Alcohol-intoxicated eyewitnesses' memory

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Abstract

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Eyewitnesses are an important source of information in many criminal investigations. However, the memory of an eyewitness is not always accurate, and errors may occur that have serious consequences. Alcohol-related crimes are common, and therefore, intoxicated witnesses are common. However, only a handful of published studies have described how alcohol affects eyewitnesses' memory.

The overall aim of the research described in this thesis was to examine how alcohol affects eyewitnesses' memory. The thesis comprises three studies, which followed similar general procedures. The participants in the studies consumed an alcoholic or non-alcoholic beverage during a 15-minute period and then witnessed a film that depicting a staged kidnapping. The retention interval and recall format varied between the studies. The aim of **Study I** was to examine the influence of alcohol on eyewitnesses' performances in a line-up setting. The participants ($N = 123$) were randomly assigned to a 3 (Beverage: control [0.0 g/kg] versus lower alcohol dosage [0.4 g/kg] group versus higher alcohol dosage [0.7 g/kg] group) × 2 (Line-up: target-present versus target-absent) between-subject design. One week after alcohol intoxication and the critical event, the participants were exposed to the line-up. The results showed no significant difference between the groups in terms of performance in the line-up, under either the target-present or the target-absent condition. In general, the participants performed better than chance at identifying the culprit. However, all witnesses performed quite poorly. **Study II** ($N = 126$) examined the effects of alcohol (Beverage: control [0.0 g/kg] versus lower alcohol dosage [0.4 g/kg] group versus higher alcohol dosage [0.7 g/kg] group) on the amount of information reported (completeness) and accuracy rate. There was no difference in the completeness between the control group and the higher alcohol dosage group or between the control group and the lower alcohol dosage group. When comparing the two alcohol groups, participants in the higher alcohol dosage group remembered fewer details than those in the lower alcohol dosage group. No differences were found between the beverage groups in recall accuracy. The aim of **Study III** ($N = 99$) was to elucidate the best time to interview intoxicated witnesses. Participants were randomly assigned to a 2 (Beverage: control [0.0 g/kg] versus alcohol dosage [0.7 g/kg] group) × 2 (Recall: repeatedly, i.e., immediate plus delayed interviews versus single, i.e., delayed interview only) mixed design. Overall, alcohol-intoxicated eyewitnesses produced less accurate testimonies than the sober witnesses. Although the difference was significant, the intoxicated witnesses were only slightly less accurate in their recollections. Both the sober and the intoxicated witnesses recalled details with a relatively high accuracy. There was no difference with regards to the amount of information reported between the intoxicated and the sober witnesses. An immediate interview was more beneficial than a delayed interview. However, the best recall was by witnesses who were interviewed twice, and this was true for both the sober and the intoxicated witnesses. New details provided at the second interview, by either group, were often correct.

In summary, this thesis shows that alcohol consumption does not have a negative effect on either witness's line-up performance (recognition) or on the amount of information reported during investigative interviews (recall). However, the accuracy of their recall was slightly impaired by consumption of alcohol (Study III). This thesis shows that representatives of the legal system may expect that witnesses with low to moderate intoxication (blood alcohol concentration <0.10%) will perform at approximately the same level as sober witnesses. It is however reasonable to assume that more profound memory impairments can be expected for witnesses with higher intoxication levels.

Key words: alcohol, intoxication, eyewitnesses, memory, recognition, recall, line-up, interview

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Svensk sammanfattning

För att rättsväsendet ska kunna klara upp brott är ögonvittnen viktiga, och ibland den enda informationskällan (t.ex. Fisher, 1995; Fisher & Schreiber, 2007; Wells & Olson, 2003). Det är förekommande att polisen genomför en intervju med ett vittne redan på brottsplatsen, men ibland sker intervjun först efter en tid. Ibland arrangerar polisen även en vittneskonfrontation där vittnet antingen får titta på personer (live-konfrontation) eller på ett antal foton (foto-konfrontation) för att försöka identifiera gärningspersonen (Evans, Schreiber Compo, & Russano, 2009). Allmänheten får lätt uppfattningen utifrån filmer och TV-serier att brott bäst löses med hjälp av DNA teknik eller förmågan hos en extraordinärt skicklig utredare, men i själva verket är vittnesmål den viktigaste informationskällan i brottsutredningar (Granhag, Ask, & Mac Giolla, 2013). Det är ett erkänt faktum att vittnen kan minnas fel, något som ibland kan få mycket allvarliga konsekvenser (Kassin & Gudjonsson, 2004). Ett felaktigt vittnesmål kan bidra till att en person döms för ett brott som denne inte har begått (Wells & Olson, 2003).En faktor som kan påverka vittnets minne är om han eller hon var alkoholpåverkad vid bevittnandet av brottet (Granhag et al., 2013).

I västvärlden är alkoholrelaterade brott vanliga. Med detta avses brott där gärningsmannen, offret eller eventuella vittnen är under alkoholpåverkan. I Sverige är ca 50-70 % av alla våldsbrott alkoholrelaterade (Eksten, 2007; Ekström, 2009). Det senaste decenniet har alkoholkonsumtionen ökat, vilket också gör det rimligt att anta att även de alkoholrelaterade brotten har ökat (Centralförbundet för alkohol- och narkotikaupplysning, 2008).

Vad visar då forskningen om hur alkohol påverkar ögonvittnens minne? Det finns endast en handfull studier som uppmärksammat detta ämne och kunskapen är därför mycket begränsad (Evans et al., 2009; Malpass et al., 2008). Däremot finns det god kunskap om hur alkohol påverkar vårt minne rent generellt. Överlag kan man säga att alkohol påverkar minnet negativt, speciellt vid hög alkoholkonsumtionen. Konsumtion av en stor mängd alkohol under kort tid kan till och med framkalla alkoholrelaterad amnesi. Detta tar sig uttryck via antingen en *blackout* (total minnesförlust) eller en *grayout* (fragmentarisk minnesförlust) (Alderazi & Brett, 2007; Lee, Roh, & Kim, 2009). Det är inte nödvändigtvis så att den forskning som fokuserar på hur alkohol påverkar minnet generellt kan användas för att bedöma hur alkohol påverkar pålitligheten hos ögonvittnen. Till exempel kan det vara skrämmande och ångestframkallande att bevittna ett allvarligt brott och detta kan i sin tur påverka inkodningen och därmed också hur personen i

fråga minns händelsen (Chae, 2010; Penrod, Fulero, & Cutler, 1995). Det är viktigt att vi bättre förstår hur alkohol påverkar vittnens minne eftersom det i förlängningen kan vara värdefullt både för polisens utredningar och för förhandlingar i domstol.

Föreliggande avhandling består av tre experimentella studier, där respektive studie undersökte minnesförmågan hos ögonvittnen som varit alkoholpåverkade vid bevittnandet av ett iscensatt brott. Studierna baserades på deltagare från experiment som genomfördes i ett human experimentellt laboratorium vid Sahlgrenska universitetssjukhuset i Göteborg. Innan deltagare blev inkluderade i experimentet fick de genomgå en läkarundersökning samt en undersökning av deras mentala hälsa och endast de som hade en god fysisk och mental hälsa inkluderades i studierna. Deltagarna fördelades slumpmässigt till att antingen få dricka juice (kontrollgrupp), en lägre dos av alkohol (0.4 g/kg) eller en högre dos av alkohol (0.7 g/kg). I Studie I och Studie II användes de två olika doserna av alkohol, i Studie III användes endast den högre dosen. Deltagarna medverkade gruppvis i ett laboratorium som var inrett som ett vardagsrum. De hade 15 minuter på sig att konsumera sin dryck. Därefter fick de titta på en film som använts i tidigare vittnespsykologiska studier (t.ex. Allwood, Granhag, & Jonsson, 2006; Granhag, 1997). Filmen visade ett iscensatt brott där en kvinna kidnappas av två män. En vecka senare fick deltagarna genomföra en vittneskonfrontation (Studie I) och en intervju (Studie II), i nyktert tillstånd. Deltagarna i Studie III genomgick samma procedur, men nu blev hälften av deltagarna intervjuade omedelbart efter händelsen, d.v.s. när de fortfarande var under alkoholpåverkan. Alla deltagare i studien blev sedan intervjuade i nyktert tillstånd en vecka efter brottet.

Syftet med **Studie I** (N = 123) var att undersöka om alkohol påverkade vittnens förmåga att identifiera huvudgärningsmannen i en fotokonfrontation. Deltagarna fördelades över en kontrollgrupp (N = 41), en grupp med en lägre dos av alkohol (N = 42) och en grupp med en högre dos av alkohol (N = 40). Hälften av deltagarna i varje grupp fick se en fotokonfrontation där gärningsmannens foto var med (target-present). Resterande hälft fick se en konfrontation där gärningsmannens foto inte var med (target-absent). Resultaten visade att grad av alkoholpåverkan vid bevittnandet av brottet inte påverkade hur väl vittnena presterade i vittneskonfrontationen. Grupperna presterade generellt sett bättre än slumpen. Det betyder att de som fick se konfrontationen med gärningsmannens foto lyckades peka ut honom i en större utsträckning än vad slumpen gett. Deltagarna som fick ta del av en konfrontation där gärningsmannens foto inte fanns med var bättre på att avgöra att hans foto inte var där, jämfört med vad slumpen gett. Trots detta var det relativt få vittnen som lyckades fatta ett korrekt beslut vid vittneskonfrontationen, och då även de vittnen som varit nyktra när de bevittnade brottet. Resultaten visar

hur svårt det ibland kan vara för ögonvittnen att fatta ett korrekt beslut under ett konfrontationsförhör.

Studie II bestod av 126 deltagare, fördelade i en kontrollgrupp (N = 42), en grupp med en lägre dos av alkohol (N = 40), och en grupp med en högre dos av alkohol (N = 44). Syftet med studien var att undersöka hur alkohol påverkade vittnens minne. Minnesprestationen mättes genom att undersöka hur många detaljer (fullständighet) vittnena mindes från kidnappningen, samt hur korrekt deras berättelse var. Alla deltagare intervjuades en vecka efter händelsen i nyktert tillstånd. Intervjuerna transkriberades och kodades innan analyserna utfördes. Huvudfynden visade att det inte var någon skillnad i antalet berättade detaljer mellan de nyktra vittnena i kontrollgruppen och vittnena i gruppen med den högre dosen av alkohol, ej heller mellan kontrollgruppen och gruppen med lägre dos av alkohol. När man däremot jämförde de två alkoholdoserna mindes vittnena som fått den lägre dosen av alkohol signifikant fler detaljer än vittnen som fått den högre dosen av alkohol. När det gällde hur korrekta vittnena var i deras vittnesmål så var det ingen skillnad mellan de olika grupperna.

Studie III bestod av 99 deltagare som var fördelade över en kontrollgrupp (N = 48) och en grupp med en högre dos av alkohol (N = 51). Precis som i Studie II var syftet att undersöka hur alkohol påverkade vittnenas minne med avseende på fullständighet och korrekthet, dock var frågeställningen något mer specifik; *när* är det bäst att intervjua alkoholpåverkade vittnen? Studie III gick utöver Studie II genom att hälften av deltagarna intervjuades under alkoholpåverkan direkt efter brottet, samt att alla deltagare intervjuades i nyktert tillstånd en vecka senare. Intervjuerna transkriberades och kodades i syfte att beräkna antalet berättade detaljer och graden av korrekthet. Resultaten visade att de alkoholpåverkade vittnena var något mindre korrekta i sina utsagor, men de rapporterade samma mängd information som de nyktra vittnena. Även om de alkoholpåverkade vittnena var mindre korrekta så var de endast några procent mindre korrekta än de nyktra vittnena. Studien visade också att det var mer fördelaktigt, i termer av fullständighet och korrekthet, att intervjua vittnen två gånger (både vid en direkt och vid en uppföljande intervju) jämfört med att genomföra en direkt intervju eller endast en sen intervju. En direkt intervju var dock mer fördelaktig än en sen intervju.

