How elevated blood alcohol concentration level and identification format affect eyewitness memory: A field study

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Summary
Research shows that alcohol has a small and inconsistent effect on eyewitness recall and no effect on witnesses' lineup decisions. Much of this literature has tested participants with low-to-moderate blood alcohol concentration (BAC) levels, and no study has directly examined how identification procedure impacts intoxicated witnesses' decisions. In the present study, bar patrons' (N = 132) BAC levels were recorded before participating in a task. Midway through the task, they were interrupted by an intruder. Participants then recalled the incident via a staged interview and attempted to identify the intruder from a target-present or target-absent showup or lineup. Although elevated BAC levels (high as 0.24%) reduced the quantity and quality of information provided, BAC had no effect on witnesses' identification decisions regardless of format. Results highlight the importance of testing witness memory across a broad BAC spectrum and provide evidence that alcohol does not affect witnesses' identification ability.

KEYWORDS
alcohol, memory, lineups, identifications, interviewing

1 | INTRODUCTION

Investigators frequently interact with intoxicated witnesses given their presence in a variety of criminal situations (Altman, Schreiber Compo, Hagsand, & Evans, in press; Evans, Schreiber Compo, & Russano, 2009; National Council on Alcoholism and Drug Dependence, 2016; Palmer, Flowe, Takarangi, & Humphries, 2013). Despite their potential to provide helpful information, many in the legal system (e.g., investigators, jurors, and experts) are hesitant to accept information provided by intoxicated witnesses given the negative stigma surrounding intoxication and memory (Evans & Schreiber Compo, 2010; Kassin, Tubb, Hosch, & Memon, 2001). That is, most research examining the alcohol–memory relationship using “basic” stimuli (e.g., word lists, word pairs, and digit spans) generally confirms a detrimental effect of alcohol on memory (see Dougherty, Marsh, Moeller, Chokshi, & Rosen, 2000 and Mintzer, 2007, for reviews). Recent studies, however, suggest caution when extrapolating from this body of work to episodic events similar to eyewitness situations, showing that alcohol does not consistently affect eyewitness recall and identifications (see Altman, Schreiber Compo, McQuiston, Hagsand, & Cervera, 2018, for a review). This recent body of work, however, is mostly based on participants with low-to-moderate blood alcohol concentration (BAC) levels who are typically tested using paradigms that do not closely mimic the conditions that real-world intoxicated witnesses often experience. The goal of this research was to test witnesses' event memory and identification abilities at elevated BAC levels using an interactive and engaging staged event.

1.1 | Alcohol and memory processes

Alcohol negatively affects all stages of the memory process, particularly encoding and consolidation (Mintzer, 2007; Molnár, Boha, Czigler, & Gaál, 2010). Two hypotheses explain why this occurs, one stemming from the alcohol myopia theory (AMT) and the other from the literature on alcohol-induced blackouts. The original AMT was
proposed to explain why intoxicated individuals make impulsive and irrational decisions (Josephs & Steele, 1990; Steele & Josephs, 1990). According to this theory, alcohol depletes mental resources, forcing individuals to concentrate on more salient aspects of a situation at the expense of less salient aspects. When rendering decisions, this cognitive impairment affects a drinker’s ability to consider alternative consequences for one’s actions, leading the intoxicated individual to act on impulse and desire rather than deliberative thought (see Abbey, Saenz, Buck, Parkhill, & Hayman, 2006; George, Rogers, & Duka, 2005). This decrease in inhibition when intoxicated has been demonstrated across a variety of situations and leads to more irrational and impulsive decisions (Abbey, Saenz, & Buck, 2005; George et al., 2005).

Although the AMT was intended to predict and explain social–behavioral differences, some researchers have adopted a more literal translation of the theory (referred to in this paper as the adapted AMT) when explaining how alcohol narrows a drinker’s perceptual ability and hinders the capacity to recall information (e.g., Dysart, Lindsay, MacDonald, & Wicke, 2002; Harvey, Kneller, & Campbell, 2013a; Harvey, Kneller, & Campbell, 2013b). That is, functioning under limited cognitive resources, drinkers can only attend to details they feel are important to the situation (central) at the expense of details they consider less relevant (peripheral). This narrow vision leads drinkers to encode less information than do sober people in similar situations. Given their weakened memory, intoxicated individuals are also more likely to recall inaccurate information, especially when prompted by an outside source or provided misinformation (e.g., van Oorsouw, Merckelbach, & Smeets, 2015). This extension of the AMT has received modest support; however, there are concerns regarding the “adaptation” of the theory, which are discussed later in the paper.

The literature on alcohol-induced blackouts suggests that alcohol slows down pyramidal cell activity and impairs drinkers’ ability to transfer information between working memory and long-term memory (White, 2003). Drinkers can therefore participate in various events but later have no recollection of the experience, a phenomenon referred to as a blackout (see Wetherill & Fromme, 2016, and White, 2003, for reviews). Alcohol-induced blackouts occur in two forms, en bloc and fragmentary. En bloc blackouts occur when pyramidal cell activity is completely stopped and encoded information is no longer transferred to long-term memory. Once this occurs, drinkers are no longer able to form new memories, even for events in which they were actively engaged. Fragmentary blackouts are more common and occur when pyramidal cell activity is reduced but still operating (Lee, Roh, & Kim, 2009; Perry et al., 2006). Drinkers experiencing this type of blackout will remember only portions of the event in which they participated. These memory gaps can later be filled if provided with internal or external cues about the event. However, identifying the specific BAC level at which a blackout of either variety will occur is difficult because they appear across a broad range of BACs and are dependent on a variety of factors (see Perry et al., 2006; Wetherill & Fromme, 2016; White, 2003). Conservative estimates suggest that the lowest BAC level at which an en bloc blackout can occur is 0.14% (White, 2003). Signs of fragmentary blackouts (although unlikely) have been found at BAC levels as low as 0.10% (Perry et al., 2006). The AMT and literature on alcohol-induced blackouts suggest that intoxicated individuals should experience memory impairments. The goal of the present research is to better understand how and when these alcohol-induced impairments affect memory for engaging, interactive, and arousing events similar to those that eyewitnesses observe.

