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Intoxicated witnesses: Testing the validity of the Alcohol Myopia Theory

Abstract

In an assessment of the Alcohol Myopia Theory, this research investigated the effects of alcohol on an eyewitness's recall of high and low salience details. In Study 1, participants watched a staged videoed theft in a laboratory whilst either sober (control or placebo), above (M_{BAC} = 0.09%) or below (M_{BAC} = 0.06%) the UK drink-drive limit. A week later a free recall and recognition test were completed. These levels of intoxication were not found to reduce the accuracy of an individual's recall using either recall task. In Study 2, while on a night out participants watched the videoed theft with either high (M_{BAC} = 0.14%) or low (M_{BAC} = 0.05%) levels of intoxication. A week later the free recall and recognition test were attempted. High levels of intoxication were seen to impair recall when memory was assessed through free recall but not with the recognition test. Neither study however found the narrowing of attention predicted by Alcohol Myopia Theory using either the recognition test or free recall, although poor recall for peripheral details in all groups may have contributed to this result. The findings of this research are discussed in terms of their real world value and the path of future research.

Keywords: Alcohol, Intoxication, Eyewitness memory, Recall, Alcohol Myopia Theory

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Alarmingly, as alcohol consumption increases so does the probability of being targeted by criminals (Touhig, 1998). In 2011/12, over 900,000 violent crimes were committed in the UK, where alcohol was consumed by the witness, victim or perpetrator (Office for National Statistics, 2013). Available statistics in relation to the extent of witness intoxication however are limited to crimes committed in North America. According to US police officers, around 41% of interviewed witnesses were deemed to be under the influence of alcohol at the time of the crime, and most likely over the drink drive limit (Evans, Schreiber-Compo & Russano, 2009). Further to this, about a third of witness testimonies heard in US courts were from individuals under the influence of alcohol (or other drug) at the time of the crime (Palmer, Flowe, Takarangi & Humphries, 2013). Despite the apparent role alcohol plays in criminal offences, and consumption levels in the UK and US increasing (WHO, 2011), this field is a widely under-investigated area (Malpass et al., 2008).

To date only ten published studies have explored the effects of alcohol on eyewitness memory for event details (Hagsand, Roos-af-Hjelmsäter, Granhag, Fahlke & Söderpalm-Gordh, 2013a; Harvey, Kneller, & Campbell 2013a; Harvey, Kneller, & Campbell 2013b; Hildebrand, Roos-Af-Hjelmsäter, Fahlke, Granhag, & Söderpalm-Gordh, 2015; La Rooy, Nicol & Terry, 2013; Schreiber-Compo, et al., 2011; Schreiber-Compo, et al., 2012; Van Oorsouw & Merckelbach, 2012; Van Oorsouw, Merckelbach, & Smeets, 2015; Yuille & Tollestrup, 1990). However, a more comprehensive body of literature assessing the effect of intoxication on general memory processes and employing traditional recall measures does exist (e.g. Birnbaum & Parker, 1977; Bruce & Pihl, 1997; Garfinkel, Dienes, & Duka, 2006; Hashtroudi, Parker, DeLisi & Wyatt, 1983; Maylor & Rabbitt, 1993; Maylor, Rabbitt & Kingstone, 1987; Moulton et al., 2005; Parker et al., 1980; Ray, Bates, & Ely, 2004; Soderlund, Parker, Schwartz, & Tulving, 2005; Tracy & Bates, 1999). This research indicates that alcohol impairs effortful but not automatic processing, and that when consumed prior to encoding alcohol impairs memory, but enhances recall when drunk post-memory formation. In addition, studies indicate that alcohol limits the cognitive functioning of individuals by restricting the number and breadth of cues that can be perceived (Huntley, 1973; Schneider, DuMais & Shiffrin, 1984). Alcohol Myopia Theory (AMT) (Josephs & Steele, 1990) proposes that this impairment in perception and thought arises from a disproportionate degree of attention being given to immediate salient cues (both internal and external). The weaker, less salient cues in turn receive less attention (Steele & Josephs, 1990). Salience, the theory stresses, relates to the immediate superficially understood aspects of an event which have an undue influence over an individual's behaviour. Research also indicates that the concept of Alcohol Myopia has the potential to explain an individual's processing of visual stimuli whilst intoxicated (Clifasefi, Takarangi & Bergman, 2006; Harvey et al., 2013a; Harvey et al., 2013b).

Across different environments, AMT stresses that salient cues need not be consistent: an item in one event may be a prominent detail whilst in another it is of little influence. It is ultimately the event itself that determines the salience of the elements, not the nature of the element (spatial location, type of object or its role in the unfolding scenario). To date, however, studies have mainly focused on an item's 'type' to decide its salience. For example the perpetrator's face is one such type that is considered highly salient information, and in support of AMT intoxicated individuals are seen to be just as accurate as sober witnesses in their line-up decisions (Dysart, Lindsay, MacDonald & Wicke, 2002; Hagsand, Roos-af-Hjelmsäter, Granhag, Fahlke, & Söderpalm-Gordh, 2013b; Horry, Memon, Wright, Milne, & Dalton, 2013; Read, Yuille & Tollestrup, 1992; Yuille & Tollestrup, 1990).

Other item ‘types’ include actions versus descriptions (Read, et al., 1992; Van Oorsouw & Merckelbach, 2012; Yuille & Tollestrup, 1990), where actions are deemed central (high salience) and person or object descriptors are peripheral (low salience). Initial field study research (Van Oorsouw & Merckelbach, 2012) looking at perpetrator recall suggests that with a cued but not a free recall task, higher blood alcohol concentrations (M_{BAC} = 0.16%) decrease overall recall accuracy (irrespective of the type of information) when compared with moderately intoxicated (M_{BAC} = 0.06%) and sober individuals. Whilst mock witnesses, irrespective of intoxication level, were more accurate in relation to central information, when memory was assessed through free recall it was the recollection of central rather than peripheral details that was especially undermined by intoxication. This runs counter to the predictions of AMT where recall of peripheral details is expected to be impaired to the greatest extent.