Avhandlingen visar att alkohol hade olika effekt på hur vittnen presterade vid vittneskonfrontation och intervju. Alkohol hade inte någon negativ effekt på igenkänning, då både nyktra och alkoholpåverkade vittnen presterade på samma nivå i vittneskonfrontationen. Vittnena, som grupp, var dock relativt dåliga på att peka ut gärningsmannen i vittneskonfrontationen. Detta visar på att ansiktsigenkänning under en vittneskonfrontation kan vara en väldigt svår uppgift,

även för nyktra vittnen. Gällande hur vittnena presterade under intervju så visade studierna att det inte är någon skillnad i mängden rapporterade detaljer mellan vittnena i den nyktra kontrollgruppen och i gruppen med den högre alkohol dosen. När det gäller graden av korrekthet i vittnenas återgivning minskade alkohol inte graden av korrekthet i Studie II, medan Studie III fann att alkohol faktiskt minskade vittnenas korrekthet. Även om det var en signifikant skillnad mellan de nyktra och de alkoholpåverkade vittnena i Studie III, så var de alkoholpåverkade vittnena endast några procent mindre korrekta än de nyktra vittnena. Fler studier inom detta område behövs för att kunna utreda vidare hur alkohol påverkar ögonvittnens minne. Denna avhandling visar dock att alkoholpåverkade vittnen presterar på ungefär samma nivå som nyktra vittnen. Det är dock viktigt att påpeka att vittnena i avhandlingens studier hade en relativt låg till medel grad av berusning (under 1.0 i promille), vilket gör att avhandlingens resultat inte kan generaliseras till vittnen som har en högre promillehalt i blodet vid brottstillfället.

This thesis is dedicated to my late father.
In our memory, you will always live on.

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Preface

This thesis consists of a summary and the following three papers, which are referred to by their roman numerals:

I. Hagsand, A., Roos af Hjelmsäter, E., Granhag, P.A., Fahlke, C., & Söderpalm Gordh, A. (2013). Do sober eyewitnesses outperform alcohol intoxicated eyewitnesses in a lineup? *The European Journal of Psychology Applied to Legal Context, 5,* 23-47.

II. Hagsand, A., Roos af Hjelmsäter, E., Granhag, P.A., Fahlke, C., & Söderpalm Gordh, A. (2013). Bottled memories. On how alcohol affects eyewitness' recall. *Scandinavian Journal of Psychology*, *54*, 188-195. doi: 10.1111/sjop.12035

III. Hagsand, A., Roos af Hjelmsäter, E., Granhag, P.A., Fahlke, C., & Söderpalm Gordh, A. (2014). *Stumbling down memory lane: The advantages of interviewing witnesses while they are still under the influence of alcohol*. Manuscript submitted for publication.

Table of contents

Introduction

In the spring of 2010, several persons were stabbed at a private party in Sweden. Newspapers reported that the eyewitnesses were heavily intoxicated by alcohol. Due to the poor memories of the witnesses, the prosecutor was not able to gather enough information from the preliminary police investigation to establish a case. The prosecutor stated that a strong eyewitness testimony or a confession would be needed to reopen the preliminary police investigation (Johnsson, 2010; Jaslin, 2010). This case illustrates that alcohol may affect negatively eyewitness memory and result in unsolved crimes. The overarching aim of the present thesis is to examine how alcohol affects eyewitness memory.

Alcohol-intoxicated eyewitnesses may misremember, as can sober witnesses. In-depth DNA analyses have shown that several innocent persons have been imprisoned, sometimes partly due to erroneous eyewitness memory (Kassin & Gudjonsson, 2004). Studies have found that 75% of wrongful convictions may be due to faulty eyewitness memory (Wells & Olson, 2003). However, although eyewitness memory can be faulty, it is an important source of information in criminal cases (Granhag, Ask, & Mac Giolla, 2013). Indeed, for most criminal cases, eyewitnesses' testimonies are the sole source of evidence (Wells & Olson, 2003).

Alcohol-related crimes are common in western societies, and often the offender, the victim or an eyewitness is intoxicated at the time of the crime. A report estimated that in the UK, about half of all violent crimes are committed by alcohol-intoxicated individuals (Kershaw, Nicholas, & Walker, 2008). Furthermore, the Swedish Crime Prevention Council has estimated that 50%–70% of all violent crimes in Sweden involve alcohol (Eksten, 2007; Ekström, 2009). A particular problematic pattern of alcohol consumption is binge drinking, which is heavy alcohol consumption on a single occasion leading to high-level intoxication. More specific, a common definition of binge drinking involves the consumption of five or more drinks for men and four or more drinks for women on a single occasion, usually within a period of 2 hours. Binge drinking is associated with numerous adverse consequences, including impulsive behaviour, unplanned risky sexual behaviour, and impaired decision making (e.g., Townshend, Kambouropoulos, Griffin, Hunt, & Milani, 2014). Binge drinking is a common problem in many countries, for example in the US (e.g., Kuntsche, Rehm, & Gmel, 2004). The

frequency of binge drinking in Sweden has been increasing over the past decade (Tryggvesson, 2013). As a consequence of this, the rate of alcohol-related crimes is likely to increase in the future.

Although many offenders are intoxicated, less attention has been paid to the fact that many eyewitnesses are alcohol-intoxicated. One reason for this may be that researcher underestimate how often witnesses are intoxicated (Gudjonsson et al., 2004). However, the prevalence of alcohol-intoxicated eyewitnesses has been found to be high (Yuille, 1986). More recently, in a survey (Evans, Schreiber Compo, & Russano, 2009) conducted among police officers in the US, 75% of the officers reported that it was common or very common to have contact with alcohol-intoxicated witnesses. The police officers reported that alcohol-intoxicated eyewitnesses were most commonly encountered in conjunction with violent crimes, such as domestic disputes, fights, assaults, thefts, and disorderly conduct. The officers conducted interviews with witnesses more often than they conducted line-ups. Approximately 20% of the officers had conducted line-ups (approximately one a month) with intoxicated eyewitnesses. In contrast, interviews with intoxicated witnesses were conducted on average five times a week. The interview could take place directly at the crime scene when the witnesses were still intoxicated or later when the witnesses were in a sober state (Evans et al., 2009). A recent archival study from the US concluded that many witnesses in more serious criminal cases (rape, robbery and assault), also were under the influence of alcohol (Palmer, Flowe, Takarangi, & Humphries, 2013). In summary, research shows that alcohol-intoxicated witnesses are very common.

More research is needed to understand how alcohol affects eyewitness memory, both during interviews and line-ups. In the applied context, knowledge of how alcohol affects eyewitness memory may play a crucial role. It seems to be a common belief within the legal system (e.g., among mock jurors) that intoxicated eyewitnesses are less credible than sober witnesses (e.g., Michalec, 1990; Evans & Schreiber Compo, 2010; Palmer et al., 2013). Given the potentially serious ramifications for the criminal justice system, it is highly important to examine the validity of this belief.

The Present Thesis

The general aim of this thesis is to examine how alcohol affects eyewitness memory. The thesis consists of three studies with the following specific aims: 1) to examine how alcohol affects eyewitnesses' line-ups performance (Study I); 2) to

determine how alcohol affects the performances of eyewitnesses in interview settings (Study II); and 3), to elucidate the optimal timing for interviewing intoxicated eyewitnesses (Study III). The thesis is organized as follows. First, the current view of memory is presented. Second, key terms are defined and explained in relation to previous research. Third, a summary of the theoretical framework and the empirical findings on alcohol and memory is provided. Fourth, a summary of each of the three studies is presented. Fifth, the findings are discussed in the light of a theoretical framework and previous empirical work.

Memory

Models of Memory

Memory is crucial for everyday life, and it is a system that often functions well. For example, think of all the things that we actually do remember and that make our day run smoothly. Some theoretical frameworks are relevant to the present thesis. A structural model of memory is the classic modal model proposed by Atkinson and Shiffrin (1968), see Figure 1. In the modal model of memory, the first stage is the sensory register that registers the perceptual information (e.g., visual, auditory, haptic) from the outside environment. If the information does not receive attention it quickly fades away, whereas if it is given attention it can be transferred to the short-term store. According to the model, the short-term store is a buffer that can hold a limited number of items for a period that lasts some seconds to some minutes. Items that are rehearsed and elaborated can then be transferred to and consolidated in the long-term store (Atkinson & Shiffrin, 1968). Atkinson and Shiffrin (1968) assume that the short-term store is necessary for long-term learning. Thus, the information had to be *first* registered in the short-term store so as to be able to reach the long-term store. Over the years, researchers have been critical of this model, since studies have shown that patients with limited short-term memory capacity still can have an intact long-term memory (Baddeley, 2004). To resolve this discrepancy, Baddeley and Hitch developed a more complex model of the short-term memory with several components, and they termed this the 'working memory' (Baddeley, 2000; 2004).

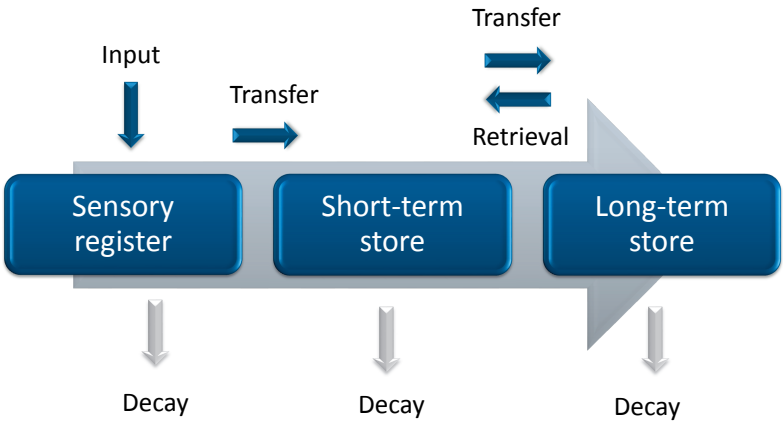

Figure 1. The modal model of memory.

A more process-oriented model, as opposed to the structural model of memory, is the levels-of-processing framework proposed by Craik and Lockhart (1972). This framework was developed to explain why even if information is present in the short-term memory it does not automatically become a long-lasting memory. Instead, this framework emphasises that the depth of processing that an item undergoes is an important factor in determining whether it will be transferred from the short-term memory to the long-term memory. It is now well-established that information that is elaborated and linked to prior knowledge is better remembered than information that is processed in a more superficial manner (Baddeley, 2004).

Episodic Memory

Currently, long-term memory is classified as either explicit (declarative) or implicit (non-declarative) memory. It is generally accepted that explicit memory consists of the sematic memory, which is involved in the remembering of facts, and the episodic memory, which is the memory dedicated to personally experienced events (Baddeley, 2004). The following quotation illustrates the characteristics of the episodic memory:

> Perhaps the most remarkable achievement of human memory is the ability to think back and relive happenings from the past. In the response to such a simple cue as, say, 'high school graduation night,' it is possible to mentally transport oneself back many years or decades and to re-experience parts of life that probably have not been considered in a long time. The type of memory that allows people to reflect upon personal experiences is called episodic memory. (Wheeler, 2000, pp. 597)

Thus, episodic memory is the capacity to recollect consciously personal events, and the essence of this memory is its specificity, i.e., its capacity to represent a specific event and to locate it in time and space. Furthermore, a distinction can be made between episodic memory and autobiographical memory. The term episodic memory can be limited to relatively recent recollective experiences, and the term autobiographical memory can be restricted to the long-term accumulation of personal knowledge (Baddeley, 2001). According to Conway's (2001) definition, episodic memory is the ability to recall in detail what happened a few minutes or a few hours ago. However, these memories may not persist unless some consolidation occurs during, for example, sleep. The autobiographical memory is a complex higher order of cognition and it serves many functions. The autobiographical memory plays an important role in the grounding of the self, of who we are. Autobiographical memories make it possible to remember clear images of life-time periods, such as what happened in high school. Lifetime periods are abstract mental models of the self during a special time period, and are defined by a theme, e.g., school, work, relationships. However, the autobiographical memory not only contains information about life-time periods, but also general events that contain information about other persons, activities, locations, and feelings that are related to more specific experiences. These memories can be of repeated events, e.g., 'walk in the fields', extended events, such as 'holiday in Australia', or more specific events, such as 'the job interview'. The general events can also be organised as 'mini-histories' around a common theme, such as learning to drive a boat, first romantic relationship, etc. The mini-histories can have a direct connection to a certain life-time period, such as, for example, high school (Conway, 2001).

Although it can be useful to distinguish between episodic memory and autobiographical memory, such a strict distinction also carries some disadvantages. The present thesis therefore uses the broader definition proposed by Gardiner (2001): "Episodic memory corresponded roughly with autobiographical memory, i.e., with memory for personally experienced events, remembered as such. Semantic memory corresponded roughly with knowledge of the world, without any

autobiographical content" (pp.11). Therefore, if one remembers a dinner in Paris last summer this can be categorised as episodic memory, and the knowledge that Paris is the capital of France is semantic memory (Gardiner, 2001). However, in real-life, there is often an interaction between the episodic memory and the semantic memory when one is remembering. Research has shown that pre-existing knowledge about something makes it easier to place the new information in context, which in turn increases the probability that this information will be remembered (Baddeley, 2004). For example, research has found that women sometimes outperform men with respect to the recall and recognition of other peoples' appearances. One explanation for this might be knowledge-based driven, in that women are more aware of, for example, fashion so they can categorise more readily information about another person's appearance into meaningful words, thereby facilitating subsequent retrieval (Horgan, Mast, Hall, & Carter, 2004).