1.2 | Alcohol and eyewitness memory

In the typical study examining the effects of alcohol on eyewitness memory, laboratory participants are randomly assigned to a sober or alcohol group before viewing a live-staged interaction, mock-crime video, or a slideshow depicting a live-staged interaction or mock crime (see Altman et al., 2018, for review). Participants are then asked to recall information about the event they witnessed and/or asked to identify an individual from the event, immediately or following a delay.

1.2.1 | Memory for events

The event memory literature has been modestly consistent with the adapted AMT. For example, Harvey et al. (2013a) showed that intoxicated participants spent more time focusing on central aspects of a scene, whereas sober participants attended more to peripheral aspects. A follow-up paper, however, found no differences between sober and intoxicated witnesses’ eye fixations (Harvey et al., 2013b). Indirect tests of the adapted AMT that examine participants’ recall of central relative to peripheral information have also yielded inconsistent findings. For example, Schreiber Compo et al. (2011) found that intoxicated participants recalled fewer peripheral details than do sober and placebo participants, but no differences were found in the number of central items reported. Other indirect tests of the theory have failed to replicate these findings (e.g., Crossland, Kneller, & Wilcock, 2016; Flowe, Takarangi, Humphries, & Wright, 2015). In addition to how the adapted AMT has been interpreted, lack of support for the theory can be attributed, at least in part, to the methodological differences across studies (see Schreiber Compo et al., 2017), including the difficulty in determining item centrality and low-to-moderate BAC levels at which participants were tested.

Item centrality

One limitation when examining the adapted AMT is the classification of central and peripheral items, which is not determined by each participant but rather predetermined and applied to the entire study population. For example, Schreiber Compo et al. (2011) determined that the bartender’s actions were central to the situation whereas fixtures behind the bartender were peripheral. In Harvey et al.’s (2013a) initial test of the theory, ratings given by pilot participants were used in conjunction with the objects’ position on the slide to determine each item’s centrality. Crossland et al. (2016) classified central and peripheral items using ratings given by pilot participants.
Varying approaches in determining item centrality help explain the mixed support for the adapted AMT, as failure to account for individual variability in item centrality could lead researchers to inaccurately score central and peripheral items for some participants (Crossland et al., 2016). Item centrality also changes throughout the duration of an event (Crossland et al., 2016; Harvey et al., 2013b). That is, participants’ initial focus may be on items considered central by most, but as the event progresses, attention shifts, in no set order, to objects that were initially considered peripheral (Harvey et al., 2013b). Findings may therefore be confounded with the amount of time witnesses have to encode information and the detail within each scene. Regardless, the adapted AMT would still predict that intoxicated individuals need more time to encode central items do sober individuals. Prolonged encoding of central items would consequently reduce intoxicated individuals’ time to attend to peripheral items, leading to fewer overall items attended to (quantity) and fewer accurate details remembered (quality). Indirect tests of the adapted AMT should therefore show that intoxicated individuals report fewer details and less accurate information than do those who are less intoxicated or sober. In support of this assumption, most studies find that alcohol negatively affects recall quantity (amount and/or completeness) with no effect on the quality (proportion of accurate or inaccurate units) of information reported (see Altman et al., in press, for a review). When significant differences in memory quality do emerge, they are often inconsistent. For example, some report deficits for cued recall (Schreiber Compo et al., 2012), central details (Flowe et al., 2015), or peripheral details (Schreiber Compo et al., 2011), whereas other studies find no differences across intoxication levels. These inconsistencies can potentially be explained by participants’ typically low-to-moderate BAC levels.

Low BAC levels

Most studies examining alcohol intoxication and witness memory have been conducted in laboratories where ethical restrictions prohibit administering high doses of alcohol to participants, thus yielding BAC levels of 0.08% or less. This cutoff is relevant because it denotes the legal U.S. driving limit and has been shown to impair motor functions (Harrison & Fillmore, 2005; Laude & Fillmore, 2015; Marczinski, Harrison, & Fillmore, 2008). However, according to Evans et al. (2009), real-world witnesses often exceed this range and reach average BAC levels of approximately 0.11%. The 0.08% cutoff also fails to test memory under conditions in which participants are likely to experience blackouts, suggesting that participants’ vision might not be impaired to a degree that consistently exposes the perceptual deficits alluded to by the adapted AMT. However, a handful of field studies examining participants voluntarily consuming larger quantities of alcohol (BAC levels as high as 0.23–0.29%) found that intoxication negatively affected the quantity and quality of witnesses’ reports (Altman et al., 2018; Crossland et al., 2016).

1.2.2 Memory for faces

The perpetrator of a crime is arguably central to a criminal event. According to the adapted AMT, intoxicated individuals are just as likely as sober ones to focus on the perpetrator and make an accurate identification (Flowe et al., 2017; Hagsand, Roos af Hjelmsäter, Granhag, Fahlke, & Söderpalm Gordh, 2013b), unless they experience a blackout and their ability to encode central information is compromised. The original AMT suggests that alcohol only affects identification decisions when made while intoxicated (Josephs & Steele, 1990; Steele & Josephs, 1990). That is, while drinkers’ cognitive resources are limited, they are less likely to consider alternative options and more likely to rely on a liberal decision criterion (Colloff & Flowe, 2016). Compared with that of sober witnesses, this liberal decision criterion ostensibly leads to more false identifications in target-absent situations with no impact on decisions in target-present situations (Altman et al., in press; Dysart et al., 2002). This effect on target-absent decisions, however, may be dependent on the identification procedure employed.