Within alcohol and forensic memory studies spatial location has also been used to group items (Harvey et al., 2013a; Schreiber-Compo et al., 2011), where information that is at the physical centre of a person’s field of vision is deemed central (high salience) and details surrounding this are peripheral (low salience). In their bar-lab, Schreiber-Compo et al., (2011) had a confederate bar-tender ensure he remained the focus of participants’ attention during a lengthy interaction whilst he prepared and they drank their drink, immediately after which a free recall task was completed. The appearance and actions of the bartender were thereby deemed central, whilst descriptions of the environment were classed as peripheral. In line with the expectations of AMT, the recall of intoxicated individuals (M_{BAC} = 0.08%) was significantly poorer than both control and placebo (M_{BAC} = 0.01%)

participants for peripheral information. For central information no effect of intoxication was found. However, intoxicated individuals provided their free-recall whilst still under the influence of alcohol and so the conclusions drawn from this research, and the support offered for AMT are potentially confounded by state-dependency recall effects (Parker, Birnbaum & Noble, 1976; Weissenborn & Duka, 2000).

Each of the aforementioned studies that has sought to test or discuss their results with respect to AMT (Dysart et al., 2002; Hagsand et al., 2013a; Harvey et al., 2013a; Harvey et al., 2013b; Read, et al., 1992; Schreiber-Compo, et al., 2011; Van Oorsouw & Merckelbach, 2012; Yuille & Tollestrup, 1990) have classified the items observed by participants as either of high or low salience based upon the type/nature of the item or its spatial location. However, salience as proposed by Steele and Josephs (1990) does not classify information in these terms. The salience of the item, the theory emphasises, depends on the event or scenario. As a result salience must take into account both spatial location and semantic understanding. A classification of information salience which takes into account, not one but both of these factors and also involves a complex and forensically-relevant event is therefore needed to fully assess the applicability of AMT to explain the recall of an intoxicated eyewitness.

The aim of the present research was therefore to examine the effects of intoxication on the recall of high and low salience information where salience was determined by both its semantic meaning and its spatial location within a complex event. A recognition test and a free-recall task were employed to assess the validity of the AMT as an explanation of the memory pattern of intoxicated witnesses. In light of the propositions of AMT detailed by Steele and Josephs (1990), it was hypothesised that alcohol would reduce the overall recall accuracy of participants, with items of both low spatial and semantic salience suffering the greatest impairment.

STUDY 1

Method

Participants

Based on a priori power analysis to obtain statistical power at the recommended .80 level (f = .25, α = .05; Cohen, 1988) a total of 88 undergraduates (63% female) participated with a mean age of 20.92 years (*SD* = 6.22). All student volunteers were recruited through the University's SONA participant pool management software and received £5 and course credit for their participation. Each student completed a comprehensive screening process to establish their eligibility to participate. Age, weight, drinking history and any medical conditions were established to ensure it was safe for them to consume alcohol.

Design

The study utilized a 4 (drinking condition: 0.8g alcohol dose, 0.6g alcohol dose, non-alcohol, placebo) x 2 (information salience: high, low) mixed design with information salience assessed within participants. Those 44 participants in the alcohol conditions were randomly given a dose of either 0.6g or 0.8g of ethanol per kg of body weight with lemonade to make up 450ml of fluid. These doses were based upon previous studies (Harvey et al., 2013a; Harvey et al., 2013b). As per previous research (Fillmore & Vogel-Sprott, 1995) 22 placebo participants were given an equivalent volume of lemonade with 5ml of ethanol floating on top, and a 50:50 mixture of ethanol and water spritzed around the glass' rim. The 22 participants' in the non-alcohol condition were given a drink of comparable volume, comprising only of lemonade. All drinks were made out of sight of participants. Whilst non-alcohol participants were told that they would not be drinking alcohol, both alcohol conditions and placebo participants were told only that their drink contained enough alcohol to put them over the drink drive limit. For low dose alcohol and placebo participants this information was inaccurate.

Materials and measures

Stimuli Event

The three minute stimuli event video showed a man walking into a building. He initially walked down a corridor where he touched a number of lockers before attempting to break-in to two, but failed. He then entered a classroom which he walked around before stealing a laptop and putting it in his bag. In this room the power-point screen was showing $E = MC^2$ and there were multiple posters on the walls covering a range of different teaching topics. There was also a desktop computer, mugs, chairs and tables as well as large windows through which cars and other buildings could be seen. He left this room and entered into a staffroom area which contained chairs and a sofa, and where the walls were again covered in teaching posters. He initially attempted to open two doors but failed and then picked up and dropped a large teddy bear, before looking into a bag and stealing money from a purse. He then left the room and the video ended.

Recognition test

Using the stimulus event, a 40 item recognition test was developed. Within this test participant memory was assessed in relation to what was seen throughout the video, both in terms of salience and spatial location. Details of what the man was doing, wearing and what was seen in the environment were also included. Classification of statements as either high or low salience was determined in a 2-stage process focusing on the semantic *and* spatial nature of the details (Wright & Stroud, 1998).

Firstly, semantic salience was established by a separate sample of 25 participants (*M*

= 29.56 years; *SD* = 9.73) who, whilst watching the video, indicated the salience of each of the 40 statements on a 7 point scale (1 = High salience to 7 = Low salience). Participants were allowed to pause the video to code the statements and were informed that they were to consider statements as more salient if they were important in relation to what they were viewing. The details of such statements would not necessarily be located at the centre of the screen. The details of low salient statements in contrast were those that were not the focus of attention although they need not be on the periphery of the screen (Sutherland & Hayne, 2001). With these distinctions, participants deemed statements such as “the man stole a laptop” to be of high salience whilst, “there was an orange and a white mug on the laptop desk” were considered to be of low salience. The mean score for each statement was then used to split the statements into high (*M* = 2.34, *SD* = 0.20; range: 2.04 – 2.92) and low salience (*M* = 6.36, *SD* = 0.47; range: 4.96 – 6.36) with no overlap between the two groupings. A free marginal Kappa of 0.71 for high salience and 0.61 for low salience statements (Fleiss, 1971) indicated a substantial and moderate agreement between rater’s respectively (Landis & Koch, 1977).

Secondly, a spatial classification for each statement was produced by the researchers according to the location of the detail on the screen in relation to the perpetrator – the focus of the participants’ attention. Highly spatially salient details were those that shared screen space with the perpetrator, but were not obscured by his presence, or were the only details on the screen. Details of low salience were those that were partially obscured by the perpetrator or were far from the perpetrator on the screen. Those statements that were classed as of high salience for *both* semantic and spatial assessments were considered as such within the recognition test and the subsequent analyses. Those statements deemed to be of low salience both semantically and spatially were again considered as such within the recognition test. This resulted in 20 critical statements (10 high and 10 low salience) with 50% being true and

50% false. The remaining 20 statements (those not consistently of high or low salience) were used as fillers. Statements were made false by altering a detail, such as stating that the colour of the perpetrators jacket was green when it was actually black. Each recognition test consisted of these 40 statements in a different randomized order with a confidence scale for each.