As a person is witnessing a criminal event, the memories are stored in the episodic memory. Therefore, this is the system of most relevance for the present thesis. Some parts of the episodic memory are of special relevence for eyewitnesses' memory. As Pozzulo, Dempsey, Crescini, and Lemieux (2009) have explained, witnesses are often asked by law enforcement officers to describe what happened at the scene of the crime and to describe the appearance of the perpetrator(s). Sometimes, witnesses are also asked to identify the perpetrator in a line-up. Thus, witnesses may be asked to perform two separate tasks: 1) recall (describing the crime and perpetrator); and 2) recognition (identifying the perpetrator from a line-up). The processes of recall and recognition are elaborated upon in greater detail below.

Phases of Memory

It can be useful to separate any memory system into three phases; encoding, storage, and retrieval. Encoding refers to that information is registered. The information might then be stored in the memory, which means that the information is maintained over time. The information might subsequently be retrieved through for example recognition or recall (Baddeley, 2004). Factors can influence all stages of memory and affect how well the information will be remembered. Some types of memory failures is errors of omission (i.e., a memory fails to come to mind) and errors of commission (i.e., an incorrect memory comes to mind). It is well-known that memory errors can have severe consequences, both in everyday life and within

the legal system. A specific and very common memory failure is referred as the error of *transience*, which means that the memory is weakened or lost over time and can therefore be classified as an error of omission (Schacter, 2001).

The present thesis primarily focuses on how alcohol affects the encoding phase of episodic long-term memories (Studies I–III). In addition, in Study III, half of the witnesses were asked to recall the event in an immediate interview while they were still were under the influence of alcohol. Hence, this study focused also on how alcohol may affect the retrieval phase.

System and Estimator Variables

Much research has been conducted on factors that potentially affect the accuracy of eyewitness recognition and recall. It is common to categorise these factors into system and estimator variables. System variables are variables that can be controlled by representatives of the criminal justice system, for example, which instructions the police give to an eyewitness before a line-up or the types of questions posed to a witness during an interview (e.g., leading or non-leading questions). Knowledge of system variables informs the legal system on, for example, how to design fair line-ups and conduct productive interviews (Wells & Olson, 2003).

Estimator variables are variables that cannot be controlled or manipulated by representatives of the criminal justice system, such as characteristics of the eyewitness (e.g., age or sex) (Wells & Olson, 2003). Importantly, the level of alcohol intoxication of eyewitnesses is an estimator variable (Evans et al., 2009; Malpass et al., 2008). Other estimator variables are characteristic of the criminal event (e.g., exposure time, lighting, distance) (Wells & Olson, 2003). For example, an eyewitness might just get a glimpse of the culprit's face or might be standing facing the perpetrator for a rather long time. As could be expected, eyewitnesses who have been exposed to a perpetrator's face for only a few seconds have greater difficulty with identifying the perpetrator later (e.g., Memon, Hope, & Bull, 2003). Knowledge about how different estimator variables affect eyewitness memory is important, since it can be helpful in assessing the amount and accuracy of the information that an eyewitness can remember from a particular crime scene (Wells & Olson, 2003).

Recall and Recognition

As described above, the eyewitnesses could be asked to perform two different memory retrieval tasks: recall (interview), and recognition (line-up). The recall task might be to describe the culprit's appearance, clothes, and actions, as well to describe what happened at the scene of the crime. It can be difficult for a witness to describe the appearance of a culprit in a way that enables the police to identify that person. For example, the description "male, dark hair, black clothes, glasses, average weight and height" fits many males in the population (Wells, 1993). The researcher Alan Baddeley offers a neat illustration of the difficulties associated with recalling a person's features, which have been encoded visually. Baddeley (2002) states that "verbal descriptions are likely to be of very limited value. Try, for example, to describe yourself in such a way that a stranger would recognize you" (pp. 18). While descriptions of the culprit can be accurate, it is often the case that very few details are reported that are helpful to the police (Fahsing, Ask, & Granhag, 2004). Nevertheless, recall is important because it can provide the police with information about what happened during the crime. The recall task is also fundamental to gaining information about the culprit's appearance, which is essential in composing a fair identification line-up (Evans et al., 2009).

The recognition task is to identify the culprit in a line-up (see for example: Pozzulo et al., 2009). The recognition task is important because information that reaches beyond the interview can be obtained. Thus, while it can be difficult to describe a culprit in words, that culprit might instead be identified in a line-up (Wells, 1993). The recognition task is an additional and important element to the interview, although interviews are used much more often than line-ups (Evans et al., 2009).

It has been argued that recall and recognition are two different types of processes (Pozzulo et al., 2009). The type of information that is processed during recall is mostly dependent upon internal stimuli, such as eyewitnesses' knowledge about what happened at the scene of the crime. Recognition relies more on external stimuli, such as vision. Recognition is based on a feeling or sense of familiarity with respect to one of the presented alternatives, for example to one member of a line-up (Robinson, Johnson, & Robertson, 2000). Pozzulo et al. (2009) found no significant association between a line-up decision and the amount of information recalled during an interview. Thus, if a witness performs poorly (or well) in one of the two memory tasks, this result cannot be used to predict that that witness will also perform poorly (or well) in the other task (Pozzulo et al., 2009). Importantly, if the conditions at the scene of the crime are favourable (e.g., adequate lighting, short

viewing distance, long exposure time), high-quality encoding is possible, with the result that the witness may perform well in both a line-up and an interview (Yarmey, 2004).

Interviews

When witnesses are asked in an interview to tell about an experienced event, the memory task in question is recall. With intoxicated witnesses, investigators may have the possibility to decide when to conduct the interview. In this respect, some of the available options are: a) interview the witness immediately, while he or she is still intoxicated; b) delay the interview until the witness is sober; and c) conduct both an immediate and a delayed interview. A survey reported by Evans et al. (2009) showed that it was about equally common to have an immediate interview (while the witness was still intoxicated), as to delay the interview until the witness was in a sober state. In a study that investigated cases of rape, robbery, and assault, interviewing the witnesses on the same day as the crime took place was the most common practice. This was the procedure used both for sober and intoxicated witnesses, and the police did not seem to delay deliberately interviews with intoxicated witnesses or use different information-gathering techniques when dealing with those witnesses (Palmer et al., 2013). Furthermore, police officers seem to hold the belief that intoxicated witnesses should be interviewed repeatedly (Evans et al., 2009).

Research has shown that immediate recall retards the process of forgetting, both in standard memory tests (e.g., Odinot & Wolters, 2006; Yuille, 1973), and among alcohol-intoxicated witnesses (Yuille & Tollestrup, 1990). When new details are recalled at a follow-up interview, reminiscence has occurred. In a follow-up interview, it is possible that the witnesses recall most of the things reported during the immediate interview, plus some extra new details (Gilbert & Fisher, 2006). The obvious downside of a delayed interview is that is likely that the witnesses have forgotten information, since more time has passed since the event (e.g., Baddeley, 1991). Another downside of a delayed interview is that social influences during the retention interval may affect the witness (Granhag, Memon, & Roos af Hjelmsäter, 2010; Read & Connolly, 2007). While memory research suggests that an immediate interview is beneficial, it is not known whether this is also true for alcohol-intoxicated witnesses. Only one previous study (Yuille & Tollestrup, 1990) has investigated the effects of timing of the interview (immediate versus delayed) and

recall trial (first or second recall). That study showed that alcohol reduced both the completeness and accuracy of the witnesses' testimonies. Among the witnesses who were interviewed twice, regardless of intoxication level, the amount of reported information was greater in the delayed recall than in the immediate recall. This suggests that reminiscences occurred. When the delayed interview was the second recall trial, the completeness of the statements was higher than for participants for whom the delayed interview was the first recall trial (Yuille & Tollestrup, 1990).

Face Recognition

Facial recognition is crucial in human social life. By viewing a face, we are not only able to conclude whether the person in front of us is a friend, a stranger or an enemy but we are also able to receive information about the person's age, gender, health, mood, etc. Some individuals experience difficulties in recognising faces, and sometimes this is a sign of prosopagnosia. Prosopagnosia is a selective recognition deficit, whereby the individual has lost the ability to recognise faces, while the ability to identify other objects remains intact (Grüter, Grüter, & Carbon, 2008). Approximately 2.5% of the Caucasian population has prosopagnosia from birth. Thus, the prevalence of prosopagnosia is on the same level as that of dyslexia (Grüter et al., 2008; Kennerknecht et al., 2006), which means that prosopagnosia is a relatively common deficit.

Even without prosopagnosia, recognising faces that have been viewed for only a short period of time is very difficult. It is especially difficult when conditions, such as viewpoint, lighting, facial expression, and appearance, vary from the first time of seeing the person (the encoding phase) to the recognition task (retrieval phase). Humans are experts in recognising familiar and known faces. Familiar faces can be recognised even under poor viewing conditions (Hancock, Bruce, & Burton, 2000; Johnston & Edmonds, 2009). To identify a person, the brain has to activate information stored in the semantic and episodic memory, which includes who this person is, where he or she was seen previously, and if the name is known. As there are more clues and information about a familiar face, these activate more stored information and the face is therefore more easily recognised. In the case of a rather unfamiliar face, perhaps one that has been encountered only once previously, there are fewer clues, so the identification is more difficult (Leveroni et al., 2000). Researchers and practitioners should be aware that recognising unfamiliar faces is

difficult, as it may lead to inaccurate eyewitness identifications. Therefore, the recommendation is not to base the conviction of a suspect exclusively on eyewitness identification (Baddeley, 2002).

Line-Ups

A line-up is a parade (through photographs, and video or live) of the suspect together with other individuals (foils). This parade is shown to the witness so that he or she can confirm or not confirm the police's hypothesis that a particular suspect is the actual culprit (Wells & Olson, 2003). In real-life situations, the police do not know if the suspect is the real culprit or not. In order to reflect this, laboratory studies usually composite line-ups with the known culprit among innocent foils (target-present line-up) or with an innocent replacement person among innocent foils (target-absent line-up) (Brewer & Palmer, 2010; Wells & Olson, 2003). The witness can make a correct or an incorrect line-up decision. In a target-present line-up, the identification of the culprit is a correct decision. The identification of a foil or a rejection (*not there* response) is incorrect. In a target-absent line-up, rejection is correct, whereas identifications of the culprit's replacement or foil are incorrect decisions (Cutler & Kovera, 2010). In contrast to laboratory-based experiments, the problem in real-life is that the police do not know if they have composed a target-present or a target-absent line-up, that is, they do not know whether their suspect is the true culprit.

There are large differences in eyewitnesses' line-up performances across different studies. In general, research has showed that identification performance is rather poor, although the range of values is wide. Two meta-analyses have found that in target-present line-ups, the accuracy rate is usually around 50% (Steblay, Dysart, Fulero, & Lindsay, 2001; Steblay, Dysart, & Wells, 2011), although it ranges from 25% (e.g., Brewer, Weber, Clark, & Wells, 2008) to 90% (e.g., Yuille & Tollestrup, 1990). For target-absent line-ups, meta-analyses have shown that the rate of correct rejection tends to be 43%–49% (Steblay et al., 2001, 2011), although the performance range is again very wide (Pozzulo et al., 2009). A meta-analysis has shown that a high number of witnesses fail to identify the culprit if the culprit's face and appearance have changed, even just a little, from the time of encoding (Shapiro & Penrod, 1986). This implies that the chance of being able to recognise a face increases if the difference in the physical appearance is small between the time-point at which the person was first seen and the time-point of the recognition

task (Longmore, Liu, & Young, 2008). In addition, the characteristics of an eyewitness' testimony that can be used to determine if the witness made accurate or incorrect line-up identification have been investigated. Most of this research has examined the association between eyewitness confidence that the line-up choice made is correct and the actual line-up performance. However, there are discrepant results concerning the confidence-accuracy relationship (Wells & Olson, 2003). Studies have found that witnesses who are confident in their line-up decision also make more accurate identifications of the culprit (e.g., Brewer, Keast, & Rishworth, 2002; Brewer & Wells, 2006; Brewer et al., 2008; Lindsay, Nilsen, & Read, 2000), while other studies have not found this to be the case (see; Wells & Olson, 2003). Recent research suggests that accurate eyewitness identifications may be screened out by examining witnesses who both have a high level of confidence and make their line-up decision rapidly (e.g., Brewer et al., 2008).