Two main identification procedures are utilized with eyewitnesses: a lineup, which contains the suspect alongside fillers who are known innocent individuals, and a showup, which is a singular photograph of the suspect. Although a lineup is the typical procedure used by law enforcement to gather identification evidence, a showup approach is sometimes used when a potential suspect is apprehended within the general location the crime reportedly occurred (Sjöberg, 2016). The showup procedure has been criticized by researchers and policymakers because it eliminates fillers meant to protect an innocent suspect from witnesses with an imperfect memory and is known to be potentially suggestive and biasing (Sjöberg, 2016; Steblay, Dysart, Fulero, & Lindsay, 2003; see National Research Council, 2014). Research indicates that the use of a showup can inflate the probability of a witness making a false identification than the use of a lineup (Sjöberg, 2016; Steblay et al., 2003; Wells, 2001). When it comes to intoxicated eyewitnesses specifically, the inclusion of lineup fillers should make it more difficult to locate a best match suspect, resulting in more rejections and “not sure” responses than false identifications (Clark, 2003; Fife, Perry, & Gronlund, 2014). With a showup, however, the liberal decision criterion created by alcohol combined with the absence of alternative options increases the likelihood of a false identification of an innocent suspect when that person highly resembles the perpetrator (e.g., Dysart et al., 2002). This could explain why the majority of previous research finds no effect of alcohol on lineup decisions, whereas the one study employing a showup procedure (Dysart et al., 2002) found that alcohol intoxication increased false identifications. This discrepancy in study results concerning whether and how identification format impacts intoxicated witnesses’ identification decisions necessitates further exploration.

1.3 Present study

Testing laboratory-based theories under applied and ecologically valid conditions not only strengthens our theoretical understanding of how alcohol affects witness memory across a broad BAC spectrum but also helps ensure legal practitioners find applied value in scientific results
(Carlson, 2013; Lane & Meissner, 2008). Therefore, the current study recruited participants from a bar setting in which they were voluntarily consuming alcohol. After witnessing a live-staged interaction, participants were asked to recall the event and make identifications from a lineup or showup that was either target present or target absent. Extending the literature on intoxicated witnesses' identification abilities, the present study was the first to empirically investigate how identification format impacts witnesses' decisions.

Based on the adapted AMT and previous findings, alcohol was predicted to negatively affect both memory quantity and quality. As BAC levels increased, witnesses' ability to attend to information in the environment would be restricted, resulting in less information being encoded. This was expected to result in less information recalled overall (quantity) and less accurate information (quality) specifically. Further supporting this hypothesis is the assertion that elevated BAC increases the likelihood of experiencing an en bloc or fragmentary blackout, which arguably produces gaps in memory and thereby decreases witness recall. Although the present design did not allow for the direct examination of AMT, it provided the underpinnings for the theoretical framework of the study.

Concerning lineup decisions, alcohol was not expected to affect choosing or accuracy rates when viewing a target-present lineup or showup (Flowe et al., 2017; Hagsand et al., 2013b; Steblay et al., 2003), but an interaction was predicted when the target was absent. Consistent with the original AMT, for the individuals with higher BAC levels, it was predicted that the suggestiveness of viewing a showup, combined with the liberal decision-making criterion created by alcohol, would increase the rate of false identifications than would viewing a lineup. Individuals with higher BAC levels viewing a lineup, compared with witnesses viewing a showup, were also expected to utilize a more liberal decision-making criterion, but the similarities across faces were expected to make it difficult to find a best match suspect, resulting in more rejections and not sure responses. It was predicted that sober or less intoxicated witnesses would respond similarly to the lineup and showup. Thus, alcohol was only expected to affect false identifications in the showup condition but has no effect on false identifications in the lineup condition.

2 | METHOD

2.1 | Participants

Participants were recruited from a local bar in the Northeastern United States across a 2.5-month span. On testing nights (eight randomly selected weekend nights) between 7 p.m. and 1 a.m., patrons were randomly asked to participate in a study examining the effects of alcohol on cognitive and motor functions. Patrons were made aware there was no incentive for participating and that the study took 20–25 min to complete. The sample consisted of 132 participants (53% male) ranging in age from 19 to 66 (M = 38.83, SD = 15.08). Participants identified themselves as White/Caucasian (97.7%), African-American (1.5%), and Hispanic/Latino (0.8%). Participants' BAC levels ranged from 0.00% to 0.24% (M = 0.08, SD = 0.06).

2.2 | Design

This study was a 2 (Identification Procedure: Lineup vs. Showup) × 2 (Target Presence: Target Present vs. Target Absent) + 1 (Intoxication) between-participants design. Intoxication levels of this magnitude could not ethically be manipulated; therefore, this acted as a continuous quasi-experimental independent variable. Dependent measures were the total number of informational units reported by participants (memory quantity); the percentage of accurate, inaccurate, “I don't know”, subjective, and irrelevant informational units reported (memory quality); identification choosing and accuracy rates; and identification certainty.

2.3 | Materials and procedure

Across the eight testing nights, bar patrons were approached and asked to participate in a 20- to 25-min study examining the effects of alcohol on cognitive and motor functions. Research assistants (RAs) were instructed to approach participants randomly to avoid selection bias (e.g., approach patrons from different areas of the bar and approach an equal number of males and females, if possible). For their own safety and ethical concerns regarding consent, RAs were also instructed not to approach participants who were visibly/obnoxiously intoxicated (e.g., falling off their chair and slurring their words). Agreeing patrons signed an informed consent document and were taken, one at a time, to a separate room inside the bar void of other guests where they were prohibited from drinking until the conclusion of the experiment.

2.3.1 | Intoxication measurements

Inside the secluded room, participants had their BAC levels recorded using one of two BACtrack S80 Pro Breathalyzers: Professional Edition (KHN Solutions, 2016). These handheld devices are similar to others used in field and laboratory experiments (e.g., Dysart et al., 2002; Hagsand et al., 2013b; Hagsand, Roos af Hjelmsäter, Granhag, Fahlke, & Söderpalm Gordh, 2013a, 2017). The two breathalyzers were also pilot tested against a calibrated benchtop model Intoxilyzer 5000, one of the most accurate tools available for measuring BAC levels (Department of Transportation, 2012). Across 39 trials, the handheld breathalyzers produced the same reading as the Intoxilyzer 30 times (77%); the other readings differed by less than 0.02%. Before the experiment commenced, the breathalyzers were also shipped to the manufacturer where they passed a three-point recalibration test (KHN Solutions, 2016). Based on these tests, it was determined that the breathalyzers used in this study were valid instruments to assess participants BAC levels, which participants remained blind to throughout the experiment. Participants were also asked to provide a
subjective rating of their intoxication on 0 (not drunk at all) to 100 (extremely drunk) scales.