Dependent measures of recall were: the number of true/false responses to the critical recognition test statements, and the confidence associated with each response (5-point scale: 1= total lack of confidence, 5 = total confidence). Following the procedure of Yuille and Tollestrup (1990), each detail provided by participants in the written free recall task was given two scores reflecting either the amount of correct or incorrect information that was given. For example: ‘the thief wore a white t-shirt’ scored 2 correct points (1 for the accurate colour and 1 for the style of top), ‘the thief wore a white round neck t-shirt’ scored 3 (the extra correct point gained for the collar shape). If the collar had been incorrectly recalled as square then the statement would have scored 2 correct points and 1 incorrect point. A higher correct or incorrect score therefore indicated more correct or incorrect units of information respectively. With two scorers blind to the participants drinking condition an inter-rater reliability score of 0.91 was obtained using the Kappa statistic.

Procedure

Stage 1: On arriving at the research venue, participants’ were breathalyzed using a Lion Alcometer 500 to confirm their 0mg/L Breath Alcohol Concentration (BrAC), and weighed before being randomly assigned to a drinking condition. On being handed their beverage participants had 15 minutes to consume the drink at a steady pace, and a further 15 minutes to allow their BrAC to raise and ensure they were on the ascending limb of the Blood Alcohol Curve (Jones, 1990) as with previous research (Harvey et al., 2013a; Harvey et al., 2013b). Participants were then breathalyzed (but were not advised of the reading) and asked to provide a subjective rating for their perceived level of intoxication on a scale of 0-100 (0 = completely sober to 100 = as drunk as they had ever been). All participants then proceeded to watch the stimulus event. At the end of the video participants were informed as to their drinking condition and their BrAC. This session lasted on average 50 minutes. Those over the UK drink drive limit were advised to remain in the lab until their BrAC lowered to below 0.30mg/L or M_{BAC} = 0.07% (i.e. under the UK drink-drive limit).

Stage 2: A week later participants returned to the lab and were breathalyzed to confirm their sober state. A written free recall task was then completed with participants detailing anything they could recall from the video, followed by the self-administered 40-item recognition test. If individuals were unsure as to the veracity of a statement they were told to give the response they thought was more accurate (true or false), and reflect their lack of confidence on the accompanying scale. Once the test was completed participants were debriefed.

Results

Breath Alcohol Concentration

Participant intoxication was initially assessed through their breath alcohol concentration. However, in order to be in line with previous research all BrAC's were converted to blood alcohol concentrations (BAC) with a blood: breath ratio of 2,300: 1. With individuals metabolizing the ethanol at different rates, there was a crossover in the intoxication readings of participants in the 0.6g and 0.8g alcohol conditions (0.6g BAC range = 0.03- 0.10%); 0.8g BAC range = 0.07- 0.11%). Although a significant overall difference in the BrAC's of participants in these conditions was confirmed (t (42) = 7.48, p <.001) it was deemed pertinent and of greater ecological validity to regroup the 44 alcohol participants according to their BAC, rather than the quantity of alcohol consumed[1]. Consequently, prior to watching the stimuli event the 21 participants with the highest BAC readings provided samples ranging from 0.08 - 0.11% (*M* = 0.09%; *SD* = 0.01). The 23 alcohol participants with the lowest readings provided samples between 0.03- 0.07% (*M* = 0.06%; *SD* = 0.01). This participant split ensured that low BAC participants were under the UK drink drive limit of 0.08%, whilst high BAC participants were over this limit. All placebo participants provided a BAC of 0.00% to confirm their sober state.

Perceived Intoxication Levels

To confirm the success of the placebo manipulation a rating of perceived intoxication was taken on a scale of 0-100 (completely sober to as drunk as you've ever been). Compared with the placebo (M = 14.18; SD= 14.1) and sober condition (M = 0.00; SD = 0.00), high (M = 45.95; SD = 17.7) and low (M = 39.30; SD = 20.14) BAC participants provided significantly higher ratings of intoxication F (3, 84) = 43.59, p < .001. High BAC and low BAC participant ratings however were not significantly different from each other (p = .47). Of the 22 placebo participants only 4 believed themselves to be entirely sober (score = 0) and no significant correlation was found between the perceived level of intoxication of high and low BAC participants and their BAC (High: rho (21) = - .15, p = .53; Low: rho (23) = 0.25, p = .25). Thus, it was concluded that the placebo manipulation was moderately successful.

Recognition Test Responses

The number of accurate responses given by each participant to the 20 critical statements was calculated and a 2 x 4 mixed ANOVA was conducted. As seen in Table 1, irrespective of drinking condition, participants provided a significantly higher number of

[1] Although participants were regrouped according to their BAC, additional analyses with groupings according to alcohol dosage produced the same main/ interaction effects for the recognition and free recall tests of study 1.

accurate responses (out of 10) to highly salient items (*M* = 7.52, *SD* = 1.41) compared to those of low salience (*M* = 5.18, *SD* = 1.41) (F (1, 84) = 115.14, p <.001, ηρ² = .58). Placebo participants recalled the highest number of correct details overall. Differences were fairly minimal by salience across drinking conditions, but whilst the high BAC participants provided the fewest accurate responses to highly salient details their response accuracy was the greatest for information of low salience. There was however no effect of drinking condition (F (3, 84) = 0.79, p =.50, ηρ² = .03) or interaction with information salience (F (3, 84) = 0.43, p = .73, ηρ² = .02).

In terms of the confidence of participant responses a 2 x 2 mixed ANOVA indicated a main effect of salience (F (1, 84) = 623.74, p <.001, ηp² =.88) with high salience details (*M* = 37.16; *SD* = 5.97) being recalled with greater confidence than low salience information (*M* = 22.17; *SD* = 6.39). A main effect of BAC was also indicated (F (3, 84) = 3.87, p = .012, ηp² = .12), with sober participants (*M* = 32.52; *SD* = 5.52) being significantly more confidence than high BAC's (*M* = 27.19; *SD* = 5.65). All other comparisons were non-significant (p >.05). No interaction between these variables was highlighted (F (3, 84) = 1.36, p > .05, ηp² = .05).