Line-Up Composition and System Variables

In this section, some system variables that have been found to affect eyewitnesses' performances in line-ups will be discussed. Studies have found that before an eyewitness is presented with a line-up, it is beneficial to inform the eyewitness that the culprit may or may not be present. This reduces the rate of wrongful identifications, which is important since a mistaken identification can cause an innocent person to be charged or convicted (e.g., Steblay, 1997).

A line-up may be unfair if the suspect is very different in appearance from the foils (e.g., the suspect has blond hair and glasses, while the foils have brown hair and no glasses). This might lead to the suspect being selected just because he or she stands out, and not as an outcome of the witnesses' memory. On the other hand, if the suspect appears to be too similar to the foils, identification will be very difficult. In those cases in which the suspect is the real culprit, the line-up can be perceived as being unfair, since there is an increased risk that the culprit will not be identified. Choosing foils can be accomplished by at least two different methods. One method is matching by physical similarity. Matching foils on the basis of physical similarity to the suspect is a method that is more likely to be influenced by the persons who are composing the line-up. Such matching can lead to the suspect being too similar in appearance to the foils, which may make it too difficult for the witness to distinguish the culprit. An alternative method is to match the foils to the

verbal description of the culprit provided by the witness, which may create a fairer line-up (Brewer & Palmer, 2010; Wells et al., 2000; Wells & Olson, 2003).

A line-up can be presented to the witness in a simultaneous or sequential manner or through a show-up procedure. A show-up consists of a single person or photograph. A simultaneous line-up is when all the line-up members are presented simultaneous to the witness. When the line-up members are presented simultaneously, witnesses tend to use relative-judgment decisions and are more likely to choose the person who most closely matches their memory of the culprit. However, the real culprit may not be in the line-up, and the witness might than identify an innocent suspect or foil. In a sequential line-up, the line-up members are presented in a sequential manner to the witness. Witnesses may then use an absolute-judgment decision process in which they matching each face separately to their memory of the culprit. Thus, the risk of choosing an innocent suspect or foil is reduced (Wells & Olson, 2003). Meta-analyses have shown that sequential line-ups reduce the rate of mistaken identifications in target-absent line-ups, although they also reduce the rate of correct identifications in target-present line-ups (Steblay et al., 2001, 2011). The question as to which line-up method is optimal has become a matter for debate among psycho-legal scholars (see Lindsay, Mansour, Beaudry, Leach, & Bertrand, 2009a, 2009b; Malpass, Tredoux, & McQuiston-Surrett, 2009). Although the sequential line-up may appear to be superior, some researchers also acknowledge the benefits of simultaneous line-ups. The advantage of a reduction in the rate of false identifications in the sequential line-up is not necessarily more important than an increase in the rate of correct identifications found in simultaneous line-ups (Malpass et al., 2009; McQuiston-Surrett, Malpass, & Tredoux, 2006). Some researchers argue that a new approach should be adopted. Instead of the witness giving a *yes* or *no* response to each photograph, the witness should rate the likelihood that each person in the line-up is the culprit. The downside to this approach is that a court of law usually requires a definitive line-up decision from the witness (Brewer & Palmer, 2010).

Another factor that may influence the identification performances of witnesses is the number of foils used. Although a show-up is commonly used by the police, it is regarded as a suggestive method by researchers in the field. The absence of foils results in more false identifications of innocent persons, as compared with a sequential or simultaneous line-up (Brewer & Palmer, 2010). In a standard line-up that is composed on the basis of fairness, the chance that an innocent suspect will resemble the actual culprit more than the other foils is 1/N, where N is the number of line-up members. Thus, the chance that an innocent suspect is identified in an eight-person line-up is simply 1/8 (12.50%). In contrast, the chance of identifying an innocent suspect in a two-person line-up is 1/2 (50%). The Swedish Police states

in their official guidelines that the number of foils should be at least 6 persons, but preferably 8–10 persons (Rikspolisstyrelsen, 2005).

The choice that an eyewitness makes in a line-up situation depends on the match between the line-up members and the memory that the witness has of the culprit. This match must pass the witness' own identification criteria, which determine the willingness to identify an individual in the line-up (Clark, 2003). In many cases, the witness is not completely certain whether his or her line-up decision is correct, and may state this. A limitation in most of the previous studies on this topic is that the witness has been forced to give a definite answer, i.e., either make an identification or reject the line-up. Recent research has shown that it is beneficial to include a *not-sure* response option (Steblay & Phillips, 2011). Providing the witnesses with this option might improve line-up accuracy by screening out those witnesses who are not certain regarding their decisions (Weber & Perfect, 2011). If an eyewitness has a *good* memory of the culprit, he or she may still hesitate in choosing one of the line-up members. This might be because the culprit's appearance has changed or because the witness has a high identification criterion (low willingness to make an identification). If a witness with a *poor* memory and a high identification criterion is presented with a line-up, the witness has the opportunity to choose the *not-sure* response, instead of a definitive *yes* or *no* response. A witness with a *poor* memory but a low identification criterion (high willingness to make an identification) would probably give an definitive *yes* response if only presented with the dichotomous response options (*yes* or *no*). It is easy to see the benefits of offering a *not-sure* response, even for this witness. In brief, adding a *not-sure* response may result in less incorrect identification of foils and less correct identification that are arrived at by guessing. Furthermore, a study conducted by Weber and Perfect (2011) showed that 19% of the participants gave a *not-sure* response when this alternative was offered, whereas only 2% of the participants came up with this response on their own when the *not-sure* option was not explicitly offered. The use of a *not-sure* response option seems to be spreading to police practices in, for example, the USA (Steblay & Phillips, 2011), and is an element that is adapted in the present work.

Furthermore, research has shown the importance of adapting a double-blind testing procedure. That is, the administrator is blinded as to which person in the line-up is the suspect. This is important, as otherwise the administrator might consciously or unconsciously influence the line-up decision of the witness (Wells & Olson, 2003). All of the described system variables were taken in consideration when composing the line-up experiments in the present thesis.

Sex Differences as an Estimator Variable

The most important estimator variable for this thesis is the level of alcohol intoxication when witnessing a crime. However, the sex of the witnesses is also an estimator variable which may affect the memory performance. One meta-analysis has shown that males and females perform at the same level in facial identification tasks (Shapiro & Penrod, 1986). However, a separate meta-analysis has revealed that women outperform men in facial identification tasks (Hall, 1984). In recent years, more studies have appeared that demonstrate that women outperform men, both in person identification tasks (e.g., Casiere & Ashton, 1996; Lindholm & Christianson, 1998) and in general face recognition (e.g., Herlitz, Nilsson, & Backman, 1997; Rehnman & Herlitz, 2007). It seems that women outperform men to an even greater extent if the target face is another woman (Lovén, Herlitz, & Rehnman, 2011; Lovén et al., 2012). Furthermore, a recent study has shown that women are more accurate than men in descriptions of persons (Areh, 2011). This might be explained by the fact that women tend to be superior to men in verbal ability, which enhances the recall (Herlitz & Rehnman, 2008). A meta-analysis has suggested that women are not only better at recognising faces, but also in recalling details about faces during an interview (Horgan et al., 2004). Usually, women have a greater tendency than men to be concerned about their own physical appearance and the appearances of others. In brief, women's comparatively better performance might be due to the fact that they encode information in larger amounts and with more detail. The female advantage could also be knowledge-based driven, since women may have more labels for physical appearance and hence are better at categorising this information into meaningful and easily accessed pieces (e.g., light brown-golden colour, Hollywood curls, and long hair with a diadem). Moreover, it has been found that it is easier for both females and males to recall women's appearances than men's appearances (e.g., Horgan et al., 2004). A possible explanation for this is that women's physical appearances are often richer in details, i.e., hairstyle, fashion clothes, jewellery, and accessories (Horgan et al., 2004). It is worth noting that although sex differences in episodic memory may be attributable to social and cultural factors, researchers have also suggested that a more biological explanation has validity. For example, sex hormones may be part of the explanation for the observed differences in episodic memory between men and women, whereby the female hormone oestrogen may have a stimulating effect (Yonker, Eriksson, Nilsson, & Herlitz, 2003).

Research suggests that alcohol influences men and women in different ways. Women sometimes reach higher blood alcohol concentrations, even when they

consume the same amount of alcohol as men of similar body weight. This can be explained by the fact that women generally have lower water content of the body (Graham, Wilsnack, Dawson, & Vogeltanz, 1998). Women can be more cognitively impaired by alcohol, especially with regard to tasks that involve memory and divided attention (Mumenthaler, Taylor, O'Hara, & Yesavage, 1999; Tucker, Vuchinich, & Schonhaut, 1987). Women may also be more at risk of experiencing memory loss, including grayouts and blackouts (Rose & Grant, 2010). In contrast, one study found that moderate alcohol consumption could enhance cognitive functions, such as the episodic memory in women (Yonker, Nilsson, Herlitz, & Anthenelli, 2005).

Despite the above, it is not known whether alcohol influences women's and men's *eyewitness memory* differently. Studies of intoxicated eyewitnesses have not found any clear sex differences (Dysart, Lindsay, MacDonald, & Wicke, 2002), or they have not examined the matter at all (e.g., Harvey, Kneller, & Campbell, 2013a; King, 2005; Michalec, 1990; Schreiber Compo, Evans, Carol, Villalba, et al., 2011; Schreiber Compo, Evans, Kemp, et al., 2011; van Oorsouw & Merckelbach, 2012; Yuille & Tollestrup, 1990). The present thesis seeks to address the current scarcity of knowledge concerning how alcohol affects men and women as eyewitnesses. Further on, the next section focuses on the most important estimator variable for this thesis, namely alcohol.

Alcohol

Measurements

To measure how much alcohol an individual consumes, a measurement termed the *standard glass* is used in alcohol research. This measurement is also used by the healthcare authorities in several countries to estimate an individual's alcohol intake (Nilsen, Holmqvist, Hultgren, Bendtsen, & Cedergren, 2008). In the USA, the definition of a standard drink is 14 g pure ethanol, while it is lower both in the UK (8–10 g) and Australia (10 g) (Kerr, Patterson, Koenen, & Greenfield, 2009). In Sweden, a standard glass is equivalent of 12 g pure ethanol, which is the amount of alcohol that is normally found in a glass of wine (12–15 cl, approximately 11%–13%), a bottle of strong beer (33 cl, approximately 5%) or a shot of alcohol (4 cl, approximately 40%). The definition of standard glasses used in the present thesis is

taken from the Swedish version (Bergman, 1994) of the well-known screening instrument for hazardous alcohol intake, the Alcohol Use Disorder Identification Test (AUDIT) (Babor, Higgins- Biddle, Saunders, & Monteiro, 2001).

Even if the same amount of alcohol is consumed, individuals may exhibit different behavioural changes, and also may differ with respect to the subjective experience of alcohol intoxication (Holdstock & de Wit, 1998). Furthermore, it is not possible to know if two persons who consume the same amount of alcohol will reach the same objective level of alcohol intoxication. This variation can be due to age, sex, presence or absence of food in the stomach, mental and physical health, genetic factors, and tolerance to and previous experience with alcohol (e.g., Lee et al., 2009; Paton, 2005). Therefore, the level of intoxication is most commonly assessed by measuring the blood alcohol concentration (BAC). This is the measure used when drivers are stopped by the police and asked to exhale into a portable device, a Breathalyzer. In Sweden, the drink and drive limit is a BAC of 0.02%, whereas in some other countries the drink and drive limit is higher. For example, in some European countries and in some states in the US, the drink and drive limit is a BAC of 0.08%. As an important clarification for understanding this thesis; some countries uses BAC (%) as unit for the level of intoxication, while some other countries (including Sweden) uses per mille (‰). However, it is easy to understand the two units as a BAC of 0.02% is equivalent to 0.20 ‰, a BAC of 0.10% is equivalent to 1.00‰ etc.

Short-Term Effects of Alcohol Consumption

Alcohol is a substance that has both short-term and long-term effects on human physical and psychological functions. Alcohol has been considered as the most harmful of all drugs in a recent investigation, taking in account the harm it can inflict on both the individual and others (Nutt et al., 2010). That alcohol accounts for approximately 4% of the global health burden illustrates the negative long-term effects of the substance (Lee et al., 2009). However, in the present thesis, the focus is on the short-term effects of alcohol, more specific; the acute effect of alcohol on the episodic memory. When a person consumes alcohol, the BAC level rises, which results in behavioural changes (see Table 1). The behavioural changes listed in Table 1 relate to how healthy non-dependent individuals may respond to different BACs.