### 2.3.2 Staged interaction

After providing a BAC recording and subjective rating of their intoxication, participants were exposed to a live-staged interaction. The live-staged interaction involved an adapted version of Cornhole, a recreational game in which players throw bean bags at wooden platforms with holes on the surfaces. The platforms and bean bags were used in this study, but the scoring system was adapted. For this adapted version, participants were given five bean bags by the RA in charge of that station. Participants were instructed that the objective was to accumulate as many points as possible across four rounds of throwing the bean bags at the wooden platforms using the custom scoring system. Midway through the game, each participant was interrupted by a female confederate intruder (Alex) who ostensibly wanted to join. The experimenter in charge of the game informed Alex she was in a restricted area and would have to leave. Ignoring the experimenter’s comment, Alex sat down at the nearest table and began touching the study equipment (e.g., breathalyzers and participant charts). In a more agitated tone, the experimenter informed Alex she must leave or the owner of the bar would be notified. Seemingly upset, Alex stood up, yelled back at the experimenter, knocked over a chair, and left the room. This intrusion lasted approximately 60 s. During that time, Alex remained approximately 14 ft away from the participant who viewed her face from multiple angles. Afterward, the experimenter apologized for the intrusion, explained that it was unexpected and had never happened before, and asked the participant to finish their tosses before providing a second BAC and subjective intoxication measurement. A second RA then entered the Cornhole room and was told there was a disturbance during the participant’s game. The two RAs briefly discussed university protocol for documenting incidences at the bar, and then the second RA immediately escorted the participant to another room void of outside guests and noises to complete the interview and identification portions of the study.

### 2.3.3 Interview

Inside the second room was a third RA waiting to conduct the eyewitness interview and identifications. Participants were told the purpose of the additional room was to provide a quiet space for their cognitive assessments. Before the assessments were completed, however, each participant was told that disturbances at the bar needed to be documented immediately, for university purposes, using a standard incident report. Participants were then asked to provide an audio-recorded statement about the disturbance should the university need to verify any information. Each interview was conducted by a trained experimenter and began with two open-ended questions followed by 11 cued questions directed at specific aspects of the intrusion (Appendix S1A). These questions were asked in a neutral tone so that the interviewer’s emotions or rapport did not affect participants’ recall.

### 2.3.4 Identification materials

Following the interview/recall portion of the study, participants took part in the identification portion. As interviews varied in length, the timing of the identification portion varied slightly across participants (2–3 min). For the identification portion, participants were told that the bar owner provided photos of individuals who had previously caused disturbances (Appendix S1B). Each participant was then asked to look at the photo(s) provided and state whether the person who disrupted their Cornhole game was pictured or not and, if so, to identify her. Participants were also given the option to reject the photos or state they were not sure whether her picture was present. Participants were then randomly assigned to view a showup or lineup. Those in the showup condition viewed one photo of either the confederate (target present) or a person similar in appearance to the confederate (target absent). Participants in the lineup condition viewed a six-person simultaneous lineup that included the confederate’s photo alongside similar-looking fillers (target present) or six photos of individuals who were similar in appearance to the confederate (target absent).

Pilot testing of the filler photos was done to ensure fillers were reasonable matches to the confederate. Initially, three experimenters unfamiliar with the confederate were asked to describe a photograph of her. Any feature mentioned by at least two of them was used to create a composite description. This description was given to a new set of experimenters, also blind to the confederate’s appearance, who were asked to find females (e.g., friends and family members) who matched the description. An additional set of experimenters was given the confederate’s photo and asked to find people who matched her general appearance. In total, nine females who fit the confederate’s description and/or appearance were identified as potential fillers. Independent judges (N = 56) were then asked to rate how well each potential filler matched the confederate’s description on a 0 (not at all) to 100 (perfect match) scale. The six highest rated individuals, along with the confederate, were used to create the lineups and showups (see Appendix S1C).

The target-present lineup consisted of the confederate’s photo and the five highest rated fillers. Six versions were created by arranging the photos in a randomized order. The target-absent lineup consisted of the six highest rated filler photos, again presented in random order to participants. The target-present showup was the confederate’s photograph (see Appendix S1C, Photo A). For the target-absent showup, each filler photo served as the confederate replacement, creating six possible versions, presented in a randomized order. This helped ensure choosing was not a function of any one filler’s unreasonably high or low similarity to the perpetrator.

After making a decision about the photo(s) presented, each participant was asked to provide an estimate of their certainty in their decision using a 0 (not at all certain) to 100 (extremely certain) scale. Participants were then debriefed about the true purpose of the study and taken to a third room to complete a questionnaire.
2.3.5 Questionnaire

In the third and final testing room, participants were asked to quantify how long and how much they had been drinking on the night of the experiment and on a “typical” drinking night. Each participant was also asked to rate on a 0 (not at all) to 10 (completely) scale how believable the confederate intrusion, interview for university purposes, and photos provided by the bar were during the study. Several demographic items were also included. Participants were then dismissed from the testing area and repeatedly asked to not discuss the study with anyone who might be a future participant. Experimenters responsible for recruiting listened for discussions regarding the study around the bar, and none were heard.

2.4 Scoring

2.4.1 Event memory

Witnesses’ interviews were transcribed and broken into units of information (Altman et al., 2018; Schreiber Compo et al., 2011, 2012). A unit was defined as the smallest piece of information that could be scored for accuracy in its relation to the interaction. One experimenter unitized all transcripts to ensure consistency. Using detailed instructions, three trained experimenters independently scored each unit as accurate, inaccurate (contained inaccurate or modified information about the interaction), I do not know (IDK; participant said some variation of the phrase “I don’t know”), subjective (nonverifiable information such as emotions or feelings), or irrelevant (did not include information related to the question or event) in its relation to the event. Interclass correlations for all 132 transcripts were high for accurate (0.99), inaccurate (0.97), IDK (0.93), subjective (0.96), and irrelevant (0.82) units.

