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Evidence of alcohol induced *weapon focus* in eyewitness memory

Alistair J. Harvey | Alistair Sekulla

Department of Psychology, University of Portsmouth, Portsmouth, UK

Correspondence
Alistair J. Harvey, Department of Psychology, University of Portsmouth, King Henry I Street, Portsmouth, PO1 2DY, UK.
Email: alistair.harvey@port.ac.uk

Summary

We examined the effects of acute alcohol on eyewitness memory for a simulated armed robbery under laboratory conditions. Alcohol and placebo participants viewed a slide series showing a target male taking a laptop from a helpdesk assistant, either on loan or at gunpoint. Following a brief retention period, participants responded to “central” multiple-choice questions, about the target's actions face and clothing, and “peripheral” questions about other scene features. Alcohol participants shown the no-weapon scene displayed poorer peripheral memory than placebo controls, though alcohol did not impair peripheral memory among weapon scene viewers. Alcohol participants also showed a weapon focus effect, providing less accurate responses to central questions related to details about the target male than no-weapon controls. These findings are consistent with alcohol myopia theory and suggest intoxicated eyewitnesses may be more susceptible to weapon focus than sober counterparts.

KEYWORDS
alcohol intoxication, eyewitness memory, recognition, weapon focus

1 | INTRODUCTION

On the 8th July, 2017 Daniel Baird was fatally stabbed during an altercation in Birmingham, England in the early hours of the morning. The incident was sparked inside a pub but spilled outside where it was witnessed by 60–100 bystanders, many of whom were intoxicated with alcohol (BBC News, 2014). This is just one example of the 1.4 million violent assaults reported annually in the UK (Bolling et al., 2007). Given 18% of these incidents occur at night in public places, it is no surprise that many who witness them are inebriated (Flatley, 2016). In a recent survey of seven UK police constabularies, 82% of officers remarked that drunk witnesses were a common occurrence (Crossland et al., 2018). In a similar survey of US police forces, 81% of officers had encountered intoxicated witnesses either at a crime scene or during a subsequent investigative interview (Evans et al., 2009).

So, what impact does alcohol have on a witness's ability to retrieve crime scene details? At present, data from the applied psychology literature provide no clear answer. Studies of alcohol on face identification in a forensically meaningful context such as an identification parade show little effect of the drug, at least at low to moderate blood alcohol concentrations (BACs) of around 0.03–0.08% (Altman et al., 2018; Colloff & Flowe, 2016; Dysart et al., 2002; Flowe et al., 2017; Hagsand et al., 2013; Harvey et al., 2013a; Kneller & Harvey, 2016; Read et al., 1992; Yuille & Tollestrup, 1990), although a few authors have found identification impairments (e.g., Dysart et al., 2002; Harvey et al., 2020; Read et al., 1992). Conclusions regarding the impact of alcohol on memory for wider scene features are similarly difficult to draw (for reviews see Altman et al., 2019; Jores et al., 2019). Some studies show negligible effects of intoxication (Crossland et al., 2016, Exp. 1; Hagsand et al., 2017; Harvey

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The experiment was approved by the host university's ethics committee and administered in full accordance with the British Psychological Society Code of Ethics and Conduct.

et al., 2013a; Hildebrand Karlén et al., 2017; Schreiber Compo et al., 2012) while others reveal significant impairments (Altman et al., 2018; Crossland et al., 2016, Exp. 2; Harvey et al., 2013b; Read et al., 1992; Schreiber Compo et al., 2011, 2017; Van Oorsouw et al., 2015; Yuille & Tollestrup, 1990). In a meta-analysis of 13 studies of acute alcohol effects on witness recall, Jores et al. (2019) found that BACs in the 0.03–0.09% range tend to reduce the number of correct rather than incorrect details reported, with the rate of incomplete reporting dropping further for more highly intoxicated witnesses (BAC > 0.09%).

Where alcohol has been shown to impair witness accuracy, features with high visual or contextual salience are typically well retained. For example, Schreiber Compo et al. (2011) had sober, placebo and intoxicated participants (M BAC ≈ 0.08%) recall a "bar-lab" drinking experience and found alcohol significantly impaired participants' memories of the lab surroundings but not their ability to recall conversations with the bartender. This finding is supported by other observations of alcohol narrowing the focus of attention to central stimulus features, which are explained by Steele and Josephs's (1990) *alcohol myopia* theory (e.g., Bayless & Harvey, 2017; Canto-Pereira et al., 2007; Clifasefi et al., 2006; Harvey, 2016; Harvey et al., 2017; Hoyer et al., 2007; Jaffe et al., 2019; Moskowitz & Sharma, 1974; Schulte et al., 2001). According to this view, a rising blood alcohol concentration gradually reduces cognitive capacity, restricting the drinker's attentional scope to only the most central or salient scene details. In the Schreiber Compo et al. (2011) study the bartender was central to each participant's experience, in much the same way as an assailant may capture the attention of a witness. Perpetrator salience may therefore explain why adverse effects of alcohol on face identification are rarely found. But dramatic crimes such as assault and affray present other prominent visual cues that compete for attention, including crowd chaos, injuries and distressed victims, possibly preventing witnesses from adequately encoding the perpetrator's face.