(Insert Table 1 here)

To further investigate the effects of alcohol on recall a more sensitive measure of response accuracy was derived by adjusting response accuracy by confidence (Dalton & Daneman, 2006). Through this procedure a correct response to each of the 20 critical statements is assigned a base score of 5 and an incorrect answer is given a score of 0. To this was added the confidence rating for that statement (1-5). If the response was accurate the confidence rating (1-5) was simply added to the base of 5 ensuring a result between 6 and 10. A score of 6 or above therefore indicated an accurate response and the closer the score was to 10 the more confident the individual was in their response. For an incorrect answer a reversed confidence rating (1 = 5; 2 = 4; 3 = 3; 4 = 2; 5= 1) was added to the base score of 0 resulting in a mark from 1 to 5. A score of 5 or below therefore indicated an inaccurate response and the closer the score was to 1 the more inappropriately confident the individual was in their response.

Using this revised scoring system the response accuracy for each of the 20 critical statements was adjusted by confidence for each participant, and a 2 x 4 mixed ANOVA was conducted. The main effect of salience persisted, with details of high salience being recalled with greater accuracy and confidence (High: M = 73.59, SD = 8.89; Low: M = 56.43, SD = 4.97) (F (1, 84) = 224.32, p<.001, $\eta\rho^2$ = .73). As seen in table 2, although placebo participants were the most accurate and confident there was not a main effect of drinking condition (F (1, 84) = 1.30, p = .28, $\eta\rho^2$ = .04), or interaction between salience and drinking condition (F (3, 84) = 0.64, p = .59, $\eta\rho^2$ = .02),

(Insert Table 2 here)

In summary, when participant recall was assessed using the recognition test, high salience details were recalled more accurately but no significant difference was found in the recall accuracy between drinking conditions. There was also no significant interaction between drinking condition and salience indicated. This main effect of salience, lack of main effect of drinking condition and lack of interaction persisted even when accuracy was adjusted by confidence.

Free Recall Completeness for High and Low Salience Details as per the Recognition Test

The salience of the free recalled details was determined by whether that detail was deemed to be of high or low salience within the recognition test, thereby taking into account both semantic and spatial definitions of salience. As a result details that were recalled but were not classed as high or low salience within the recognition test were not coded or analysed. Using the scoring procedure of Yuille and Tollestrup (1990), the higher the free recall scores produced, the more correct or incorrect units of information recalled. As more than one point was available for each of the critical statements, a maximum score of 26 was possible for high salience details and a maximum score of 24 for low salience details. To ascertain the completeness of the participants recall the number of correctly recalled details was divided by the maximum scores possible for each type of information as seen in table 3. A 2 x 4 mixed ANOVA indicated participants provided a significantly less complete account in relation to low rather than high salience details (Low: $M = .03$, $SD = .05$; High: $M = .45$, $SD = .20$) (F (1, 84) = 473.382, $p < .001$, $\eta\rho^2 = .85$) with no difference between the overall number of details correctly recalled by the four drinking conditions (F (3, 84) = 0.87, $p > .05$, $\eta\rho^2 = .03$). No interaction between drinking condition and salience (F (3, 84) = 1.44, $p > .05$, $\eta\rho^2 = .05$) was highlighted.

(Insert Table 3 here)

Free Recall Accuracy

In line with the research of Schreiber-Compo et al. (2011), Hagsand et al. (2013a), and Van Oorsouw and Merckelbach, (2012) the accuracy of free recall was also analysed. Accuracy rate was established by dividing the number of correct units recalled by the total number of correct and incorrect details remembered. As there were participants in each of the drinking conditions who did not recall any peripheral details, analyses of accuracy looked only at the effect of drinking condition not salience. There were also no confabulations from participants and only 11 participants provided subjective details in their written accounts which were ignored in the analyses. A univariate ANOVA on accuracy rate did not indicate a significant difference between low BAC (*M* = .95, *SD* = .10), high BAC (*M* = .94, *SD* = .15), placebo (*M* = .96, *SD* = .05) and non-alcohol (*M* = .95, *SD* = .10) participants (F (3, 84) = 0.59, p > .05, $\eta\rho^2$ = .02).

DISCUSSION

Contrary to initial expectations, alcohol did not significantly affect the completeness or accuracy of an individual's account when memory was assessed through either the recognition test, free recall or when response accuracy on the recognition test was adjusted by confidence. This lack of effect supports the findings of Van Oorsouw and Merckelbach (2012) and Schreiber-Compo et al., 2012, where no effect of BAC was found when recall accuracy was assessed via free-recall. In terms of recall completeness however the interaction between intoxication and type of detail found by Van Oorsouw and Merckelbach (2012) was not evident in this study. This discrepancy may be the result of the different means of defining salience used in the two studies.

With regards to the anticipated dissociative effects of alcohol on the memory of high and low salience details, neither the recognition nor free recall test indicated this interaction. This conflicts with the conclusions of Schreiber-Compo et al. (2011) where intoxication led to poorer recall of peripheral details. Within the present study however the influence of floor effects in relation to the recall of low salience details could account for this difference as event when sober low salience recall was poor. Ultimately alcohol does not appear to impair the recall of high and low salience details at the moderate BAC's safely attainable within a laboratory. Therefore, the purpose of Study 2 was to replicate the initial research, but in an environment where the higher levels of intoxication typically associated with real world drinking are attained (Kalant, 1996; White, 2003). Additionally, two word processing tasks were added to test whether these real world levels of intoxication were sufficient to produce the disruption to effortful but not automatic processing typically found in traditional alcohol and memory research (Hasher & Chromiak, 1977; Tracey & Bates, 1999). A verbal interview rather than a written free recall task was also incorporated to improve the ecological validity of the study. As with Study 1 it was hypothesised that higher BAC's at encoding would result in greater impairments in the memory of stimuli event details when recalled sober. In line with Alcohol Myopia Theory it was predicted that this deficiency would be greatest for low salience elements.

STUDY 2

Method

Participants

Based on a priori power analysis to obtain statistical power at the recommended .80 level (*f* = .25, α = .05; Cohen, 1988) a new sample of 54 undergraduate volunteers (76% female) participated with a mean age of 19.5 years (*SD* = 1.27). Potential participants were recruited and incentivised as per study 1 but were also given free entry to the Student Union (SU) bar. Each student also completed the same comprehensive screening process to determine their eligibility as in Study 1.