Memory quantity was defined as the total number of units reported by each participant. Memory quality was assessed using the proportion of accurate, inaccurate, and IDK units reported by each participant. These proportions were calculated by dividing the number of units in each category by the total number of accurate, inaccurate, and IDK units provided by that participant. For example, accuracy was derived by dividing the number of accurate units reported by the participant by the total number of accurate, inaccurate, and IDK units reported by that same participant. Subjective and irrelevant units were not included in the denominator because they could not be verified for accuracy.

2.4.2 Memory for faces

Responses of interest included the percentage of correct identifications and incorrect rejections when the target was present, and the percentage of correct rejections and false identifications when the target was absent. In classifying false identifications, a positive identification from a target-absent showup was considered a false identification. For the target-absent lineup, an identification of Filler D’s photo was considered a false identification (see Appendix S1D). This filler was designated the “innocent suspect” post hoc because of her high identification rate. Designating an innocent suspect allows for eventual analysis of false versus filler identifications, as well as examination of false identifications in the “worst case scenario” (see Clark, Marshall, & Rosenthal, 2009; Pryke, Lindsay, Dysart, & Dupuis, 2004).

3 Results

Of the 132 participants tested, 73 (55.3%) recorded a BAC level below 0.08% and 59 (44.7%) recorded a BAC level of 0.08% or higher, rendering them legally intoxicated according to U.S. standards. Of the total sample, 45 participants recorded a BAC level above 0.10%, the lowest BAC level at which signs of fragmentary and en bloc black-outs are expected to occur. The highest BAC level recorded was 0.24% (see Figure 1).

3.1 Intoxication measurements and procedure believability

Participants’ first BAC measure was significantly correlated with their second BAC measure \( r = 0.97, p < 0.01 \), their first subjective BAC measure \( r = 0.68, p < 0.01 \), and their second subjective BAC measure \( r = 0.68, p < 0.01 \). Participants’ first BAC measure was also significantly correlated with the number of drinks they reportedly drank per week, time drinking on the night of the experiment, and drinks consumed on the night of the experiment \( r > 0.40, p < 0.01 \). These correlations show that the higher the participants reported alcohol consumption (in general and the night of the study), the higher their actual measured breath alcohol level.

Regarding participants’ beliefs about the intrusion, interview, and photos, paired samples t tests revealed that participants gave higher believability ratings to the staged eyewitness interaction \( M = 7.15, SD = 3.04 \) than to the photos provided by the bar for the identification procedure \( M = 4.87, SD = 3.73, t(126) = 6.20, p < 0.01, d = 0.67, 95% CI [1.55, 3.01] \). Participants were also more inclined to believe the interview questions provided by the university \( M = 7.10, SD = 2.96 \) than to the photos provided by the bar, \( t(126) = 6.14, p < 0.01, d = 0.66, 95% CI [1.48, 2.89] \). No difference in ratings was

FIGURE 1 Number of participants (X-axis) at the various blood alcohol concentration (BAC) levels recorded (Y-axis) [Colour figure can be viewed at wileyonlinelibrary.com]
found between eyewitness interaction and the interview questions, $t(126) = 0.35, p = 0.73, d = 0.02, 95\%$ CI $[-0.44, 3.06]$. Participants’ first BAC measure was not significantly correlated with their belief in the staged eyewitness interaction, interview, or identification photos, $r < -0.09, ps > 0.31$. One-way analysis of variance showed that participants’ believability ratings did not vary significantly between the lineup and showup condition for the intrusion, interview, or photos, $ps > 0.68$.

### 3.2 Event memory

The effects of alcohol on event memory were analyzed using linear regressions. For each regression, BAC level acted as the predictor variable with outcome variables being quantity (number of units reported) and quality (proportion of accurate, inaccurate, or IDK responses) of information provided during the interviews. Given the strong correlation between participants’ objective and subjective drinking measures, participants’ first BAC measure was used for all analyses.

#### 3.2.1 Quantity

A linear regression showed that BAC level was not a significant predictor of recall quantity, $F(1,128) = 1.60, p = 0.21, R^2 = 0.01, \beta = -0.11, 95\%$ CI $[-0.42, 0.10]$ (see Figure 2). However, when irrelevant and subjective information was excluded from this count, BAC level was a significant predictor of recall quantity, $F(1,128) = 25.35, p < 0.01, R^2 = 0.17, \beta = -0.41, 95\%$ CI $[-1.25, -0.68]$. As BAC increased, the number of relevant informational units reported decreased.

#### 3.2.2 Quality

Linear regressions were used to examine the relationship between participants’ BAC level and recall quality (see Figure 3). A regression showed that BAC level was a significant predictor of recall accuracy, $F(1,128) = 44.37, p < 0.01, R^2 = 0.26, \beta = -0.51, 95\%$ CI $[-1.25, -0.68]$. As BAC increased, the proportion of accurate units reported decreased. Participants’ BAC level was also a significant predictor of recall inaccuracies, $F(1,128) = 23.87, p < 0.01, R^2 = 0.16, \beta = 0.40, 95\%$ CI $[0.37, 0.88]$. As BAC increased, the proportion of inaccurate units reported increased. Participants’ BAC level was also a significant predictor of the proportion of IDK units reported, $F(1,128) = 6.95, p < 0.01, R^2 = 0.05, \beta = 0.23, 95\%$ CI $[0.05, 0.33]$. As BAC increased, so did the proportion of IDK units reported. Participants’ BAC level was also a significant predictor of the proportion of irrelevant information reported, $F(1,128) = 27.60, p < 0.01, R^2 = 0.18, \beta = 0.42, 95\%$ CI $[0.53, 1.16]$. As BAC level increased, so did the proportion of subjective information reported.

### 3.3 Memory for faces

#### 3.3.1 Choosers versus nonchoosers

**Target present**

Of the 61 participants in the target-present condition, 41 (67.20%) chose a photo, 17 in the lineup condition and 24 in the showup condition (see Table 1). A logistic regression examined whether BAC level, identification procedure, or the interaction between the two variables (predictors) helped classify witnesses’ choosing behavior. A model with these predictors was able to classify 68.90% of participants’ decisions, but this was not significantly more than the 67.20% of cases classified by a model with no predictors, $\chi^2(3) = 2.28, p = 0.52$, Nagelkerke $R^2 = 0.05, OR = 3.84$. That is, BAC level and identification procedure did not predict choosing behavior in the target-present condition.