One of the most compelling examples of visual saliency is *weapon focus* (WF), where witnesses are so narrowly fixated on an assailant's weapon their ability to later remember the scene and identify him is impaired (Loftus et al., 1987). An extensive body of research reveals that participants who view an armed crime tend to remember the assailant less accurately relative to viewing him unarmed in an otherwise matching scene (Carlson et al., 2017; Cutler et al., 1986, 1987a, 1987b; Erickson et al., 2014; Loftus et al., 1987, Experiment 2; Pickel, 1999; Tooley et al., 1987). It is possible that the sight of a perpetrator's weapon triggers a defensive stress response that narrows witness attention to the threatening object, blocking processing of less important peripheral stimuli. This is known as the *arousal hypothesis*, which emerged from Easterbrook's cue-utilisation theory (Easterbrook, 1959; Loftus et al., 1987). According to this view, optimal levels of arousal focus attention by restricting the range of available cues only to those directly relevant to the threatening stimulus, such as the location and orientation of a gun (for a review of the arousal and witness memory literature, see Deffenbacher et al., 2004).

While scene memory studies have shown the focus of attention to narrow on to emotionally evocative stimuli (Christianson, 1992; Davies et al., 2008), the intensity of arousal elicited by most experimental mock-crimes rarely equals that experienced by real witnesses (Kocab & Sporer, 2016). In laboratory-based studies the effect is more likely driven by the contextual novelty or salience of a weapon's presence, which is referred to as the *unusualness* hypothesis (e.g., Carlson, Pleasant, et al., 2016; Pickel, 1998, 1999, 2009).

The unusualness hypothesis is supported by evidence of attention narrowing to surprising but non-threatening objects wielded by scene actors, such as a banana or feather duster (e.g., Hope & Wright, 2007; Pickel, 1998). For example, Carlson and Carlson (2012; 2014) removed the potency of a weapon to distract attention by placing an unusual item (a large black sticker) on the perpetrator's face. Weapon group participants who viewed the gunman wearing the face adornment were poorer at identifying him from a line-up than those who saw him without it. So, an unusual non-threatening item may disrupt witness face encoding more than a weapon, even when the novel item is situated on the perpetrator's face itself. More recently, however, Mansour et al. (2019) found a larger face identification impairment among viewers of a mock crime in which the perpetrator carried a weapon rather than a plastic flamingo, but only for a shorter version of their stimulus scene. During longer scenes, the presence of a weapon *enhanced* memory performance relative to a flamingo substitute, which is essentially a WF reversal.

Whatever its cause, weapon presence has demonstrably impaired mock-witness recall and recognition through the apparent restriction of attention to this salient item, and meta-analytic reviews suggest this attention-tunnelling effect has a larger impact on scene memory accuracy than on perpetrator identification performance (Fawcett et al., 2013; Kocab & Sporer, 2016; Steblay, 1992).

Given that weapons *and* acute alcohol intoxication have been shown to narrow visual attention, we consider whether the presence of an armed perpetrator intensifies WF for intoxicated viewers in a test of eyewitness scene memory. Interestingly, Altman et al. (2018) used a mock armed crime recording to measure the effect of elevated BACs (i.e., greater than 0.08%) on witness memory among a sample of local bar patrons. Alcohol spared face identification accuracy but reduced the quantity and quality of recall with cued questions increasing the amount of inaccurate information elicited from highly intoxicated participants. But as a no-weapon control scene was not incorporated into the design of that study, it is difficult to gauge the extent to which weapon focus influenced witness memory.

The combined effects of alcohol intoxication and WF on witness memory have so far been explicitly examined in only one study (Harvey et al., 2020). Harvey and colleagues had a group of sober and alcohol-intoxicated (BAC range = 0.04–0.23%) bar drinkers view one of two slideshows depicting a young male queuing for assistance at a university help desk. In the weapon scene he arrived at the counter and pointed a gun at the assistant, who responded by handing him a laptop, which he left with. The no-weapon control scene was the same except the male extended his Student ID card to the assistant when arriving at the counter. After a five-minute retention interval, participants completed a 20-item multiple-choice questionnaire testing their memory for central (target-related) and peripheral (non-target related) scene details then attempted to identify the male from a (target-present or target-absent) line-up array. Surprisingly, weapon presence enhanced rather than impaired target identification accuracy – another reversal of the standard WF effect – but BAC increases were associated with a reduction in correct identifications and an increase in false identifications. Crucially, for present purposes, general scene memory in that study was not influenced by alcohol or weapon presence.