Alcohol is a drug which produces opposite effects. Consumers of the drug can experience both stimulant effects (e.g. increased heart rate, talkative) and sedative effects (e.g. slowness, fatigue). For example, experience of stimulation by dopamine release in the brain as well as sedation in form of anxiolytic effects is an explanation to why consumers of alcohol experiences positive effects, and also continues to use the drug (Hendler, Ramchandani, Gilman, & Hommer, 2013).

Table 1
Short-Term Effects of Alcohol on Human Behaviours

Blood alcohol concentration	Manifestations
<0.05 %	• Talkative • Relaxed • More confident
0.05%–0.08 %	• Talkative • Acts and feels self-confident • Judgment and movement impaired • Inhibitions reduced
0.08%–0.15 %	• Speech slurred • Balance and co-ordination impaired • Reflexes slowed • Visual attention impaired • Unstable emotions • Nausea, vomiting
0.15%–0.30 %	• Unable to walk without help • Apathetic, sleepy • Laboured breathing • Unable to remember events • Loss of bladder control • Possible loss of consciousness
>0.30-0.40 %	• Coma • Death

Note. Table adapted from Government of South Australia (2012).

Alcohol-Induced Amnesia

Alcohol may affect the encoding, storage, and retrieval phases of memory. Importantly, a review of laboratory studies has shown that alcohol intoxication affects the encoding process of episodic memory to a far greater extent than it does the retrieval process (Mintzer, 2007). Both non-dependent individuals and alcohol-dependent individuals may experience complete or partial memory loss if binge drinking or heavy consumption of alcohol occurs *before* encoding; this is a sign of anterograde alcohol-induced amnesia (White, 2003). A large body of research indicates that alcohol consumed before encoding impairs memory (e.g., Bisby, Leitz, Morgan, & Curran, 2010; Brown, Brignell, Dhiman, Curran, & Kamboj, 2010; White, 2003). Researchers agree that acute alcohol consumption disturbs cellular activity in the brain (White, 2003; White, Matthews, & Best, 2000), affecting primarily the hippocampus (White et al., 2000). This may have serious consequences, since the hippocampus plays a central role in the formation of new autobiographical memories (White, 2003). However, alcohol consumed *after* encoding may *enhance* memory performance, which is known as the retrograde enhancement effect (e.g., Bruce & Phil, 1997; Knowles, 2004; Tyson & Schirmuly, 1994). This enhancing effect might be explained by that alcohol intoxication can leads to a decrease in retroactive interference (Mann, Cho-Young, & Vogel-Sprott, 1984). Thus, alcohol suppresses cognitive activity, which otherwise would have interfered with the storage and formation of new memories (Moulton et al., 2005). Alcohol's retrograde enhancement effect and anterograde impairment effect have been found in several studies (e.g., Bruce & Phil, 1997; Garfinkel, Dienes, & Duka, 2006; Knowles & Duka, 2004). The focus of this thesis is anterograde alcohol-induced amnesia, i.e., how alcohol consumption before encoding affects eyewitnesses' memory.

The memory loss linked to alcohol-induced amnesia can either be total, as in blackouts, or more commonly, fragmentary, as in the case of grayouts (Lee et al., 2009). Blackouts and grayouts occur in both alcohol-dependent individuals and social drinkers. As many as four out of five students have experienced grayouts (White, 2003). Although the probability of experiencing blackouts or grayouts is higher with higher intoxication levels (Perry et al., 2006), they can occur already at BACs of 0.06%–0.08% (Wetherill & Fromme, 2011). In addition, minor memory impairments can occur after consumption of a relatively small amount of alcohol. It should however be noted that alcohol does not seem to have a negative impact on memory at relatively low doses, with a BAC of around 0.03% (e.g., Breitmeier, Seeland-Schulze, Hecker, & Schneider, 2007). Thus, higher doses of alcohol have

serious deleterious impacts on memory (e.g., Söderlund, Parker, Schwartz, & Tulving, 2005; White, 2003).

Individuals who experience memory failures may try to fill in the gaps. Memory failure is quite common among consumers of alcohol, and sufferers often tend to reconstruct the past. Since they may not have any memory (as in the case of blackouts) or a very fragmentary memory (as in the case of grayouts), these individuals cannot use internal cues (e.g., sensory and contextual details) to decide if the memory is true or false. Instead, they have to rely on external sources (e.g., gather information from friends, photographic or physical evidence). The desire to fill in the gaps can lead these persons to trust rather unreliable sources. In turn, this can lead to the creation of false beliefs and inaccurate memories (Nash & Takarangi, 2011). This may be one explanation for why alcohol in some studies, for example in the studies conducted by Read, Yuille and Tollestrup (1992) and Yuille and Tollestrup (1990), has been found to decrease the levels of accuracy of eyewitnesses' recollections.

Importantly, the effect of alcohol on memory depends on several factors, such as which task is being performed (e.g., recall or recognition), which memory system is involved (e.g., the episodic or the semantic memory), and whether the BAC is increasing or decreasing (Söderlund et al., 2005). For example, alcohol is more likely to affect explicit (conscious) memory than implicit (unconscious) memory (Lister, Gorenstein, Fisher-Flowers, Weingartner, & Eckardt, 1991; Ray, Bates, & Ely, 2004). The way in which alcohol affects semantic memory, such as the remembering of word lists (e.g., Tracy & Bates, 1999) may not be the same as the way it affects the episodic memory of a crime (Evans et al., 2009). The effect of alcohol is also moderated by individual differences. For example, not all individuals who rapidly consume a large amount of alcohol experience an alcohol-induced blackout. This might be due to variations in genetic factors that affect the central nervous system (Lee et al., 2009). It is difficult to predict which individuals will experience alcohol-induced blackouts and grayouts, as well as to predict the time-points at which memory impairments will occur within the same person (Knowles, 2005).

Furthermore, the expectancy effects of alcohol have been shown to moderate memory performance. It has been found that when placebo groups believe that alcohol will enhance their memory, they remember more than the control group and more than participants who believe that alcohol will impair their memory (Kvavilashvili & Ellis, 1999; van Oorsouw & Merckelbach, 2007). Importantly, for the present studies, we decided not to include a placebo group, since it would have low relevance in the context of intoxicated eyewitnesses. In real-life situations, eyewitnesses would know whether or not they have consumed alcohol.

Alcohol and Eyewitness Interview Studies

The methods used for studying the effects of alcohol on recall with legal relevance can be summarised as follows. Participants consume alcohol, either self-administrated in a bar (e.g., van Oorsouw & Merckelbach, 2012) or administered at different dosages in a laboratory setting (e.g., Schreiber Compo, Evans, Kemp, et al., 2011; Yuille & Tollestrup, 1990). The BAC was usually ≤0.10%. A crime takes place, either staged live (Schreiber Compo, Evans, Carol, Villalba, et al., 2011; Yuille & Tollestrup, 1990) or on film (van Oorsouw & Merckelbach, 2012). The participants view the crime, from an eyewitness perspective (Schreiber Compo, Evans, Carol, Villalba, et al., 2011; Yuille & Tollestrup, 1990) or perpetrator perspective (van Oorsouw & Merckelbach, 2012; Read et al., 1992), or they witness an interaction (Schreiber Compo, Evans, Kemp, et al., 2011). The participants perform a recall task that is open-ended (Yuille & Tollestrup, 1990), free and cued recall (van Oorsouw & Merckelbach, 2012), or written free recall (Schreiber Compo, Evans, Kemp, et al., 2011). The recall task is conducted either immediately (Schreiber Compo, Evans, Kemp, et al., 2011; Schreiber Compo, Evans, Carol, Villalba, et al., 2011), with a delay of some days (van Oorsouw & Merckelbach, 2012) or both immediately and with one week delay (Yuille & Tollestrup, 1990).

The results obtained from previous research efforts are mixed. Alcohol has found to decrease the amount of information recalled (e.g., van Oorsouw and Merckelbach, 2012; Yuille & Tollestrup, 1990), although there are also studies that show no effect of alcohol on the overall completeness of statements (Schreiber Compo, Evans, Kemp, et al., 2011). Concerning accuracy rates, studies have found that alcohol reduces the accuracy of the statements (Read et al., 1992; Yuille & Tollestrup, 1990), although there are exceptions to this (Schreiber Compo, Evans, Carol, Villalba, et al., 2011). In addition, one study has found that alcohol reduces the accuracy of cued recall, but not that of free recall (van Oorsouw & Merckelbach, 2012). This might be explained by the theoretical framework offered by Koriat and Goldsmith (1996), which suggests that when individuals have the opportunity to decide which information to report, as in free recall, they may choose to report only those pieces of information that they are certain about, resulting in a rather high accuracy level. However, if these individuals are forced to cued questions, they may report the details they are not very certain about, which could may reduce the level of accuracy. This theoretical framework has found empirical support in several studies (e.g., Koriat & Goldsmith, 1996; Koriat, Goldsmith, Schneider, & Nakash-Dura, 2001).

Alcohol and Eyewitness Line-Up Studies

There have been few studies conducted on the effects of alcohol on eyewitnesses' line-up performances. The method used to examine how alcohol affects memory in a legal context and the findings from the previous studies can be summarised as follows. The studies have included either exclusively male participants (King, 2005; Michalec, 1990; Yuille & Tollestrup, 1990) or both female and male participants (Dysart et al., 2002; Harvey et al., 2013a). Alcohol was administered in a laboratory and in the majority of the studies the BAC had reached approximately 0.05%–0.12% by the time of the witness event (Harvey et al., 2013a; King, 2005; Michalec, 1990; Yuille & Tollestrup, 1990). The exception to this is one study that was conducted in a bar and in which the intoxication level was much higher than in the other studies, being in the range of 0.00%–0.21%, although the mean BAC was 0.05% (Dysart et al., 2002). After alcohol consumption, the event shown involves either criminal (Harvey et al., 2013a; Yuille & Tollestrup, 1990) or non-criminal (Dysart et al., 2002; King, 2005; Michalec, 1990) activities. The retention interval was a few minutes (Dysart et al., 2002), one hour (King, 2005), one day (Harvey et al., 2013a), two days (Michalec, 1990), or one week (Yuille & Tollestrup, 1990). All the studies used line-ups under both target-present and target-absent conditions; some line-ups were simultaneous (Harvey et al., 2013a; Michalec, 1990; Yuille & Tollestrup, 1990), either simultaneous or sequential (King, 2005), or a show-up (Dysart et al., 2002). The results obtained were mixed. Some studies found no effect of alcohol intoxication on identification accuracy, neither under the target-present condition nor under the target-absent condition (Harvey et al., 2013a; Yuille & Tollestrup, 1990). Other studies found that alcohol reduced the accuracy of the witnesses' identifications but only under the target-present condition (Michalec, 1990) or the target-absent condition (Dysart et al., 2002; King, 2005). The discrepancies in the results might be explained by the different methods used. For example, differences in the witnesses' BACs, stimuli, retention intervals, and line-up composition. The set-ups used in the previous studies in this domain influenced the method for the line-up study (Study I) in the present thesis, and this will be further discussed below.

Theoretical Approach

The Alcohol Myopia Theory

Myopia is the medical term for the eye disorder of near-sightedness. Individuals with this impairment can see close and central objects clearly, whereas objects that are located further away appear blurred (Douglas, 2002). The alcohol myopia theory suggests that alcohol-intoxicated individuals are in a state of myopia and primarily encode the most central stimuli and fewer peripheral details. Intoxicated individuals are cognitively impaired by alcohol and cannot pay attention to as many stimuli as sober individuals. According to the theory, a comparatively smaller amount of information will therefore be encoded by intoxicated individuals (Josephs & Steele, 1990; Steele & Josephs, 1990). Several studies, not directly related to the eyewitness field, support the alcohol myopia theory (e.g., Clifasefi, Takarangi, & Bergman, 2006; Harvey, Kneller, Campbell, 2013b; MacDonald, MacDonald, Zanna, & Fong, 2000).

In the case of eyewitnesses and line-ups, some researchers have tried to apply the alcohol myopia theory to intoxicated eyewitnesses (e.g., Dysart et al., 2002; Harvey et al., 2013a; Schreiber Compo, Evans, Carol, Villalba, et al., 2011; Schreiber Compo, Evans, Kemp, et al., 2011; van Oorsouw and Merckelbach, 2012). However, the support gained for this theory is mixed. There are at least three views as to how to interpret the alcohol myopia theory for intoxicated eyewitnesses. The first view, as presented by Dysart et al. (2002), suggests that intoxicated witnesses encode the central features of the culprit's face to the same extent as sober witnesses. However, due to the myopic state caused by the alcohol, they encode fewer peripheral details. For a target-present line-up, there is no difference in identification performance between sober and intoxicated witnesses, since when they see the culprit both groups are as likely to recognise him. However, for a target-absent condition, the intoxicated witnesses would be less likely, as compared with sober witnesses, to conclude that the culprit is not present. The intoxicated witnesses would use a "salient cue matching strategy", whereby the most salient details of the memory of the culprit are matched with the salient details among the foils in the target-absent condition. Since the intoxicated witnesses encode fewer peripheral and subtle cues, the small differences between the memory of the appearance of the real culprit and an innocent foil in a target-absent condition might not be detected. Thus, intoxicated witnesses would find it more difficult to discriminate between the real culprit and a similar-looking foil, and the

rate of false identifications in a target-absent condition would then be higher than for sober witnesses (see; Dysart et al., 2002).