### FIGURE 2

Relationship between blood alcohol concentration (BAC) level (X-axis) and the total number of units reported with and without subjective and irrelevant units included (Y-axis) [Colour figure can be viewed at wileyonlinelibrary.com]

### FIGURE 3

Relationship between blood alcohol concentration (BAC) level (X-axis) and the percentage accurate, inaccurate, I do not know (IDK), irrelevant, and subjective units (Y-axis) [Colour figure can be viewed at wileyonlinelibrary.com]
The model was also unable to distinguish the regression line from zero. Interestingly, 12.50% of participants correctly rejected the target absent lineup condition. It could be argued that the false identification rate of the remaining 49 participants, 15 made a false identification (lineup N = 6; showup N = 9) and 34 participants provided either a not sure response (lineup N = 9; showup N = 12) or, in the lineup condition, identified a filler photo (N = 13). Of primary concern for analyses were false identifications and correct rejections.

A logistic regression was used to examine whether BAC level, identification procedure, or the interaction between the two variables helped classify false identifications. A model with these predictors was able to classify 85.90% of false identifications, the same percentage as a model with no predictors, \( \chi^2(3) = 6.82, p = 0.08, \text{Nagelkerke } R^2 = 0.16, \text{OR } = 0.44. \) Thus, BAC and identification procedure had no impact on the rate of false identifications.

Correct rejections could not be calculated due to the limited number of participants who rejected the photos (N = 22). Bootstrapping techniques and iteration enhancements were again performed to try and simulate more data, but the regression line in the model could not be distinguished from zero. Interestingly, 12.50% of participants correctly rejected the target-absent lineup versus 46.15% who correctly rejected the target-absent showup.

### Target absent

Of the 71 participants in the target-absent condition, 28 (39.40%) chose a photo, 19 in the lineup condition and nine in the showup condition (see Table 1). A logistic regression examined whether BAC level, identification procedure, or the interaction between the two variables helped classify witnesses’ behavior. A model with these predictors was able to classify 71.80% of participants’ decisions, significantly more than the 60.60% of cases classified by a model with no predictors, \( \chi^2(3) = 12.52, p < 0.01, \text{Nagelkerke } R^2 = 0.22, \text{OR } = 3.16. \) Identification format was the only significant predictor in the model, \( \beta = 1.97, \text{SE } = 0.91, \text{Wald}(1) = 4.73, p < 0.05, \text{Exp}(\beta) = 7.19, \text{OR } = 0.14, 95\% \text{ CI } (0.03, 0.82), \) showing that participants were nearly two times more likely to make an identification from a lineup than from a showup.

### 3.3.2 | Accuracy

#### Target present

Of the 61 participants in the target-present condition, 35 (54.09%) correctly identified the confederate (lineup N = 11; showup N = 24). Of the remaining 28 participants, six identified a filler (lineup), nine incorrectly rejected the photos (lineup N = 2; showup N = 7), and 11 provided a not sure response (lineup N = 5; showup N = 6). Of primary concern for analyses was correct identifications and incorrect rejections.

A logistic regression was used to examine whether BAC level, identification format, or the interaction between the two variables helped classify correct identifications. A model with these predictors was able to classify 63.90% of witnesses who identified the perpetrator, which was not significantly different from the 57.40% of cases classified by the model with no predictors, \( \chi^2(3) = 4.46, p = 0.22, \text{Nagelkerke } R^2 = 0.10, \text{OR } = 3.27. \) Thus, alcohol and identification procedure had no effect on witnesses’ ability to correctly identify the confederate. Despite this nonsignificance, the difference between the correct lineup identification rate (45.83%) and showup identification rate (64.86%) is worth noting. Incorrect rejections could not be analyzed due to the low cell counts. That is, the maximum likelihood estimation of the regression failed to converge given the few participants (N = 9) who rejected the photos (lineup N = 2; showup N = 7).

The model was also unable to distinguish the regression line from zero after bootstrapping techniques were used to simulate more data and the number of iterations was increased.

#### Target absent

Of the 71 participants in the target-absent condition, 22 (31.00%) accurately rejected the photos presented (lineup N = 4; showup N = 18). Of the remaining 49 participants, 15 made a false identification (lineup N = 6; showup N = 9) and 34 participants provided either a not sure response (lineup N = 9; showup N = 12) or, in the lineup condition, identified a filler photo (N = 13). Of primary concern for analyses were false identifications and correct rejections.

A logistic regression was used to examine whether BAC level, identification procedure, or the interaction between the two variables (predictors) helped classify false identifications. A model with these predictors was able to classify 85.90% of false identifications, the same percentage as a model with no predictors, \( \chi^2(3) = 6.82, p = 0.08, \text{Nagelkerke } R^2 = 0.16, \text{OR } = 0.44. \) Thus, BAC and identification procedure had no impact on the rate of false identifications.

Correct rejections could not be calculated due to the limited number of participants who rejected the photos (N = 22). Bootstrapping techniques and iteration enhancements were again performed to try and simulate more data, but the regression line in the model could not be distinguished from zero. Interestingly, 12.50% of participants correctly rejected the target-absent lineup versus 46.15% who correctly rejected the target-absent showup.

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1Because all six faces were used in the target-absent showup as an attempt to prevent false identifications from being unique to one filler’s target similarity, each face was presented to only six to eight participants, thereby preventing the rate of false identifications of any one filler (e.g., Filler D) from being directly compared with the overall false identification rate of that same filler in the target-absent lineup condition. It could be argued that the false identification rate from the target-absent lineup should also be an aggregate of false identifications from any of the six fillers—essentially an all-suspect lineup—however, an all-suspect lineup is a fundamentally different scenario than a showup procedure and should be treated as such. Thus, we did not directly compare the two as it concerned false identifications. Although we acknowledge that this approach may have limitations, it (a) highlights the importance of filler similarity and (b) may explain Dysart et al.’s (2002) target-absent showup false identification rate based on one high-similarity filler. Having said that, the analysis of aggregate identifications of any face from the target-absent showup versus aggregate identifications of any face from the target-absent lineup is included in Section 3.3.1 of this paper.
3.3.3 | Identification certainty

A linear regression examined how BAC level and choosing impacted participants’ certainty in their identification decisions. For this regression BAC level, choosing behavior, and the interaction between the two variables acted as the predictors, whereas participants’ certainty ratings acted as the outcome variable. These variables did not predict identification certainty, $F(3, 99) = 0.87, p = 0.46, R^2 = 0.03, 95\% CI [-0.43, 19.48].$

4 | DISCUSSION

The aim of this study was to examine witnesses’ memory for a live-staged interaction at elevated BAC levels and how identification format impacts witnesses’ identification decisions. Two central findings emerged: (a) Alcohol intoxication significantly affected witnesses’ event memory by reducing both the quantity and quality of relevant information reported, and (b) alcohol had no effect on identification accuracy, regardless of identification format.