That Harvey et al. (2020) found no effect of witness intoxication on scene memory was not a big surprise as such null effects are relatively common in the applied alcohol and memory literature. The absence of a WF effect is more unusual, particularly as the design of that study was a replication of the seminal Loftus et al. (1987) WF demonstration. Here, we test the possibility that both null effects are attributable to three limitations of the Harvey et al. (2020) design. First, the multiple-choice memory questionnaire was limited by the absence of a "do not know" response option for each item. This is important because Crossland et al. (2016) found highly intoxicated witnesses who viewed a mock theft made significantly more "do not know" responses to cued recall questions than sober responders, and these memory gaps were primarily for questions concerning peripheral scene features of low salience (i.e., those not spatially or semantically connected to the target "thief" and his actions). As the multiple-choice questionnaire of Harvey et al. (2020) included only four response options per item (1 correct, 3 incorrect), correct guessing may have inflated accuracy for the tougher "peripheral" questions rendering their questionnaire insensitive for the detection of alcohol narrowing effects.

The second problem is that participants in the Harvey et al. (2020) weapon scene were able to view the target's face prior to him revealing the weapon. The target's face featured in the last 9 of the 18-slide scenes (exposure time = 13.5 s) but he only exposed his gun in the last 5 of these (exposure time = 7.5 s). Viewers therefore had a 6 s opportunity to encode the target's face without the presence of a weapon competing for their visual attention, which is potentially enough face exposure to reduce or eliminate WF. For example, Erickson et al. (2014) used a mock crime slideshow to manipulate weapon (or novel item) exposure to occur either before, during or after the target's face was visible and found target identification was impaired only when his face and weapon had been co-presented, not when the target's weapon was revealed before or after his face was visible. More recently, Carlson, Young, et al. (2016) found no differences in eyewitness recall or identification performance between a 10 s scene in which the target's weapon and face were co-presented and a 10s scene in which his face was visible for 8 s prior to weapon exposure.

Third, the Harvey et al. (2020) field study was restricted to a quasi-experimental design in which participants could not be randomly assigned to an alcohol or no-alcohol beverage treatment. Pre-existing differences between sober and alcohol groups, such as the amount of time spent drinking or the amount of food eaten just prior to the study were therefore not controlled. We addressed these problems by running that experiment under placebo-controlled laboratory conditions, using an edited version of the slide series in which the target's face is seen for a shorter period and is not presented until the gun (or neutral control stimulus) is revealed. We also added a "do not know" option to the memory questionnaire to drive down guessing and increase the sensitivity of this instrument for the detection of moderate alcohol effects.

All participants were expected to show better memory performance for questions related to central rather than peripheral scene features (Crossland et al., 2016; Harvey et al., 2013a; Harvey et al., 2013b; Schreiber Compo et al., 2011). Due to anticipated effects of WF, those shown the weapon scene were expected to show poorer scene memory accuracy than no-weapon controls (Loftus et al., 1987). In accordance with alcohol myopia theory, relative to sober controls, the alcohol group were expected to show poorer recognition accuracy for items related to peripheral rather than central (target related) scene features (Harvey et al., 2013a; Jaffe et al., 2019; Schreiber Compo et al., 2011), while the combination of WF and alcohol myopia was expected to produce the lowest peripheral memory scores of all. Finally, based on work by Harvey and Tomlinson (2020) suggesting alcohol narrows the focus of attention to the external region of unfamiliar faces, particularly hairstyle, we thought alcohol participants may show improved accuracy for the two questions concerning the target's scalp hair length and colour (external face features) relative to the question concerning his facial hair (an internal face feature).

2 | PARTICIPANTS

We tested 93 participants (57 females, 36 males) ranging from 18 to 54 years of age ($M = 23.84$ years, SD = 7.68). Most were undergraduate or postgraduate students recruited across campus and compensated with a £10 payment, though 19 were psychology undergraduates who received course credit. All reported normal or corrected-to-normal vision. Sample size was determined by a priori power analysis ($\beta = .8$) using G*Power 3.1.2 (Faul et al., 2009). This was based on use of a three-way mixed-design analysis of variance with four groups and one within-subjects variable (Stimulus Category). Using this test to detect a medium-sized three-way (within-between) interaction effect ($f = 0.25$; partial eta squared = 0.07) at least 76 participants were required, assuming a correlation between central and peripheral memory recognition scores of 0.2 and an alpha of 0.05. The experiment was advertised as a study of the effects of alcohol on visual attention and all respondents were screened for eligibility prior to testing. They were emailed a copy of the participant information sheet, a health and alcohol use questionnaire and a copy of the Michigan Alcohol Screening Test (MAST) (Selzer, 1971), which were completed and returned to the experimenter prior to appointing a test slot. The alcohol use questionnaire was used to ensure all participants were aged 18 years or over, alcohol tolerant (i.e., that they regularly consumed at least five alcohol units per week) and had no medical conditions precluding alcohol consumption (including pregnancy or possible pregnancy). The MAST was used to exclude "problem drinkers," defined as those obtaining a score of six or more on that measure. Eligible respondents were booked for a test session via an email reply. Participants were asked not to drink alcohol 24-hours prior to their test session nor eat within 4-hours of arriving at the lab.