Design

The study utilized a 2 (drinking condition: high BAC, low BAC) x 2 (information salience: high, low) mixed design with salience being assessed within participants. Dependent measures of free recall, recognition accuracy and confidence were produced as per Study 1. Two further dependent measures were produced to confirm that the BAC's achieved were sufficient to provide disruption to effortful but not automatic processing: number of words recalled and mean estimated frequency of words presented multiple times.

Materials

The stimuli event and recognition test were identical to those of Study 1. For the automatic and effortful processing tasks a free recall and word estimation task was produced based on the work of Tracey and Bates (1999) and the procedure of Hasher and Chromiak (1977). Four lists of 90 words were constructed with 27 unique words within each list. The words were chosen to be high in both mental imagery (> 6.0 on a scale of 1–7, Paivio, Yuille, & Madigan, 1968) and frequency in the English language (>50 occurrences per million; Thorndike & Lorge, 1944) as per Tracey and Bates (1999). The unique words were repeated at different frequencies with four presented once, five presented twice, six presented three times, six presented four times, three presented five times, two presented six times, and one presented seven times.

Procedure

Stage 1: On the day of the study, whilst sober, participants were informed that during their night out they would be asked to complete a couple of tasks and would watch a video. They were asked to sign the consent form if they agreed to continue. Participants were also instructed to engage in their normal drinking behaviour during their night out at the SU bar, namely that whether a student typically drank alcohol or not then this was fine and would not affect their ability to participate. Participants were told however that if they did decide to drink alcohol then not to consume alcohol for 20 minutes prior to their allotted appointment time. This protocol would ensure the breathalyser produced an accurate BrAC.

Stage 2: During their evening out in the SU bar, participants were met by the researcher at the pre-arranged time and taken to a quiet room to complete stage 2 of the study. Participants were initially asked to confirm that they had not drunk alcohol for the previous

20 minutes and then to detail the quantity and type of all beverages consumed that evening. Those that had not abstained from drinking alcohol in the previous 20 minutes were required to wait 20 minutes before providing a breath sample. A subjective measure of intoxication was also taken as per Study 1. Participants were then randomly allocated one of the four word lists. The selected 90 words were read aloud to them in a random order at a presentation rate of one every two seconds. At completion participants were breathalysed again and asked to recall as many of the words as possible (effortful processing task), before estimating the frequency with which the 27 unique words were presented (automatic processing task). Participants proceeded to watch the stimuli event, before and after which they were breathalysed. This 2nd stage lasted between 25 and 45 minutes depending on how long participants abstained from alcohol before they took part. At the end of stage 2 participants returned to the SU bar to continue with their evening.

Stage 3: A week later, during the day, participants arrived at a separate venue and the Stage 2 procedure of Study 1 was followed. The only exception being the written free recall task was replaced with a semi-structured verbal interview and recorded on a Dictaphone.

Measures

Dependent measures of recall accuracy were the same as in Study 1 with the number of true/false responses to the recognition test, and the confidence rating associated with each response (5-point scale; 1= total lack of confidence, 5 = total confidence) being recorded. Yuille and Tollestrup’s (1990) scoring procedure was again followed for the verbal free recall task where a higher correct or incorrect score indicated more correct or incorrect units of information had been recalled. This scoring technique, with two scorers blind to the participants BAC, achieved an inter-rater reliability score of 0.94 using the Kappa statistic.

Results

Breath Alcohol Concentration

Participants reportedly consumed between 2.7 and 28 units of alcohol[2] (*M* = 10.84, *SD* = 6.74), resulting in BAC's ranging from 0.00 - 0.23% (*M* = 0.10%, *SD* = 0.06). There was a highly positive correlation between units consumed and BAC (r (54) = .51, p <.001). Using the mean of the four BAC's produced by each individual, during the second stage, participants were divided in to those with high and low BAC's. The 26 participants in the low BAC condition generated readings between 0.00 - 0.07%) (*M* = 0.05%, *SD* = 0.02), whilst those providing higher BAC's ranged from 0.08 - 0.23% (*M* = 0.14%, *SD* = 0.04). This split ensured that low BAC's were below the drink drive limit whilst high BAC's were above the drink drive limit. A significant difference in the level of intoxication in the two BAC conditions (t (52) = 10.31, p <.001) confirmed the distinct nature of these populations.

Word recall and estimation task

T-tests confirmed impairment in effortful processing with high BAC individuals recalling significantly fewer words (*M* = 6.04, *SD* = 2.47) than low BAC participants (*M* = 9.77, *SD* = 2.80) (t (52) = 5.20, p <.001). As anticipated, automatic processing abilities were preserved with the mean difference between the presented frequency of words and the estimates provided by participants not being significantly different for the two BAC conditions (High: *M* = 1.85, *SD* = 1.27; Low: *M* = 1.71, *SD* = 0.92) (t (52) = 0.49, p = .87). The levels of intoxication achieved were therefore sufficient to replicate previous research, demonstrating a detrimental effect of intoxication on effortful but not automatic processing.

Recognition Test Response

[2] The highest number of units was consumed by a participant claiming to have drunk 750ml of rum and 8 shots of vodka

A 2 x 2 mixed ANOVA conducted on recognition test responses indicated a main effect of salience, where participants provided significantly less correct answers (out of 10) in relation to low salience details (High: $M = 7.04$, $SD = 1.18$; Low: $M = 5.80$, $SD = 1.51$) (F (1, 52) = 40.84, $p < .001$, $\eta p^2 = .34$). High BAC participants ($M = 6.21$, $SD = 1.43$) however did not provide significantly more correct responses than low BAC individuals ($M = 6.64$, $SD = 1.48$) (F (1, 52) = 4.76, $p = .13$, $\eta p^2 = .04$). Additionally, no significant interaction was indicated between BAC and information salience (F (1, 52) = 1.30, $p = .26$, $\eta p^2 = .02$).