Consistent with hypotheses and other field studies examining witness memory at elevated BAC levels (Altman et al., 2018; Crossland et al., 2016), higher levels of alcohol intoxication reduced both the quantity and quality of relevant information reported and increased the proportion of inaccurate information reported. These findings support the literature on alcohol-induced blackouts and suggest that witnesses at relatively elevated BAC levels (>$0.08\%) may have experienced signs of fragmentary and/or en bloc blackouts, decreasing the quantity and quality of information provided. It should be noted however that the number of witnesses whose BAC was extremely elevated was limited in this study. The alcohol-induced memory deficits observed may also be linked to the AMT, as elevated BAC levels restricted the amount of peripheral information encoded by participants and reduced recall quantity and quality. However, issues regarding item centrality and scoring prevented the direct examination of AMT in this study; as we did not experimentally manipulate item/recall centrality, it could have only been measured and scored post hoc, presenting its own host of issues, including defining a piece of information as central because it was reported more often. One unique finding in the present study is that alcohol did not have an initial impact on recall quantity. Only after irrelevant and subjective information was excluded from participants’ quantity measures did alcohol have the expected effect.

This difference is likely a function of the encoding experience used in the present study; that is, participants were actively engaged in an interaction with a confederate whereas in previous studies participants passively observed a videotaped mock crime. Indeed, how information is encoded and stored from varying experiences can be notably different (Cabeza & St Jacques, 2007; Read, Yuille, & Tollestrup, 1992)—engaging events are often accompanied by emotional information that is sometimes absent in events we only passively observe (Kassin, 2004; Smith & Kosslyn, 2007). Having less information to provide about the incident in our study, witnesses at higher BAC levels might have felt the need to report emotional information to form a more complete account. For example, one participant stated she was “shocked when the girl (i.e., confederate) walked in and was wondering how she got there. Like one time when a guy walked into the ladies room by accident and I didn’t know what to do, so I just stood there, frozen.” However, participants at lower BAC levels who provided more complete reports of the incident may not have felt the need to provide emotional or irrelevant information. Albeit speculative at this point, it is also possible that emotional information is more salient and hence more likely to be encoded and reported when intoxicated. The positive relationship between participants’ BAC levels and the proportion of subjective and irrelevant information provided (i.e., thoughts and feelings that could not be verified for accuracy) supports this assumption and helps explain why the quantity of information provided by participants’ at higher BAC levels might have been artificially inflated. Along these lines, it would be interesting for future research to examine how participants’ confidence in their memory recall varies as a function of account accuracy and BAC levels.

The present findings also align with research showing that elevated BAC levels may reduce ‘offenders’ ability to recall accurate and plentiful information about a criminal activity they performed (Read et al., 1992; van Oorsouw et al., 2015; van Oorsouw & Merckelbach, 2012). In fact, Read et al. (1992) also exposed participants to an engaging live-staged interaction. Whereas Read and colleagues found that those with higher BAC levels reported more subjective information, van Oorsouw et al. (2015) scored participants’ recall using a predetermined list of items; thus, subjective information was not included in participants’ recall measures. Future studies in the area should therefore consider the relevance of information provided during witness interviews to avoid artificially inflating intoxicated individuals’ measures and potentially missing a detrimental effect of alcohol on memory.

Taken together, data from the present study and others that have examined memory for a criminal event at elevated BAC levels support the conclusion that the null/inconsistent findings throughout the literature (e.g., Flowe et al., 2017; Hagsand et al., 2013a, 2017; Schreiber Compo et al., 2011) may be due to the low-to-moderate BAC levels often tested in laboratory settings. At these BAC levels, the effects of alcohol may not be powerful enough to reliably expose cognitive deficits in witnesses’ perceptual and consolidation abilities. As BAC levels increase, however, pyramidal cell activity continues to slow down (Lee et al., 2009; Perry et al., 2006; White, 2003) and drinkers’ ability to attend to peripheral information in the environment is further reduced (Josephs & Steele, 1990; Steele & Josephs, 1990). Alcohol-induced memory deficits are therefore more apparent and consistent at elevated BAC levels because less information is encoded and transferred to long-term memory. In addition to reducing the quantity of information transferred to long-term memory, the present data suggest that elevated BAC levels simultaneously produce weaker/incomplete and more inaccurate recall. Further, these data suggest that at high intoxication levels, witnesses’ reports may also include more emotionally tinged details. Future studies would do well...
to ensure they include participants at elevated BAC levels in order to fully and reliably examine intoxicated witnesses.

As expected, alcohol and identification format had no effect on witnesses’ lineup or showup decisions when the target was present. When the target was absent, we argued that alcohol would create a more liberal decision-making criterion, which would lead to increased choosing and false identifications in the showup condition but be offset by the fillers in the lineup condition. In contrast to this prediction, participants who viewed a target-absent lineup were more likely to make identifications than those who viewed a target-absent showup. The increased choosing rate in the lineup condition was not accompanied, however, by an increase in false identifications when compared with that in the showup, suggesting that the fillers satisfied their intended purpose and siphoned away would-be false identifications. Worth noting, however, are the relatively low and unequal cell sizes across identification conditions, which may have provided insufficient power to reveal differences across conditions but could not be avoided given the limited access to and availability of the testing location and the participant pool. As such, we recommend that the identification results be interpreted tentatively.