3 | DESIGN

A 2(Beverage Group: alcohol vs. placebo) × 2(Scene Group: weapon present vs. weapon absent) × 2(Stimulus Type: central vs. peripheral features) mixed factorial ANOVA was used to test the effects of alcohol intoxication and weapon presence on scene feature memory, with Stimulus Type serving as the sole within-subjects variable. The dependent variable was recognition performance on a 20-item multiple-choice memory questionnaire.

4 | APPARATUS AND MATERIALS

Breath alcohol was measured using a Dräger Alcotest 3000 breathalyser with the unit reported by the device (mg/100 mL) converted to a blood alcohol concentration (BAC% by volume) estimate based on a 2100:1 blood-breath partition ratio.

Harvey et al. (2020) presented participants with a slideshow depicting three students waiting in line to be served by a female assistant at the counter of a university administration office. In the no-weapon scene, a male reaches the counter and shows his student identification card to the assistant who responds by handing him a laptop computer, with the implication that she is loaning him the device. The weapon scene shows the same actors in the same scenario except the male pulls a gun on the assistant as he reaches the counter. She again responds by handing him a laptop, although the scene now obviously resembles an armed robbery. Harvey et al. (2020) counterbalanced two weapon/no-weapon stimulus scenes with each pair showing a different target male. However, given a change of target in that study had no influence on scene memory performance, for the present experiment we used only an edited version of the stimulus scene featuring "Target A" from that study.

The original sequence comprised 18 slides that we reduced to six, following removal of those in which the target's face was visible prior to presentation of his gun or the harmless control item in the no weapon scene (the ID card). In our weapon sequence, the target appears for the first time in slide #3 in which he points a gun at the assistant. His face remains visible on slide #4 and #5, as the assistant hands him a laptop, and the side of his head is shown on the final slide as he exits the scene with gun no longer visible (see Figure 1). The no weapon control sequence was the same except the target is first seen showing the assistant his ID card in slide 3. With each slide presented for 1.5 sec, the target's face was visible for a total of 6 sec. Photos were shot in colour with a Canon E0S 1300D DSLR digital camera.

We used the Harvey et al. (2020) "*Where's Wally?*" filler task, which participants completed during a 5-minute memory retention interval. This comprised a series of six detailed illustrations depicting hundreds of characters engaged in various activities in a themed location (e.g., a beach or fun fair). Participants had to pick "Wally" out from this crowd, a character uniquely distinguished by a red and white striped hat and sweater.

The memory measure adapted from Harvey et al. (2020) contained 20 multiple-choice questions. Each item had five response choices, one correct, three incorrect plus a "do not know" option designed to reduce guessing. Seven questions related to details about the target male and his actions ("central" questions) including the