The second view is that proposed by Harvey et al. (2013a), who assume that the entire face of a culprit is a central cue for both sober and intoxicated witnesses. Based on this assumption, both sober and intoxicated witnesses are as likely to identify the culprit's face in a target-present condition as they are to note the absence of the face in a target-absent condition. Therefore, regardless of the line-up condition, there would be no difference in line-up performance between sober and intoxicated eyewitnesses (Harvey et al., 2013a).

The third view, mentioned by Schreiber Compo, Evans, Carol, Villalba, et al. (2011) is that the *entire* stimulus material in the form of a video or staged crime may be perceived as very central to all witnesses, regardless of intoxication level. Thus, sober and intoxicated witnesses would perform to the same level in both target-present and target-absent line-ups.

The various view-points regarding the alcohol myopia theory are similar in that they make a distinction between central and peripheral details. They differ is that they set different limits or thresholds concerning which details are central and which are peripheral. It should be pointed out that the studies described in the present thesis were not designed to examine the alcohol myopia theory. The reason for discussing this theory is that it may provide a broader explanation of the results presented in the thesis.

Summary of the Empirical Studies

The overall aim of the studies was to examine how alcohol affects eyewitnesses' memory, in terms of line-up performance (Study I) and during investigative interviews (Study II and Study III). Table 2 provides an overview of the three empirical studies. The studies were conducted in a controlled laboratory environment, with the aim of simulating a real-life eyewitness scenario. The first two studies originate from the same data collection, and the third study is based on a separate data collection procedure. Participants from the first data collection were not allowed to take part in the second data collection.

Previous studies on alcohol-intoxicated eyewitnesses have not examined the effects of different dosages of alcohol in a controlled laboratory environment. Therefore, for Study I and Study II, two different alcohol dosages were used. Based on the findings obtained in Study Studies I and II, only the higher alcohol dosage was used in Study III. In all the studies, the performances of alcohol-intoxicated participants were compared with those of sober participants. In addition, participants in previous studies witnessed events that lacked elements of violence and/or weapons, which are factors that are often components of real-life eyewitness scenarios. To increase the ecological validity, the present studies used a violent criminal event in which a woman was kidnapped by two men and during which the main perpetrator pointed a weapon towards the witnesses. In previous studies, the retention interval between the crime and the follow up task has often been short, ranging from an immediate follow-up to a delay of some days. Therefore, the present studies used a retention interval of one week (Study I and Study II), and both immediate interviews and interviews at a one week after the event (Study III).

Table 2

Overview of the Three Empirical Studies Described in this Thesis

	Phase one				Phase two		
	Participants	Event on film	Immediate memory test	Retention interval	Delayed memory test	Independent variables	Dependent variables
Study I	*N* = 123 60% women 40% men	Two men kidnap a woman	-	1 week	Line-up	Beverage (control vs. lower alcohol dosage vs. higher alcohol dosage) Line-up (target present vs. target absent) Sex (women vs. men)	Line-up performance Confidence ratings
Study II	*N* = 126 63% women 37% men	Two men kidnap a woman	-	1 week	Interview	Beverage (control vs. lower alcohol dosage vs. higher alcohol dosage) Sex (women vs. men)	Total amount of information Accuracy rate
Study III	*N* = 99 58% women 42% men	Two men kidnap a woman	Interview (for half of the witnesses)	Immediate/ 1 week	Interview	Beverage (control vs. higher alcohol dosage) Recall (repeated, i.e. immediate & delayed vs. single, i.e. only delayed) Sex (women vs. men)	Total amount of information Accuracy rate *For witnesses interviewed twice:* Amount and accuracy of new details Amount and correctness of changed details

General Method

Laboratory Environment

The experiments were performed in a laboratory located at the Sahlgrenska Academy at the University of Gothenburg, Sweden. The laboratory is furnished and decorated as a living room (with couch, chairs, table, lamps, window, curtain, paintings and TV), so as to create a relaxed environment. The studies were approved by the regional Ethical Review Board (diary number: 727-09) in Gothenburg.

Participants

The participants were non-problematic social drinkers who were recruited through announcement boards at the University of Gothenburg. The participants were screened for initial eligibility in a telephone interview conducted by a research nurse (data collection for Study I and Study II) and by the first author of the studies (data collection for Study III). Potential participants were invited to an examination by a physician. They also completed the Psychiatric Symptom Checklist (Derogatis, 1983) and the Swedish translated version (Bergman, 1994) of the Alcohol Use Disorder Identification Test (AUDIT; Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). Participants were excluded from the study if they had any ongoing condition that required medication, any ongoing Axis 1 psychiatric disorder (American Psychiatric Association, 2000), any history of psychosis, any history of illicit drug or alcohol abuse or dependence, a level of education less than a high school degree, lack of fluency in Swedish, or were engaged in night-shift work. Participants with current harmful alcohol-drinking habits (AUDIT total score >10) were excluded. The latter restriction exceeds the generally accepted cut-off limits of total AUDIT scores of 6 (females) and 8 (males) for harmful alcohol consumption. However, the limit was increased to a total AUDIT score of 10 for both female and males because we considered it necessary for the participants to have previous experience of alcohol consumption, given that they were expected to consume quite a high level of alcohol in relation to a short time period of only 15 minutes. Furthermore, participants with abnormal body weight (body mass index < 19 or > 26), as well as pregnant or nursing

women, were excluded. Only individuals who had good physical and mental health were allowed to participate. Participants were accepted without regard to ethnicity. Before participation, the participants were informed that the aim of the study was to investigate how alcohol affects eyewitnesses' memory. The research nurse (Study I and Study II) or the first author (Study III) answered any questions that the participants had before they signed the formal consent. Participants were told that they could be assigned to consume either alcohol or juice.

The participants were university students (60% women) with a mean age of 25 years. In general, around 95% of the participants who took part in phase one returned for phase two of the experiment. The flow of participants in the experiments conducted in Study III is illustrated in Figure 2. The pattern was approximately the same as the data collection pathways in Study I and Study II.

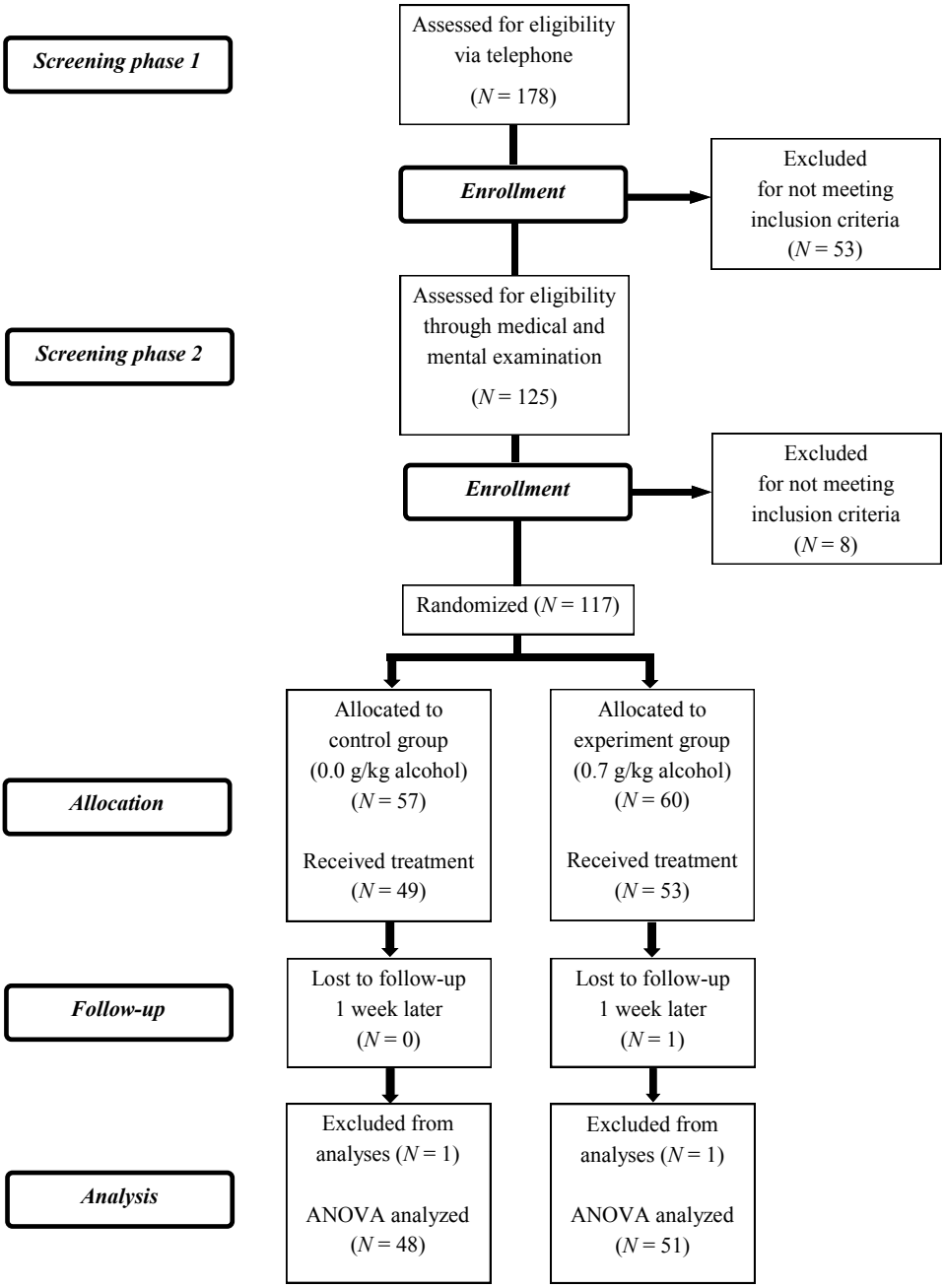

Figure 2. Sampling and flow of participants through the randomized experiment in Study III.

Instruments

The objective measure was blood alcohol concentration (BAC). BAC was estimated from the breath alcohol level (BAL) using the portable Breathalyzer Alert J5 (Alcohol Countermeasure Systems Corp, 2006).

Alcohol Dosages

The level of intoxication reached is determined not only by the administered dosage, but also by other factors (e.g., weight and sex). For example, if a person who weighs 60 kg receives the same amount of alcohol as a person who weighs 80 kg, then the lighter person will become more intoxicated. Furthermore, even when adjusting for body weight, women may achieve a higher BAC than men (e.g., Baraona et al., 2001; Mumenthaler et al., 1999). Therefore, to ensure approximately the same level of alcohol intoxication among all the participants, the alcohol dosage was adjusted for body weight (Study I and Study II) and for both body weight and sex (Study III). In Study I and Study II, there was no difference in intoxication levels between the women and men. However, as a precaution, the alcohol dosage was adjusted for sex in Study III. This was done because other studies recently conducted in our own laboratory have shown that women tend to reach a higher level intoxication when the alcohol dosage is not adjusted for sex (see Hildebrand Karlén, 2013). The beverage served consisted of alcohol (vodka, 40%) mixed with pulp-free orange juice. The participants in the alcohol groups knew that they were consuming alcohol, although they were not aware of whether they received the lower or the higher alcohol dosage (Study I and Study II).

The control group only consumed orange juice, also in the knowledge that they only received juice. Expectancy effects of alcohol were not controlled for in the studies. The lower alcohol dosage groups in Study I and Study II consumed 0.4 g/kg ethanol. This means that a person who weighs 70 kg receives an amount of alcohol that can be translated into approximately two (25 g pure ethanol) Swedish standard glasses of alcohol (e.g., two glasses of wine). The higher alcohol dosage group consumed 0.7 g/kg ethanol, corresponding to a 70-kg person consuming approximately 45 g of pure ethanol, which is equivalent to approximately four Swedish standard glasses of alcohol (e.g., four glasses of wine). The participants' BACs were expected to reach approximately 0.04% in the lower alcohol dosage group and 0.07% in the higher alcohol dosage group. In Study III, the females received 0.65 g/kg ethanol and the males received 0.70 g/kg ethanol.

