weight			-0.003	-0.010		-0.013
			(0.019)	(0.022)		(0.023)
Female					-0.530	0.154
					(0.780)	(0.734)
$\Delta \ln T_i$					-0.647	-0.696
					(0.562)	(0.528)
Constant	-2.505*	-4.076***	-13.278	-13.085*	-4.086***	-14.119***
	(1.353)	(1.177)	(6.764)	(7.346)	(1.271)	(5.392)
N	106	106	103	103	103	103
Pseudo-R^2	0.010	0.121	0.068	0.168	0.152	0.179
p-value	0.654	0.007	0.155	0.001	0.001	0.000
Log-likelihood	-66.457	-58.584	-60.550	-54.034	-55.080	-53.345

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Poisson regressions of incidents on changes score and over-optimism bias as a result of being in the drinking environment

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: Incidents$_i$			
$\Delta Score_i$	0.399**	0.334**	0.404**	0.363***	0.352**	0.375**
	(0.179)	(0.148)	(0.178)	(0.140)	(0.138)	(0.146)
$\Delta Over_i$	0.189	0.202	0.177	0.225*	0.212	0.211*
	(0.138)	(0.136)	(0.136)	(0.124)	(0.131)	(0.122)
Drinks frequently		1.055**		0.963*	1.148**	0.987*
		(0.466)		(0.520)	(0.510)	(0.513)
Units		0.053*		0.059**	0.059***	0.062***
		(0.027)		(0.023)	(0.021)	(0.021)
Height			0.057	0.051		0.053*
			(0.037)	(0.042)		(0.031)
Weight			0.004	-0.002		-0.003
			(0.019)	(0.021)		(0.022)
Female					-0.644	0.080
					(0.756)	(0.743)
$\Delta \ln T_i$					-0.705	-0.657
					(0.579)	(0.581)
Constant	-0.968***	-2.244***	-11.349**	-11.219*	-2.231***	-11.411**
	(0.290)	(0.512)	(5.632)	(6.330)	(0.513)	(4.726)
N	106	106	103	103	103	103
Pseudo-R^2	0.043	0.138	0.102	0.187	0.173	0.196
p-value	0.080	0.001	0.003	0.000	0.000	0.000
Log-likelihood	-64.191	-57.818	-58.302	-52.790	-53.731	-52.214

Robust standard errors in parentheses
* p<0.10, ** p < 0.05, *** p < 0.01.

Table 12: Sophistication *t*-Tests

Null Hypothesis	***N***	***t*-statistic**	***p*-value**
Anticipated $\Delta Score_i = 0$	106	-7.6504	0.0000
Unanticipated $\Delta Score_i = 0$	106	-2.7326	0.0037
Anticipated $\Delta Over_i = 0$	105	0.3577	0.3606
Unanticipated $\Delta Over_i = 0$	105	5.6950	0.0000

Table 13: Poisson regressions of incidents on changes score and over-optimism bias as a result of being in the drinking environment

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent variable: $Incidents_i$			
Unanticipated	0.418**	0.386**	0.412***	0.364**	0.397***	0.372**
$\Delta Score_i$	(0.172)	(0.157)	(0.147)	(0.144)	(0.147)	(0.149)
Unanticipated	0.197	0.239	0.181	0.227*	0.230	0.212*
$\Delta Over_i$	(0.147)	(0.147)	(0.122)	(0.127)	(0.140)	(0.125)
Anticipated	0.471***	0.435***	0.449**	0.428***	0.447***	0.439***
$\Delta Score_i$	(0.176)	(0.162)	(0.178)	(0.162)	(0.139)	(0.155)
Anticipated	-0.052	-0.071	0.069	0.094	-0.030	0.077
$\Delta Over_i$	(0.269)	(0.212)	(0.268)	(0.178)	(0.186)	(0.171)
Drinks		1.154**		1.039**	1.148**	1.068**
frequently		(0.474)		(0.516)	(0.488)	(0.517)
Units		0.042*		0.053**	0.049**	0.056***
		(0.024)		(0.022)	(0.021)	(0.021)
Height			0.054	0.049		0.051
			(0.035)	(0.043)		(0.033)
Weight			0.004	-0.003		-0.003
			(0.019)	(0.021)		(0.021)
Female					-0.345	0.128
					(0.629)	(0.720)
$\Delta \ln T_i$					-0.889*	-0.655
					(0.506)	(0.553)
Constant	-0.904***	-2.118***	-10.897**	-10.777*	-2.049***	-11.102**
	(0.305)	(0.477)	(5.398)	(6.507)	(0.471)	(5.008)
N	106	106	103	103	106	103
Pseudo-R^2	0.056	0.152	0.105	0.192	0.174	0.201
p-value	0.054	0.003	0.008	0.000	0.000	0.000
Log-likelihood	-63.348	-56.916	-58.113	-52.499	-55.460	-51.901

Robust standard errors in parentheses
* $p<0.10$, ** $p < 0.05$, *** $p < 0.01$.

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