Within Study 2 participants also had the option to indicate that they had absolutely no memory of the details a particular statement was referring to, by highlighting a confidence rating of 1. In these situations regardless of whether an individual elected to reply true or false, their answer was entirely a guess. Consequently all responses (whether correct or incorrect) were rescored as ‘don’t know’ if the corresponding confidence rating was 1. If participants had some recall of the statements details (no matter how small) then their confidence rating scale began at 2. Using the frequency of correct, incorrect and don’t know responses a three-way log-linear analysis examined any association between BAC condition and salience. This produced a final model that retained the BAC x decision type, and salience x decision type interactions. The likelihood ratio of this model was χ^2 (3) = 4.82, $p = .19$ with both BAC x decision type (χ^2 (2) = 19.678, $p < 0.001$) and salience x decision type (χ^2 (2) = 120.85, $p < 0.001$) interactions being significant. Chi-squared analyses with Bonferroni correction indicated a significant association between BAC and decision type (χ^2 (2) = 19.51, $p < 0.001$). As seen in table 4, low BAC’s provided significantly more correct decisions ($p < .001$) and significantly less don’t know responses than high BAC’s ($p > .001$). With regards to incorrect decisions there was no difference between high and low BAC’s ($p = .23$). Further Chi-squared analyses (with Bonferroni correction) also indicated a significant association between information salience and decision type (χ^2 (2) = 118.31, $p < 0.001$), with high salience information leading to significantly more correct decisions ($p < .001$) and significantly less don't know responses ($p < .001$) than low salience information. Again, there was no difference in the number of incorrect decisions between high and low salience information ($p = .22$).

(Insert Table 4 here)

With a confidence rating of 1 equating to no memory of a detail, the Likert confidence ratings were recoded from a scale of 1 - 5, to 1- 4 (so previous ratings of 2 were recoded to 1, 3 recoded to 2 etc.). A 2 x 2 mixed ANOVA conducted on this revised scale indicated a main effect of salience (F (1, 52) = 294.54, p <.001, ηp^2 =.85) and BAC (F (1, 52) = 9.93, p = .003, ηp^2 = .16), with high salience details being recalled with the greatest confidence (M = 22.78, SD = 7.09; M = 10.87, SD = 6.61) and low BAC participants having the most confidence in their responses (High: M = 28.78, SD = 11.68; Low: M = 38.88, SD = 11.86). There was no interaction between these variables (F (1, 52) = 1.30, p > .05, ηp^2 = .02).

Free Recall Completeness for High and Low Salience Details as per the Recognition Test

The interviews for all 54 participants were transcribed. As with Study 1 the salience of the free recalled details was determined by their classification within the recognition test and was scored as per the procedure of Yuille and Tollestrup (1990). Consequently the details that were recalled but were not classed as high or low salience within the recognition test were not coded or analysed. A maximum score of 26 was possible for high salience details and a maximum score of 24 for low salience details Whilst low BAC participants recalled between 1 and 24 correct details (M = 11.38; SD = 5.72), those with higher BAC's recalled between 0 and 18 correct details (M = 6.79; SD = 4.89). Correlational analyses indicated that items of both high (r (54) = -.52, p <.001) and low (r (54) = - .35, p = .01) salience were negatively correlated with BAC.

As seen in Table 5, a 2 x 2 mixed ANOVA indicated that participants recall was significantly less complete in relation to low salience compared to high salience details (Low: $M = 0.04$, $SD = 0.05$; High: $M = 0.31$, $SD = 0.19$) ($F(1, 52) = 149.91$, $p < .001$, $\eta_p^2 = .74$), with higher levels of intoxication resulting in significantly more complete recall overall ($F(1, 52) = 10.29$, $p = .02$, $\eta_p^2 = .10$). A significant interaction was also indicated, with low BAC's having the most complete recall irrespective of salience, and the recall completeness of high salience details being particularly impaired when BAC levels increased from low to high ($F(1, 52) = 5.78$, $p = .02$, $\eta_p^2 = .10$).

(Insert Table 5 here)

Free Recall Accuracy

As with study 1 the accuracy of free recall was also analysed across drinking conditions. An independent t-test did not indicate a significant difference in the recall accuracy rate of high ($M = .84$, $SD = .30$) and low BAC ($M = .94$, $SD = .08$) participants $t(30.47) = 1.72$, $p > .05$. Whilst a high BAC participant recalled the only fabricated piece of information it was low BAC participants in contrast who provided the greater amount of subjective information (Low: $M = 2.46$; $SD = 1.36$; High: $M = 1.43$; $SD = 1.37$) ($t(52) = 2.77$, $p = .01$) with variations on 'the man was acting suspiciously' being their most frequently repeated detail.

In summary, when memory was assessed through the recognition test the recall of low BAC participants was not significantly better than those with high BAC's. However, when 'don't know' responses were taken in to consideration high BAC individuals were seen to have the weaker memory of the video as they provided significantly more don't know responses than low BAC participants. This analysis also indicated that irrespective of BAC, participants had poorer recall for low salience details. Finally, when memory was assessed through free recall, the fewest details were recalled in relation to elements of low salience, with high BAC individuals providing a significantly less complete account of the event. Low BAC participants however provided more subjective information in their recall. In addition, there was no significant difference in the free recall accuracy rates of high and low BAC conditions.

DISCUSSION

In contrast to the expectations of AMT, but consistent with the conclusions of Study 1, the memories of those individuals with BAC's above the drink drive limit were not seen to be significantly poorer than those with BAC's below 0.08%, when recall was assessed using the true/false recognition test. The introduction of the 'don't know' response option however provided some support for the hypothesis. With high BAC participants providing more 'don't know' responses than low BAC participants it appears they have more gaps in their memory. This conclusion is supported by the free recall analysis where, in agreement with the findings of Schreiber-Compo et al. (2011), participants above the drink drive limit provided a significantly less complete account than those with low BAC's.

In line with the propositions of AMT it was hypothesised that the recall deficiency associated with higher BAC's would be greatest for low salience details. Whilst the true/false recognition test did not support this hypothesis the inclusion of the 'don't know' response option did find high BAC individuals remembered fewer details than their low BAC counterparts, with the overall poorer recall being in relation to low salience details; thereby offering some support for AMT. When assessing memory via the free recall task however, it was the completeness of recall in relation to high rather than low salience details that intoxication had the most detrimental effect on. This latter finding corresponds to the conclusions of Van Oorsouw and Merckelbach (2012) where the recall of central details was particularly undermined by alcohol on a cued recall task.