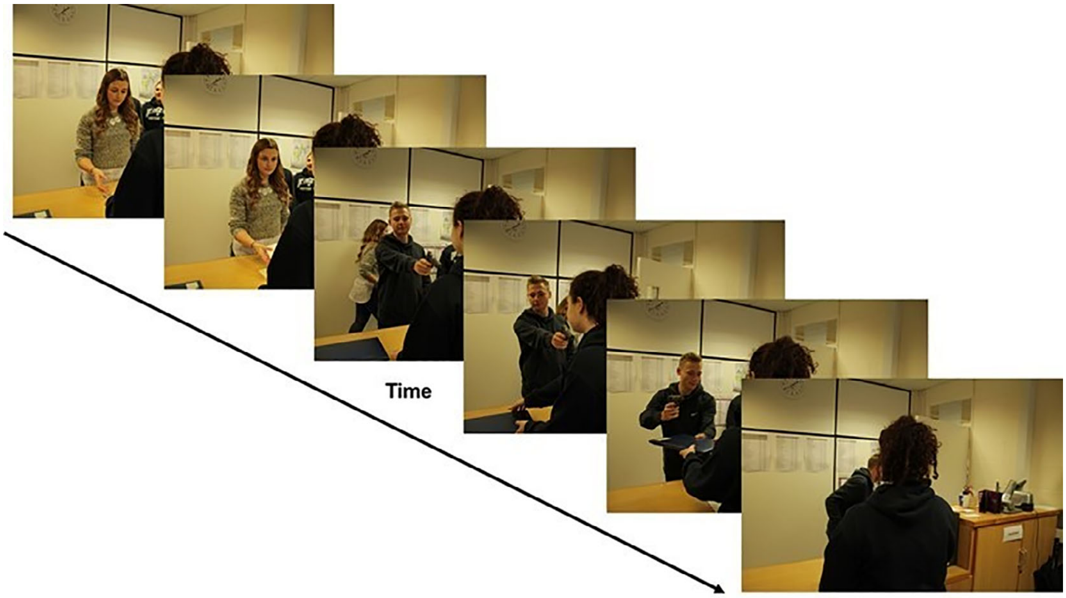

FIGURE 1 Sample slides from the "weapon" scene

object he wielded, the object he took, the colour of his hair, the length of his hair, his style of facial hair (if any), the colour of his sweater and details of the logo on it (if any). Remaining "peripheral" questions related to the colour of the office door, the number, hairstyle and clothing of bystanders and details of various signs, posters and objects located around the room.

5 | PROCEDURE

On arrival at the test venue participants read and signed a hard copy of the experiment information sheet and consent form. They were breathalysed to ensure an initial BAC of 0%, weighed to determine their alcohol dose then randomly assigned to the alcohol or placebo control group. Male alcohol participants received 1.7 mL of vodka (40% alcohol by volume) per kilogramme of body weight, mixed with sugar free Indian tonic water to produce a 500 mL drink. As females are known to become more impaired than men by equivalent alcohol doses, they were given 1.5 mL of vodka per kilogramme of body weight (Mumenthaler et al., 1999). Participants assigned to the placebo group were served 500 mL of sugar free Indian tonic water with 2 mL of vodka dropped on to the surface of the drink. The glass was then mist sprayed with three pumps of neat vodka, a long-established technique known to create the convincing odour of an alcoholic beverage (e.g., Harvey, 2016; Marczinski & Fillmore, 2003; Mulvihill et al., 1997). Participants were given 20-minutes to consume their drink followed by a 30-minute absorption period. They washed residual alcohol from their mouths with tap water then provided a second breath test, which was not disclosed.

Participants were assigned at random to view either the weapon or no-weapon stimulus sequence and told that the scene consisted of six slides each presented for 1.5 sec, which they should just view normally. Following stimulus presentation, they gave another undisclosed breath reading then began the "*Where's Wally?*" task. After this 10-minute filler exercise, participants completed the memory questionnaire, submitted to a final (disclosed) breathalyser test, were invited to ask questions about the study and then got debriefed.[1]

6 | RESULTS

6.1 | Intoxication levels

Baseline BACs were 0.00% for all participants and the placebo group remained at this level following beverage treatment. Post-treatment BACs for the alcohol group ranged from 0.03% to 0.09% with a mean of 0.067% ($SD = 0.014$), slightly below the legal limit for driving in England and Wales (BAC = 0.08%). An independent-groups t-test confirmed no significant difference in mean BAC between alcohol participants in the weapon group (M BAC = 0.066%), 95% CI [0.06, 0.07] and no-weapon group (M BAC = 0.068%), 95% CI [0.06, 0.07], $t(45) = .40$, $p = .69$, $d = 0.15$.

6.2 | Memory accuracy

The effects of alcohol intoxication and weapon exposure on memory performance were tested with a 2(Beverage Group) × 2(Scene Group) × 2(Stimulus Category) mixed factorial ANOVA, with Stimulus Category serving as a within-subjects variable. There was no significant effect of weapon presence on scene memory, $F(1, 89) = 3.159$, $p = .079$, $\eta_p^2 = .034$. The main effects of stimulus category and alcohol were statistically significant. As expected, central features ($M = 58.72$, 95% CI [54.67, 62.77]) were remembered far more accurately than peripheral features ($M = 21.81$, 95% CI [19.23, 24.39]), $F(1, 89) = 295.47$, $p < .001$, $\eta_p^2 = .769$. Furthermore, alcohol participants showed poorer overall memory performance ($M = 37.21$, 95% CI [33.49, 40.93]) than placebo controls (43.32, 95% CI [39.57, 47.08]), $F(1, 89) = 5.28$, $p = .024$, $\eta_p^2 = .056$. However, these main effects were qualified by a significant three-way interaction, $F(1, 89) = 6.59$, $p = .012$, $\eta_p^2 = .07$. As shown in Figure 2, the presence of a weapon had no impact on the central memory scores of the alcohol group, but sober weapon viewers showed better central memory performance than their no-weapon counterparts. On the other hand, the presence of a weapon made little difference to the peripheral recognition performance of the sober group, but alcohol participants showed better peripheral memory for the weapon scene compared to no-weapon controls.