Phase One

The participants arrived at the laboratory after lunch and were informed about the procedure. The BAC was measured with a Breathalyzer before the experiment started (baseline) and at 20, 35, and 50 minutes after the start of the beverage consumption. The participants were not told about their BAC levels, either during or after the experiment.

All the participants in one session were administered the same beverage at the same dosage. The participants were randomly assigned to a beverage condition. The consumption was monitored by the experiment leader, to ensure an even ingestion pace over the 15 minutes. The observed behavioural changes among the participants in the lower and the higher alcohol dosage groups was expected for those levels of intoxication. Common behavioural changes at those intoxication levels are such as extraversion, joyfulness, and talkativeness, as well as cognitive impairments of concentration, and reasoning (see Table 1), and those was observed among the participants by the experiment leader. For all the three empirical studies, the experiment leader was the author of this thesis.

Five minutes after the end of consumption, the participants witnessed the staged kidnapping on film. The film lasted 4 minutes and 50 seconds, with both culprits and the victim filmed from various angles. Close-up views of the main culprit's face were available for 31 seconds, the other culprit's face for 14 seconds, and the victim's face for 53 seconds. The film has been used in several previous studies (e.g., Allwood, Ask, & Granhag, 2005; Allwood et al., 2006; Granhag, 1997). The participants were instructed not to talk to each other about the film. After the film (35 minutes after the start of consumption), the participants completed filler tasks for 25 minutes (Study I and Study II) or 15 minutes (Study III). For ethical reasons, the participants were sent home after some hours when their BAC was 0.00% (Study I and Study II) or were sent home by taxi when they had reached a BAC of 0.05% (Study III).

Half of the participants in Study III underwent an immediate interview before they were sent home. This was a standard interview (Granhag & Spjut, 2001), and all the interviews were audio-recorded. The immediate interview was conducted while the participants were still under the influence of alcohol, and the interview lasted on average 15 minutes. The interview started with a free recall in which the participants were asked to tell everything that they could remember about the event. There followed nine open-ended questions in which the participants were asked, in the following order, to describe everything they remembered about: 1) the place where the crime took place; 2) the kidnapped woman; 3) other people present in the surrounding area before the crime took place; 4) the perpetrators' car; 5) the

persons present in the car; 6) the main perpetrator's physical appearance and clothes; 7) the second perpetrator's physical appearance and clothes; 8) other witnesses to the crime; and 9) any additional information that might be of value to the investigation. After each question, a follow-up question was posed regarding any additional information that could be remembered.

Phase Two

In phase two, the memory of the participant was tested after a retention interval of one week, and the memory tasks will be described in the chronological order of: Study I, Study II, and Study III.

The participants in the first data collection conducted the recognition task (Study I) first and thereafter the recall task (Study II). The recognition task consisted of a photographic line-up presented on a computer screen. Eight head and shoulder photographs of similar-looking men were simultaneously displayed. The participants were randomly assigned to either the target-present or the target-absent condition. The line-up was supervised by a person who was blinded to the participants' previous levels of intoxication and the line-up conditions. The task was to identify the main culprit. The participants could choose between ten alternative responses, to identify one of the eight persons in the line-up, conclude that the culprit was not present, or give a *not-sure* response. Confidence ratings, whereby the participants were asked to judge if they thought their line-up decision was correct, were collected. The scale was an 11 point Likert scale which ranged from 1 (*not at all confident*) to 11 (*completely confident*). The participants who had given a *not-sure* response did not make a confidence judgment.

After the line-up was completed, the participants in the first data collection were asked for a recall (Study II). The interview was a standard interview (Granhag & Spjut, 2001), and all the interviews were audio-recorded. This interview lasted approximately 5–10 minutes and consisted of a free recall in which the participants were asked to tell everything they remembered about the event followed by six open-ended questions about the kidnapped woman, the perpetrators, the car, and other people in the surrounding area. As an example, the question was asked: "*Can you describe, as detailed as possible, what happened at the bus station*?" After each question, a follow-up question was posed to ascertain if the participant could remember any additional details. Finally, they were asked if they had any other information that might be of value to the investigation.

In Study III, all the participants had a one week-delayed interview, in a room that they had not previously visited. The interview was the same as the immediate interview that half of the participants had undergone one week before. The only difference was that all the participants were instructed to report everything that they remembered, even if they already had reported the details in an immediate interview. For all the data collections, the participants were offered as compensation a choice of 350 SEK (approximately €40) or three cinema tickets.

Preparation of the Data

Each interview was transcribed and coded for the amount of reported information and accuracy rate. The coding followed the principles used in previous studies (e.g., Roos af Hjelmsäter, Strömvall, & Granhag, 2011). Each statement was broken down into small units (e.g., the sentence "*the man pointed a black gun*" was counted as three units: "*the man pointed*" and "*a gun*" and "*black*"). The total number of units reported by each participant was counted (completeness), and then each unit was coded as correct, incorrect or undefined (e.g., correct details were units that were completely correct; for example, "*the woman's hair was dark red*"). Thus, the total amount of information consisted of correct, incorrect, and undefined units. The accuracy rate was calculated by dividing the number of correctly reported details by the total amount of reported information.

In Study III, additional codings were conducted for participants who were interviewed twice. These codings were conducted to examine the amount and accuracy rate of new information; details that were not reported in the first interview but were reported in the second interview. Also, the amount of changed information was examined; details that were mentioned in the first interview but that were subsequently changed in the second interview, and if those details more often ended up as incorrect or correct. All statistical tests were conducted using the SPSS for Microsoft Windows version 18 software (SPSS Inc., Chicago, IL, USA). The results for the recall studies (Study II and Study III) are illustrated in Table 3 for comparative reasons.

Study I

The aim of Study I was to examine how different dosages of alcohol affected the performances of eyewitnesses in line-up identifications. In line with the assumptions presented by Dysart et al. (2002) regarding the alcohol myopia theory (Josephs & Steele, 1990; Steele & Josephs, 1990), it was hypothesised that the BAC would not affect line-up performance in the target-present condition (Hypothesis 1). For the target-absent condition, it was predicted that a higher degree of alcohol intoxication would result in a poorer line-up performance (Hypothesis 2). The study also examined how alcohol affected eyewitnesses' line-up performance with respect to sex differences.

Results

There was no significant difference between the beverage groups in terms of line-up performance, neither in the target-present condition (Hypothesis 1 supported) nor in the target-absent condition (Hypothesis 2 not supported). This result held true even when those participants who gave a *not-sure* response (never made any identification) were excluded from the analysis. Across the two line-up conditions (target-present and target-absent combined), 32% of the participants gave a *not-sure* response. In the target-present condition, 25% of the witnesses gave a *not-sure* response and the corresponding number in the target-absent condition was 38%.

In general, all the groups performed better than would have been expected by chance. Despite this, all the groups, regardless of intoxication level, performed quite poorly. In other words, few of the witnesses in the target-present condition correctly identified the culprit, and few of the witnesses in the target-absent condition rejected the line-up. No difference was found in confidence levels between the different groups with respect to their line-up decisions, and no sex-related differences were detected.

Conclusions

The intoxicated witnesses performed at the same level as their sober counterparts. Although their performance levels were greater than would have been expected by chance, the absolute performance levels were rather poor. This was true for both the sober and the intoxicated eyewitnesses. The poor performances resulted in a floor effect, which hindered the detection of any group differences.

As noted above, the lack of differences between the groups remained even when the participants who gave the *not-sure* responses were excluded. If the *not-sure* response alternative had not been available, it is likely that more participants would have identified a foil. It is also possible that more witnesses would have made correct identifications simply by guessing. The relatively high frequency of *not-sure* responses reflects the real-life situation in highlighting the difficulties witnesses experience in deciding whether the culprit is present or not. The present results are similar to those from the previous study of Steblay and Phillips (2011), which reported 27% *not-sure* responses for a target-present line-up.

Study II

The first aim of Study II was to examine how alcohol intoxication affected the completeness of the testimony (amount of recalled information) provided one week after witnessing a criminal event. The predictions were that the higher alcohol dosage group would recall fewer details than: a) the lower alcohol dosage group; and b) the control group (Hypothesis 1). Moreover, the lower alcohol dosage group was predicted to recall less information than the control group (Hypothesis 2). In a previous study, the participants were divided into a lower (sober and lowly intoxicated participants *combined*) and a higher BAC group (e.g., Dysart et al., 2002). Using this same split, we predicted that the witnesses who had a lower level of intoxication (the control group and the lower alcohol dosage group combined) would recall more details than the witnesses in the higher alcohol dosage group (Hypothesis 3). The second aim of this study was to examine how alcohol affected the accuracy of witnesses' statements. In line with previous research (e.g., Yuille & Tollestrup, 1990), it was predicted that alcohol would negatively affect the accuracy (Hypothesis 4).

Results

There was no significant difference with respect to the amount of recalled information between the control group and the lower alcohol dosage group (Hypothesis 2 not supported). Furthermore, no difference in the amount of recalled information was found between the control group and the higher alcohol dosage group (Hypothesis 1b not supported). However, comparing the two alcohol dosage groups, the lower alcohol dosage group recalled a significantly larger amount of information than did the higher alcohol dosage group (Hypothesis 1a supported). In a comparison of the participants with low levels of intoxication (participants in the control group and lower alcohol dosage group combined) and the participants in the higher alcohol dosage group, it was found that the highly intoxicated witnesses recalled less information, which confirms Hypothesis 3. There were no main effects of sex with respect to the amount of recalled information, and there was no interaction effect. Furthermore, there were no significant differences in accuracy rates between the beverage groups. Thus, Hypothesis 4 was not confirmed. There were no main or interaction effects of sex and alcohol dosage on accuracy.

Conclusions

The main finding was that there was no difference in the amount of recalled information between the sober witnesses and the witnesses in the lower alcohol dosage group. Furthermore, there was no difference in the amount of recalled information between the sober witnesses and the witnesses in the higher alcohol dosage group. Importantly, the intoxicated witnesses did not provide more confabulated or erroneous information. Differently put, the accuracy rates of the sober and intoxicated witnesses' statements were similar. Comparing the two alcohol dosages, witnesses who had consumed the lower dosage of alcohol recalled significantly more details than the witnesses in the higher alcohol dosage group, which was expected. The witnesses in the lower alcohol dosage group recalled the same amount of information as the sober witnesses, although there was a non-significant trend that the witnesses in the lower alcohol dosage group remembered slightly more details than the sober ones, see Table 3. While these findings are difficult to explain, it is possible to interpret them in line with previous research that has found that some drugs may have a stimulating effect and thereby enhance cognitive performance. As described in a literature review by McGaugh and

Roozendaal (2009), drugs have been found to facilitate performance on cognitive tasks such as attention, perception, motivation, arousal, as well as influences on neurobiological processes involved in learning and memory.

Study III

The main research question posed in Study III was: When should alcohol-intoxicated eyewitnesses be interviewed? More specifically, the focus was on three questions: 1) Is there a difference in memory performance between witnesses who have an immediate interview (i.e., still intoxicated) and witnesses who have a delayed interview (i.e., in a sober state)?; 2) Is there a difference in the combined memory performance between witnesses who are interviewed twice (immediate plus delayed interview) and those who are interviewed once (only a delayed interview)?; and 3) Among witnesses who are interviewed twice, is there a difference between sober and intoxicated witnesses in terms of the amount and accuracy and of new information provided during the second interview? Also, is there a difference in the amount of details that are changed between the first and the second interview, and does those details more often end up as incorrect or correct?

The first hypothesis was based on the notion that alcohol intoxication results in less-accurate recall (Nash & Takarangi, 2011), as well as the findings of previous empirical research (Yuille & Tollestrup, 1990). Thus, the alcohol group was predicted to be less accurate than the control group, regardless of whether they underwent an immediate or delayed interview (Hypothesis 1a), and regardless of whether they had a single or repeated interview (Hypothesis 1b). In line with the results of previous studies showing a negative main effect of alcohol on the amount of reported details (e.g., van Oorsouw and Merckelbach, 2012; Yuille & Tollestrup, 1990), it was predicted that the alcohol group would recall less information than the control group, regardless of whether they had an immediate or delayed interview (Hypothesis 2a), and regardless of whether they had a single or repeated interview (Hypothesis 2b).

It was expected that witnesses who were interviewed immediately after the event would be more accurate than witnesses interviewed one week later (Hypothesis 3a). Furthermore, in line with natural forgetting (e.g., Baddeley, 1991; Schacter, 2001), it was predicted that witnesses who were interviewed immediately would recall more details than witnesses interviewed one week later (Hypothesis 3b).