General Discussion

The findings of this research did not indicate the narrowing of attention proposed by Alcohol Myopia Theory but instead suggested that the BAC's safely attainable in the laboratory ($M_{BAC} = 0.09\%$), namely those just over the drink drive limit, are not sufficient to impair an individual's recall for a complex and forensically relevant event. This lack of effect held irrespective of whether memory is assessed through the accuracy and completeness of free recall or a recognition test. However, with real world levels of intoxication, where BAC's nearly double the drink drive limit were achieved ($M_{BAC} = 0.14\%$), recall deficits were clearly apparent when memory was assessed via the completeness of free recall and also to a lesser degree with the recognition test.

In Study 2, when memory was assessed through the more ecologically valid verbal free recall task, lower BAC participants were seen to have more complete memory, in that they remembered the sequence of events that occurred and the specifics of those details. Higher BAC participants in contrast appeared to have more sketchy recall, with a higher proportion of details being forgotten entirely. In the most extreme cases, participants recalled no low salience details of the video at all. This is supported by the 'don't know' recognition test response analyses, where compared with low BAC participants, those with BAC's above the drink drive limit forgot significantly more of the event details. These conclusions are in line with the work of Van Oorsouw and Merckelbach (2012), where higher levels of intoxication resulted in less complete memories of the crime, irrespective of whether a cued or free recall task was utilized. In contrast, Schreiber-Compo et al. (2012) found that with free recall intoxicated participants did not provide significantly more 'don't know' comments than sober participants. The recall task in the latter study however was written rather than oral and the intoxicated participants were also still intoxicated when they completed the recall task. These factors may account for the discrepancy in the findings.

With regards to the accuracy of participant memories, in Study 2 high BAC individuals were not less accurate in in their free recall account compared with those individuals under the drink drive limit. This was also the case with the recognition test where BAC was not seen to significantly impact the accuracy of an individual's recall. Even when 'don't know' responses were taken into account high BAC participants did not provide more incorrect responses. These conclusions are only partially in line with those drawn by Van Oorsouw and Merckelbach (2012) who found intoxication to negatively affect the accuracy of cued but not free recall. Possible explanations for this will be discussed shortly.

Regarding AMT, Steele and Josephs (1990) proposed that due to an individual's limited processing capacity, when alcohol is consumed a person focuses on the salient items and consequently their recall for the less salient elements suffers. This pattern of recall was not found with the free recall task of Study 1, nor was it found with the recognition test in either Study 1 or 2, or by Van Oorsouw and Merckelbach (2012). Study 2's free-recall however did find an interaction between BAC and salience. In contrast to the predictions of AMT and the findings of Schreiber-Compo et al. (2011), it was information of high rather than low salience that suffered the greater impairment when higher BAC's were experienced. Consequently, this significant interaction between BAC and information salience does not follow the pattern of recall impairment initially hypothesised in this current research, and predicted by AMT. Within these present studies however the influence of floor effects in relation to the recall of low salience information needs to be considered. Participants' recall of this information was particularly poor with some individuals not recalling any of the low salience details. As a result this limits the ability of this study to draw firm conclusions regarding the attention narrowing effect associated with alcohol consumption proposed by AMT. Other factors including no random assignment of participants in study 2 and a change in interview format could also have contributed to the different findings of study 1 and 2.

Aside from these factors however there are a number of other possible explanations for the disparate findings of this research, the predictions of AMT and the conclusions of Van Oorsouw and Merckelbach (2012). As was initially reported, Van Oorsouw and Merckelbach (2012) defined the actions of the participant (in the role of the perpetrator) as being of high salience. Environmental details in contrast were deemed of low salience. Studies 1 and 2 adopted a less 'type' specific distinction when determining the salience of information by taking into account both semantic meaning and spatial location. This methodology therefore considered AMT's assertion that the salience of a detail is not determined solely by its type/nature or spatial location but rather its *role* in the unfolding event. With a significant interaction indicated between salience and BAC within the free recall task of Study 2 there is support for the use of this more complex definition of salience when investigating the validity of AMT to account for the pattern of recall of intoxicated witnesses. Van Oorsouw and Merckelbach (2012) however, suggest that fragmentary blackouts may account for their findings, rather than their choice of what constitutes salience.

A fragmentary blackout results in an intoxicated individual recalling some but not all of the details they experienced whilst intoxicated (Goodwin, 1977). A person only becomes aware that they have gaps in their memory when they are informed there are details they do not remember. Small to moderate fragmentary blackouts, research indicates, can occur with a rapid rate of alcohol consumption and with BrAC's as low as 0.66mg/L (M_{BAC} = 0.15%) (Mintzer & Griffiths, 2002; Ray & Bates, 2006; Ryback, 1971). Whilst Study 2 achieved BAC's close to this (M_{BrAC}= .62mg/L; M_{BAC} = 0.14%), no significant effect of intoxication was found with the use of the recognition test. However, one was found with free recall. If a fragmentary blackout caused gaps in an intoxicated participant's memory then their recall would be expected to be poorer irrespective of how memory was assessed; by free recall or recognition test. Nevertheless, with a 50:50 chance of giving an accurate response on the recognition test it is also possible that participants were merely guessing correctly.

An alternative explanation, however, concerns the phenomenon of acute alcohol amnesia (Goodwin, Crane, & Guze, 1969; Hashtroudi & Parker, 1986), where recall impairments can become apparent at BrAC's as low as 0.35mg/L (M_{BAC} = 0.08%) (Birnbaum, Parker, Hartley, & Noble, 1978; Carpenter & Ross, 1965; Hashtroudi et al., 1983; Jones & Jones, 1980). In contrast to blackouts, where the amnesia is fatal (i.e., the memory is permanently lost), acute amnesia is more subtle and the memory to some extent can be retrieved with appropriate cues and prompts (Goodwin et al., 1969). Such an effect would explain why the recognition test failed to find an alcohol induced impairment to memory in Study 2, as the statements prompted and reminded the participants of the details they failed to remember in the free recall task. Alternatively, the cues in the recognition test may have been sufficient to access the weaker memory trace that was not sufficiently strong enough to be accessible via free recall.