A simple main effects analysis with Bonferroni correction revealed that the higher sober central memory scores of the weapon group ($M = 68.32\%$, 95% CI [60.18, 76.47]) compared to the no weapon group ($M = 57.14\%$, 95% CI [49.00, 65.29]) did not quite meet the threshold for statistical significance ($p = .057$). The effects of weapon presence on the sober group's peripheral recall ($M_W = 23.08$, 95% CI [17.89, 28.27]; $M_{NW} = 24.75$, 95% CI [19.56, 29.94]) and on the alcohol group's central recall ($M_W = 54.76$, 95% CI [46.79, 62.74]; $M_{NW} = 54.66$, 95% CI [46.51, 62.80]) were also non-significant ($p = .652$ and $p = .986$, respectively). However, peripheral memory scores for alcohol participants in the no-weapon group ($M = 15.05\%$, 95% CI [9.86, 20.24]) were significantly lower than those of alcohol participants in the weapon group ($M = 24.36\%$, 95% CI [19.28, 29.44]), $p = .013$.

As Harvey and Tomlinson (2019) found evidence suggesting alcohol restricts visual attention to the external (hair) region of faces during encoding, we explored the influence of intoxication and weapon focus on performance for the three memory questions relating specifically to the target male's internal and external face features – namely, (i) the status of his facial hair, (ii) his scalp hair colour, and (iii) his scalp hair length. A preliminary analysis revealed alcohol effects on face memory, but these were consistent for both internal *and* external facial features. For the sake of conciseness, we therefore computed the average of all three scores to produce a general face memory measure (see Figure 3). In the no-weapon group, those who consumed alcohol had better memories of the target's face ($M = 76.81\%$, 95% CI [64.93, 88.69]) than sober controls ($M = 60.87\%$, 95% CI [48.99, 72.75]). Among the weapon group, however, alcohol participants showed poorer overall face memory

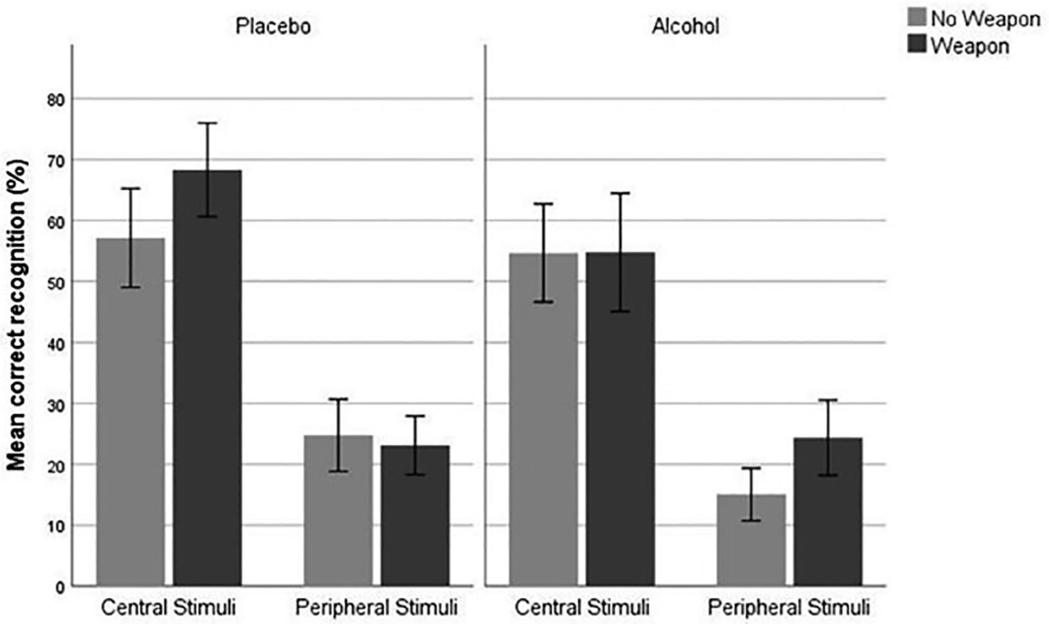

FIGURE 2 Percentage of correctly recognised central and peripheral scene features as a function of weapon exposure and alcohol treatment. Error bars show 95% confidence intervals