An explanation as to why participants viewing a target-absent lineup would have higher choosing rates than those viewing a showup is that choosing and false identification rates in the showup condition were not as high as expected. That is, our showup predictions were primarily based on Dysart et al.’s (2002) findings in which alcohol intoxication increased the likelihood of a false identification in the target-absent condition. In that research, however, the target-absent showup condition consisted of one face highly resembling the perpetrator in which all participants viewed. It is likely that this high degree of similarity, together with the liberal decision-making criterion of witnesses at elevated BAC levels, led to the high false identification rate. Alternatively, for the showup in the present study, several faces of high but varying resemblance to the confederate were used in the target-absent condition. Whereas several of these faces were often falsely identified, others were not. For example, Filler D (the designated innocent suspect based on false identifications) was falsely identified in four of the eight showups in which she appeared while other photos (e.g., Fillers B and E) were never falsely identified. Thus, overall choosing and false identification rates for the target-absent showup were impacted by the inclusion of varying-resemblance photos. This finding highlights the importance of considering similarity to the target in target-absent situations, a variable that arguably drives false identification rates. Another distinction when considering the differing false identification results is the photographic identification procedures utilized in the present study versus the live presentation in Dysart et al., as live presentations can enhance the suggestiveness of the showup procedure (Sjöberg, 2016; Steblay et al., 2003).

Although future research on intoxicated witnesses should include participants across a broad BAC spectrum, quasi-experimental field studies come at methodological costs (see Altman et al., 2018). Because BAC levels cannot ethically be manipulated, no casual claims can be made about the impact of alcohol on memory. That said, this literature overall suggests a clear negative relationship between elevated BAC levels and witnesses’ event memory and no relationship between BAC level and witnesses’ identification decisions. Also, participants often visit bars in groups, enhancing the likelihood that patrons who have already been tested will return to their group and divulge information about the study manipulations. We do not believe this is cause for concern in the present study given participants’ subjectively high believability ratings for the intrusion and interview. Experiments present on testing nights also listened for information shared between prior and future participants (no such communication was overheard). Of course, this concern is not limited to field studies and could be eliminated in future studies by asking participants if information about the study was divulged to them prior to participating. Future research should explore ways to monitor participants’ alcohol consumption in bar settings to better understand how consumption rate and alcohol type (i.e., wine, liquor, and beer) might impact witness memory. The digestion and elimination of ethanol are dependent on both the rate at which it is consumed and alcohol type (Roberts & Robinson, 2007), thus potentially impacting the psychological effects of alcohol on memory. For instance, Crossland et al. (2016) had undergraduate participants visit their campus bar before exposing them to the study procedure inside the lab on campus. Although this approach did not offer researchers the ability to manipulate alcohol type or consumption rate, it allowed for a better assessment (as opposed to self-report measures) of participants’ drinking behaviors through security cameras or RAs placed at the bar. This scenario also allows researchers to manipulate the length of time participants have to consume alcohol, potentially providing greater control over intoxication levels in field settings. Further studies in this area could also benefit from video recording participants’ actions throughout the duration of the study. For example, in Read et al.’s (1992) first study, participants’ actions outside those they were instructed to perform could not be verified, so in Study 2, experimenters placed a camera inside the testing location so that their behavior could later be verified. This allowed researchers a greater ability analyze, score, and interpret the quantity and quality of the offenders’ reports.

In actual cases, witnesses who are interviewed immediately after an event while still intoxicated are often reinterviewed at a later time in a sober state (Palmer et al., 2013). Showups, however, are often administered when a suspect is apprehended within a short time frame following the crime while witnesses are likely to still be intoxicated (Agricola, 2009). Lineups, on the other hand, typically take some time to construct (including zeroing in on a potential suspect and selecting fillers to ensure a fair lineup), which implied a delay between the time of encoding when a witness is still intoxicated and the time of recall (when the witness is likely to be sober). As such, same-state encoding and retrieval are more likely to be relevant in real-world showup scenarios, whereas different-state encoding and retrieval will be more likely in real-world lineup scenarios. Because of the potentially suggestive nature of a showup procedure (see National Research Council, 2014), if this procedure is implemented with witnesses, it is recommended that caution be used when displaying the suspect (e.g., suspect should not be in handcuffs or in a police car). Ethical considerations in this line of research, however, often prohibit
experimenters from collecting intoxicated participants’ contact information, rendering it difficult for follow-up interviews and lineup tests. Future studies could explore ways to ethically collect contact information from highly intoxicated individuals. Follow-up interviews would allow for the examination of multiple reports given by intoxicated witnesses across time and elucidate whether a sobering time delay benefits the quantity and quality of their testimony, especially those who are highly intoxicated during the crime. Whereas the present study exposed participants to an interactive and engaging event that more closely resembles an eyewitness encounter, actual eyewitnesses often experience traumatic, negative events. Studying intoxicated witnesses memory under these conditions would be more ecologically valid and helpful; however, it also presents additional ethical challenges.

Since the collection of experts’ and jurors’ opinions regarding the effects of alcohol on witness memory (Evans & Schreiber Compo, 2010; Kassin et al., 2001), a substantial amount of research has demonstrated that low-to-moderate BAC levels have, at best, little effect on event memory and had no effect on identification accuracy, casting doubt on these original opinions. Only at elevated BAC levels do impairments in event memory consistently emerge. These data align with other recent work demonstrating that alcohol, even at high levels of intoxication, does not affect witnesses’ ability to identify a perpetrator, an important finding considering the role alcohol often plays in sexual victimization (Abbey, 2002; Department of Justice, 1998). As such, these data support the recommendation that investigators err on the side of caution and administer a lineup whenever possible. More notably, these data show that although high levels of alcohol significantly impact recall, witnesses at lower BAC levels are capable of providing valuable and accurate information to investigators. More research in the area will help confirm these hypotheses and reveal under what circumstances intoxicated witnesses memory may become more fallible. If one exists, additional research may also reveal an exact BAC level at which an eyewitnesses’ memory becomes questionable, providing investigators a clear cutoff at which intoxicated witnesses’ testimonies become more harmful than helpful.

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section at the end of the article.

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