There is some support for this explanation of deficits for intoxicated recall. During debrief discussions participants frequently indicated that they experienced degrees of surprise, annoyance and exasperation at themselves when completing the recognition test. They had suddenly remembered details that they had no recollection of when completing the free recall task. This tentatively suggests that the memories an intoxicated individual has available to them are more extensive than those details they can readily access without cues and prompting. In addition to this anecdotal evidence, alcohol research has shown that whilst intoxication regularly impairs the free recall of word lists, the impairment of recognition memory is less consistent (Curran & Hildebrandt, 1999; Duka, Weissenborn, & Dienes, 2001; Hashtroudi, Parker, DeLisi, Wyatt, & Mutter, 1984). Similar findings have been reported with drugs such as ketamine (Fletcher & Honey, 2006). Ultimately this would mean the effect of alcohol concerns the accessibility of the memories rather than their availability (Tulving, 1983; Tulving & Pearlstone, 1966). An individual may retain memories of an event they witnessed whilst intoxicated, but the issue is how to access them without affecting the accuracy of what is recalled. Techniques such as the Cognitive Interview (CI) (Geiselman, Fisher, MacKinnon, & Holland, 1985) may prove useful here in helping the witness access these memories. As the multi-component model of memory (e.g. Bower, 1967; Wickens, 1970) views memory not as a single holistic representation of an event, but as a network of complex associations, it is likely that there are numerous cognitive pathways to each memory trace, each providing different details of the original event. Information that is therefore not available through one recall method may be available through another. Based upon this and the assertion of the encoding specificity principle (Tulving & Thomson, 1973), that when contextual information at encoding is also present at retrieval then the effectiveness of the retrieval method is enhanced, the CI uses multiple retrieval strategies to aid the witness in their recall. This interview technique and the Enhanced Cognitive Interview have been shown to improve recall by around 40% in the field (Clifford & George, 1996; Fisher, Geiselman & Amador, 1989) and could potentially assist intoxicated witnesses in improving their recall.

Limitations

Whilst this research provides a valuable first step in understanding the effects of alcohol on memory using a more ecologically-valid methodology, there are a number of areas where improvements may be made. First, concerns regarding floor effects in relation to low salience information should be addressed and as Study 2 only included intoxicated participants future studies should seek to include a sober group during field research. The introduction of this additional condition would enable conclusions to be drawn as to the reliability, accuracy and completeness of an intoxicated witness' testimony compared with that of a sober witness in a more ecologically valid setting. Difficulties in recruiting sufficient students, whose typical drinking behavior would ensure they were sober during the study, meant that this condition was not included in study 2.

Second, the stimuli within this study, despite being ecologically and forensically valid, required no direct involvement from participants. Health and safety concerns and legal restrictions within the bar prevented a live staged event being conducted and, as such, the effects of anxiety could not be assessed. Typically witnessing a crime involves some degree of stress which watching a videoed crime does not produce. As recall may be inhibited when encoding occurs under stress (Burke, Heuer & Reisberg, 1992; Christianson, 1992; Deffenbacher, Bornstein, Penrod, & McGorty, 2004) and with AMT predicting a role for arousal in anticipating an individual's pattern of recall, future research should seek to accommodate this variable.

Third, the introduction of the 'don't know' option to the cued recall test reduced the confidence rating to 4 points and as such resulted in a small Likert scale. This additional response option indicated that a true/false recognition test at real world levels of intoxication is not sufficient to capture the gaps in participants' memory, as participants cannot indicate they have no memory and would only be guessing with their response. Therefore, retaining a wider range of confidence scores on the Likert scale (1-5) is needed in future research which employs a recognition test.

Future Research

From a criminal justice perspective, this research indicates that those witnesses with BAC's above the drink drive limit are likely to have gaps in their memory which, when they are interviewed, may prevent them from providing as complete an account as a more sober witness. Any pattern to the impairment suffered by intoxicated individuals however is still unclear. With Study 1 indicating that the BAC’s ethically achievable in the laboratory are insufficient to significantly impair recall, future research should initially seek to replicate Study 2 with another forensically relevant event in order to confirm the conclusions drawn here. If health and safety restrictions allow, this should be a live event to further enhance the ecologically validity of the study. The introduction of a sober condition should also be attempted to enable conclusions to be made as to what recall deficits are the result of alcohol and what are the consequence of general shortfalls in witness recall accuracy. Should future studies confirm the findings of the present research then a means to improve the recall of intoxicated individuals should be sought and tested, such as the cognitive interview. The employment of this recall aid will also provide a valuable insight into whether the gaps in the memory of an intoxicated individual are the result of a fragmentary blackout, or restricted attention, or even acute amnesia.

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Table 1: Percentage of accurate recognition test responses by BAC and information salience

	High BAC (n = 21)	Low BAC (n = 23)	Non-Alcohol (n = 22)	Placebo (n = 22)	Average % correct
High Salience	73.30	73.90	75.00	78.60	75.20
Low Salience	54.80	50.00	50.90	54.10	51.78
Total	64.05	61.95	62.95	66.35	

Table 2: Mean (S.D) of response accuracy adjusted by confidence (out of 100), by BAC and information salience

	High BAC (n = 21)	Low BAC (n = 23)	Non-Alcohol (n = 22)	Placebo (n = 22)
High Salience	71.57 (10.60)	72.09 (8.14)	74.82 (8.68)	75.86 (7.89)
Low Salience	56.33 (4.82)	56.04 (4.08)	56.77 (5.77)	56.59 (5.41)
Total	127.90 (10.99)	128.13 (9.99)	131.59 (9.82)	132.45 (7.46)

Table 3: Mean (S.D) proportion of correctly recalled information and number of incorrect details recalled for free recall by BAC and information salience

	High BAC (n = 21)	Low BAC (n = 23)	Non-Alcohol (n = 22)	Placebo (n = 22)
High Salience	.39 (.19)	.47 (.21)	.48 (.21)	.45 (.18)
Low Salience	.03 (.05)	.04 (.06)	.02 (.04)	.03 (.04)
Incorrect details	.39 (.58)	.71 (.19)	.45 (1.10)	.59 (.67)

Table 4: Percentages of recognition test responses by BAC and response type

		Incorrect	Correct	Don't know	Total
Low BAC	Low Salience	10.96	20.58	18.46	50
	High Salience	13.27	31.73	5.00	50
	Total	24.23	52.31	23.46	100
High BAC	Low Salience	10.36	13.93	25.71	50
	High Salience	10.89	29.11	10.00	50
	Total	21.25	43.04	35.71	100

Table 5: Mean (S.D) proportion of correctly recalled information and number of incorrect details recalled for free recall by BAC and information salience

	Low BAC (n = 26)	High BAC (n = 28)
High Salience	0.39 (0.19)*	0.24 (0.18)
Low Salience	0.06 (0.06)*	0.02 (0.08)
Incorrect details	1.81 (1.52)	1.39 (1.47)

* $p < .05$ between low and high BAC groups