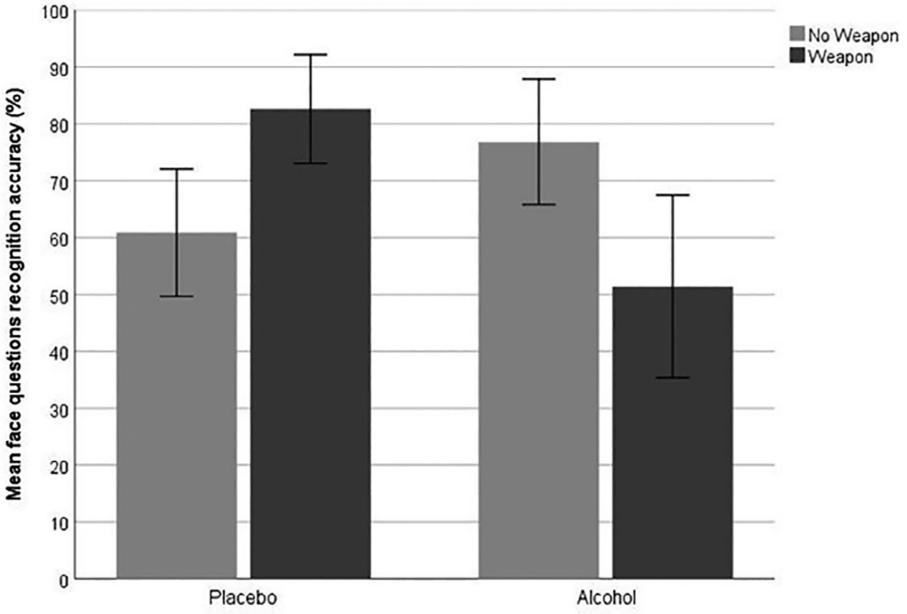

FIGURE 3 Percentage of correctly remembered facial features as a function of weapon exposure and alcohol treatment. Error bars show 95% confidence intervals

(*M* = 51.39%, 95% CI [39.76, 63.02]) than placebo controls (*M* = 82.61%, 95% CI [70.73, 94.49]). A 2(Beverage Group) × 2(Scene Group) independent factorial ANOVA revealed this interaction to be highly significant, $F(1, 89) = 15.72$, $p < .001$, $\eta_p^2 = .15$.[2]

A simple main effects analysis with Bonferroni corrections confirmed that face memory performance among alcohol participants was significantly higher in the no-weapon (*M* = 76.81%, 95% CI [64.93, 88.69]) than weapon group (*M* = 51.39%, 95% CI [39.76, 63.02], $p = .003$), suggesting a standard WF effect. Conversely, sober face memory was significantly more accurate in the weapon group (*M* = 82.61%, 95% CI [70.73, 94.49]) than in the no-weapon group (*M* = 60.87%, 95% CI [48.99, 72.75], $p = .012$), indicating a reverse WF effect.

7 | DISCUSSION

In a recent field experiment using a multiple-choice questionnaire, Harvey et al. (2020) found no adverse effects of weapon presence or alcohol consumption on eyewitness scene memory of a mock crime.

However, the perpetrator's face in that study was visible to participants *prior* to him revealing his gun. In the present placebo-controlled experiment we used the same materials and measures but showed participants a shortened version of the Harvey et al. (2020) slide sequence in which the perpetrator's face was visible only from the moment he drew his gun. We also added a "do not know" response option to each item on the multiple-choice memory questionnaire. As with Harvey et al. (2020), central memory performance was far superior to peripheral recognition, though with our revised experimental design alcohol compromised overall memory performance. Furthermore, consistent with alcohol myopia theory, the vodka dose reduced recognition accuracy for peripheral scene features, so we assume that inclusion of a "do not know" response option was effective in helping us detect adverse alcohol effects.

However, these alcohol effects were only found among participants shown the no-weapon scene. Curiously, the presence of a gun enhanced recognition performance for the weapon group and alcohol participants shown the weapon scene had better peripheral memory scores than no-weapon alcohol controls. Conversely, sober weapon-scene viewers produced a reverse WF effect, with better central memory performance than sober no-weapon counterparts, which we discuss below.

Although general memory performance was uninfluenced by weapon presence, analysis of scores for the three questions concerning the target's facial features revealed a clear WF effect among the alcohol group. Specifically, intoxicated participants were less accurate at remembering details of the armed assailant's hair colour, hair length, and facial hair than viewers who saw the male unarmed in a matched scene. This interaction suggests the gun's presence drew witness attention away from the target's face and alcohol then narrowed their focus on to the gun further still. This presumably led to poorer encoding of his facial features, relative to sober and no-weapon controls. Surprisingly, alcohol participants shown the no-weapon scene had better memories of the target's face than sober counterparts. It therefore seems that, in the absence of a gun, the target's face was the most salient visual stimulus and alcohol channelled witness attention on to this feature. We note though that our alcohol group were no better at remembering the target's scalp hair colour and length than they were at remembering his facial hair status. Thus, in contrast to the findings of Harvey and Tomlinson (2020) we found no evidence that alcohol narrows attention to external rather than internal face features.

The present WF effect was observed under placebo-controlled conditions among alcohol participants intoxicated to only 0.06% BAC, on average. As this is below the intoxication level of the Harvey et al. (2020) alcohol group ($M = 0.08\%$; $SD = 0.05$), we assume it was our editing of their stimulus sequence that elicited WF. The weapon group of Harvey et al. had a 6 s opportunity to encode the target's face *prior* to him drawing the gun, plus a further 7.5 s view of his face alongside the gun. Whereas our weapon group had only a 6 s concurrent view of the perpetrator's face and gun.

These are comparable conditions to those of a non-pharmacological WF study by Erickson et al. (2014), who manipulated a scene such that the weapon was revealed either before, during or after the target's face was apparent. Those authors detected WF only among viewers of the simultaneous face-weapon scene. Though mock witnesses in that study were presumably sober, so it is unclear why we only observed WF among our alcohol group.

In a striking contrast, our sober weapon group was significantly *more* accurate at remembering the perpetrator's face features than the sober no-weapon group. We can only speculate as to the cause of this reverse WF effect, but it is possible that in threatening to shoot an innocent receptionist the target male elicited a fascination in viewers absent in those who saw him unarmed in the mundane laptop loan transaction. Sober viewers are cognitively better equipped to indulge their interest, possessing the necessary speed and flexibility to attend to the assailant's weapon *and* face in a limited timeframe. Harvey et al. (2020) discuss this so-called "curiosity effect" when describing their reverse WF effect and cite possible evidence of it elsewhere. For example, Shaw and Skolnick (1994) inadvertently reversed a scene recall WF effect by switching the sex of an armed intruder from male (a stereotypical villain) to female (a non-stereotypical villain). More recently, mock-witness curiosity may have played a role in Carlson and Carlson's (2012; 2014) studies, in which a sticker placed on a perpetrator's face produced WF reversals.

Our findings also support recent work by Mansour et al. (2019) who manipulated the duration of a stimulus scene within the same experiment. They found WF was associated with only shorter (12 sec) scenes. Intriguingly, the memory performance of participants shown a longer (26 sec) scene (featuring either a knife or gun) was *superior* to those shown a matched scene in which the assailant carried a plastic flamingo (i.e., a salient but non-threatening object) in place of a weapon. This unexpected interaction between reverse WF and scene duration is difficult to explain but it challenges the view that stimulus threat alone drives WF. Furthermore, it underscores the importance of controlling for item distinctiveness in WF studies, by incorporating scenes in which the protagonist wields a non-threatening weapon substitute that is as visually distinctive as the weapon itself. With only a student ID card serving as the gun substitute, the present study lacked this control, so attempts to replicate the present findings should incorporate this design feature.

Future studies in this field should also address a related limitation concerning the operational definition of "central" stimulus features. The target male in the present study was central to the stimulus scene in both semantic *and* spatial terms, but these factors must be disentangled in subsequent studies to determine which of them is most important for driving the attentional bias in WF.

The retention period in future alcohol challenge studies of WF should also be extended. The 5-minute interval we imposed is short on ecological validity and so brief that alcohol participants both encoded and retrieved scene details in the same intoxicated state. Whether the present alcohol and weapon-presence interaction replicates following much longer sobering delays, and whether present alcohol memory deficits stem from disruptions to processes of encoding or retrieval are yet to be determined.

Finally, in future work ecological validity should be enhanced through use of live mock-crimes or video recordings of these enactments, in the hope of capturing more closely the dynamic realism of true armed crimes. In contrast to the present study, these dramatic scenarios will allow researchers to evaluate the influence of emotional stress, acute alcohol intoxication and WF on eyewitness memory, which has not yet been examined.

8 | CONCLUSION

The main question driving this study is whether alcohol intensifies WF by narrowing witness attention to a perpetrator's gun, thus impairing memories of him and wider crime aspects. Our findings suggest that when given just a brief and concurrent glimpse of an armed perpetrator's face and weapon, alcohol intoxicated witnesses are more susceptible to weapon focus than sober counterparts. Investigators in the criminal justice system should be aware of this deficit as it could lead to the loss of forensically important facial information about unknown perpetrators and the misidentification of suspects. Given the scant research on alcohol and WF however, a good deal more work is needed before firm conclusions may be drawn.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ENDNOTES

[1] After completing the questionnaire, prior to debrief, participants attempted to identify the target male from a 12-person line-up, though we did not end up with sufficient participant numbers to analyse these data. Furthermore, following debrief, they were invited to complete a questionnaire for a separate study (Stafford et al. 2020).

[2] This analysis revealed heterogeneity of variance that could not be addressed with a data transform.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Alistair J. Harvey https://orcid.org/0000-0003-4329-489X

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