Witnesses who had two recall trials were expected to be more accurate than witnesses who only had a single recall trial (Hypothesis 4a). In accordance with the reminiscence effect (Gilbert & Fisher, 2006), it was expected that when the two recalls were combined, witnesses who were interviewed twice would recall more information than witnesses who were interviewed only once (Hypothesis 4b). Due to the sparse nature of previous research on this topic, we made no predictions concerning sex differences.

Results

Alcohol reduced the accuracy of the participants' statements; hence Hypothesis 1a and 1b received support. However, alcohol did not affect the completeness of the reports, so Hypothesis 2a and 2b was not supported. The immediate recall rendered both a higher level of accuracy and more information compared to the delayed recall, which meant that Hypothesis 3a and 3b was supported. Witnesses who had repeated recalls were both more accurate and recalled more information than witnesses who only had a single recall, thereby supporting Hypothesis 4a and 4b. Among the witnesses who had two recalls, there was no difference between sober and intoxicated witnesses in terms of the amount or accuracy of new information that were reported at the delayed interview. Overall, for both the sober and intoxicated witnesses, of the total amount of information provided at the delayed interview, approximately 30% represented new information and those new details had an accuracy rate of 80%. Approximately 2% of the information recalled in the first interview was changed at the second interview. The changed details were more likely to end up being incorrect than correct.

Conclusions

Overall, Study III showed that alcohol had a negative effect on the accuracy of statements, but not on the total amount of reported information. It is important to point out that the quality (the accuracy) of witnesses' statements is of the highest relevance in criminal cases, since an incorrect testimony may result in the conviction of an innocent person. However, it is important to note that although intoxicated witnesses were significantly less accurate than sober witnesses; the difference was actually very small. Both the sober and intoxicated witnesses had

rather high accuracy rates, examining all details recalled. In addition, in terms of completeness and accuracy, it was more beneficial to interview witnesses twice than to conduct only an immediate or only a delayed interview. New details provided at the second interview were shown to be rather correct, both for sober and intoxicated witnesses.

Table 3

Summary of the Two Recall Studies (Study II and Study III) showing the Mean Number (SD) of the Amount of Information recalled and the Accuracy Rates of the witnesses' statements.

	Study II			Study III	
	Control group (N = 42)	Lower alcohol dosage group (N = 40)	Higher alcohol dosage group (N = 44)	Control group (N = 48)	Higher alcohol dosage group (N = 51)
Immediate recall					
Total amount	-	-	-	141.30 (35.37)	132.04 (44.38)
Accuracy rate	-	-	-	.87 (.05)	.86 (.05)
Only delayed recall					
Total amount	62.07 (19.54)	69.10 (20.17)	56.61 (24.18)	120.08 (35.27)	113.30 (30.34)
Accuracy rate	.77 (.08)	.78 (.08)	.79 (.09)	.84 (.05)	.80 (.07)
Two recalls					
Total amount	-	-	-	180.13 (48.58)	170.58 (55.61)
Accuracy rate	-	-	-	.86 (.05)	.85 (.05)

General Discussion

The major aim of this thesis was to examine how alcohol affects eyewitnesses' memory in a recognition task (i.e., a line-up) and during recall (i.e., an investigative interview). The thesis found no effect of alcohol intoxication on the performances of witnesses in line-up situations (Study I). Regarding the interview, no differences were found between sober witnesses and witnesses in the higher alcohol dosage groups in terms of the amount of recalled information (Study II and Study III). In addition, in Study II, alcohol did not have a negative impact on the accuracy of the witnesses' statements. The opposite pattern was found in Study III, whereby alcohol reduced the accuracy of the recall. Although alcohol reduced the accuracy of the reports, the difference was very small. Importantly, overall all the witnesses (both the sober and intoxicated) were able to produce reasonably reliable statements. The mean number of accuracy rates varied between .77–.87 in the two recall studies depending upon group condition, and the standard deviations varied between .05-.09. This means that some witnesses had a reasonable reliable accuracy rate around .69, while other had a high accuracy rate around .91. Furthermore, in terms of the amount of recalled information and accuracy of the statements, it was more advantageous to interview witnesses twice than to conduct only an immediate interview or only a delayed interview. Witnesses who underwent an immediate interview produced statements that contained more details and that had a higher level of accuracy than the witnesses who only had a delayed interview. This was the case both for the sober and the intoxicated witnesses. Thus, an immediate interview was beneficial, even when the witnesses had a moderate level of alcohol intoxication.

In the following sections, the most important findings will be elaborated. More detailed discussions will be offered concerning why there were no differences in the line-up performances of the sober and intoxicated witnesses; the overall poor performance levels of the witnesses in the line-ups; the factors that influence witnesses recall; recall and recognition as separate processes; the limitations of the present thesis; future directions; and finally, some legal implications.

Performance During the Line-Up

There was no difference between the three groups (control, lower alcohol dosage group, and higher alcohol dosage group) in terms of line-up performance, neither in the target-present condition nor in the target-absent condition. This result is consistent with the outcomes of some previous studies (Harvey et al., 2013a; Yuille & Tollestrup, 1990). Although the result differ from the results of other studies that have shown that intoxicated witnesses perform worse than sober witnesses, at least in one of the line-up conditions (Dysart et al., 2002; King, 2005; Michalec, 1990).

In Study I, all the groups (except for the lower alcohol dosage group in the target-present condition) performed significantly better than would have been expected by chance. Previous research has revealed large variability with respect to how well eyewitnesses perform in a line-up task. This may be due to, for example, differences in stimuli, designs, exposure time, attention levels, and retention intervals. Some studies have reported a rate of correct identification of approximately 25% (as in the control group in Study I) in the target-present condition (e.g., Brewer et al., 2008), while other studies have indicated a rate of correct identification of 90% (Yuille & Tollestrup, 1990). In brief, the rate of correct identifications in the target-present condition and the rate of correct rejection in the target-absent condition in the present study were not very impressive. For the target-absent condition, the results from Study I are in the lower part of the range (23% for the control group), while other studies have a rate of correct rejection in the range of 60%–75% (Brewer et al., 2008; Yuille & Tollestrup, 1990). In a forensic context, it is important to remember that the performance levels of eyewitnesses may vary considerably. This makes it difficult to determine the accuracy of the identifications made by individuals in line-up settings.

The poor line-up performance observed in Study I may reflect several factors. One simple, but logical, reason is the one week retention interval. It may be that the witnesses had a difficult time remembering the perpetrators face due to the time that had elapsed since the event. This could be explained by the memory error transience, in that it is natural that the memory fades and becomes weaker as time passes (Schacter, 2001). Another possible explanation is that the culprit's face was in view for approximately 30 seconds. While this is a relatively short time period, it is ecologically valid for crimes in which witnesses see the culprit's face rather briefly. However, since attention has been found to have a greater impact than exposure time on recognition memory (Wells & Olson, 2003), the line-up performance levels in Study I are surprisingly low. In the film, it is obvious who

the culprit is, since he kidnaps a woman and directs a gun towards the witnesses. Thus, the witnesses should have paid attention to the culprit. The film was realistic in the sense that there were several characters involved (two culprits, one victim, and some bystanders). This may have affected the identification performance negatively due to divided attention (Chae, 2010; Palmer, Brewer, McKinnon, & Weber, 2010).

The composition of the line-up could be another explanation for the poor performance. For example, one method is to choose foils based on the verbal description of the suspect provided by the witness, instead of matching the foils to the appearance of the suspect. Matching can lead to a low accuracy rate when the suspect and foils are too similar-looking (Brewer & Palmer, 2010; Wells et al., 2000; Wells & Olson, 2003). Matching was employed in Study I, which may explain the poor performance observed in that study.

The film quality was rather poor, which is another factor that may explain the mediocre line-up performances of the witnesses. Poor image quality has been shown to have a negative impact on line-up performance (Hancock et al., 2000). The appearance of the culprit also differed somewhat between the encoding phase and the recognition task, and change in appearance has been shown to affect negatively line-up performance (Johnston & Edmonds, 2009). However, in reality, it is not uncommon that the culprit's appearance changes from the time of the crime to the time of the line-up. It should again be highlighted that two meta-analysis has found that approximately only 50% of eyewitnesses in laboratory experiment settings make a correct line-up decision (Steblay et al., 2001, 2011). The relatively poor line-up performance may be due to the fact that humans are poor at recognising unfamiliar faces to which they have been exposed for a short period of time (Hancock et al., 2000; Johnston & Edmonds, 2009).

Line-Up Performance and the Alcohol Myopia Theory

As previously described, the alcohol myopia theory (Josephs & Steele, 1990; Steele & Josephs, 1990) might be applied to the eyewitness line-up situation, according to the interpretation of either Dysart et al. (2002) or Harvey et al. (2013a). Overall, the predictions following the alcohol myopia theory seem to hold for the target-present condition, both according to the interpretation of Dysart et al., and Harvey et al. However, the support for the theory is mixed in the target-absent condition.

One explanation for the mixed findings in the target-absent condition might be that the levels of intoxication differed between the studies. The BACs of the participants in the alcohol dosage groups in Study I were in the same range (0.03%–0.09%) as in the study of Yuille and Tollestrup (1990) (0.06%–0.12%), as well as that of Harvey et al. (2013a) who reported a BAC range of 0.05%–0.17%. In the study carried out by Dysart et al. (2002), the BACs ranged from 0.00% to 0.21%, indicating that some of these participants were more intoxicated than the participants in the other studies. However, it is important to highlight that the study of Dysart et al. (2002) used a different design, i.e., immediate show-up while the participants were still intoxicated.

Further on, it is possible that an appropriate interpretation may be that the *entire* criminal event is perceived as a central detail by most (or all) of the witnesses. Thus, then both the sober and intoxicated eyewitnesses would perform on the same level in both the target-present and target-absent line-ups (Schreiber Compo, Evans, Carol, Villalba, et al., 2011). Clearly, additional studies are needed to resolve the extent (if any) to which the alcohol myopia theory holds true for different line-up situations, and how this is related to the intoxication levels of eyewitnesses.

Performance During the Interview

Total Amount of Information

An overview of the memory performances in the two recall studies (Study II and Study III) is presented in Table 3. In both studies, there was no difference between the control group and the higher alcohol dosage group in terms of the total amount of recalled information. The main finding that there was no difference in the total amount of recalled information between witnesses in the high alcohol dosage group and the control group is in line with the results from some previous studies (Schreiber Compo, Evans, Kemp, et al., 2011), although it is not in accord with the findings from some other studies (e.g., van Oorsouw & Merckelbach, 2012; Yuille & Tollestrup, 1990). Studies showing alcohols negative effect on the amount of recalled information might be explained by that intoxication disturbs cellular activity in the brain, primarily in the hippocampus, which can lead to an interruption in the process of transferring information from the short-term memory

to the long-term memory (e.g., White, 2003). A reduction in the amount of recalled information may hence be explained by that alcohol consumption leads to a memory failure. More specific, alcohol intoxication may in some cases lead to an error of omission, which means that memories fails to come to mind (Schacter, 2001). This could explain why intoxicated witnesses in some studies remembered slightly less information than sober ones. However, the recall studies in the present thesis, along with some other studies, did not found any difference between the witnesses in the control group and witnesses in the higher alcohol dosage group in terms of the total amount of recalled information. This might be explained by several factors. First, it might be that the manipulation was too weak (i.e., to low dosages of alcohol) or that the sample groups was too small in order to detect a difference that truly exists, referred to as a statistical Type II error (Lamb, 2009). However, it could also be the case that there truly exists no difference between the control group and the higher alcohol dosage group in terms of the completeness of the statements. Second, it could also be that the intoxicated witnesses were negatively affected by alcohol, but that the alcohol consumption led to another memory failure, namely an error of commission. This means that incorrect memories come to mind and are reported (Schacter, 2001). It could explain that the intoxicated witnesses in Study III in the present thesis reported the same amount of information as the sober witnesses, but with a slightly less accuracy rate.

Furthermore, in Study III, when comparing the control group and the lower alcohol dosage group, there was no significant difference with respect to the amount of recalled information, and the lower alcohol dosage group recalled significantly more details than the witnesses in the higher alcohol dosage group. The finding that the control group and lower alcohol dosage group performed on the same level is difficult to explain, but it may be that the lower dosage of alcohol had some stimulant effects on memory. As previously mentioned, alcohol is a drug with both sedative and stimulant effects (Hendler et al., 2013), and stimulant drugs have been found to enhance cognitive performance to a certain extent (e.g., McGaugh & Roozendaal, 2009).

As shown in Table 3, there is a large difference between Study II and Study III in terms of the total amount of information that the witnesses recalled at the delayed interview. The witnesses in Study II recalled a mean number of 57–69 details (with a standard deviation around 22 details), depending on the group condition. Comparative, the witnesses in Study III who only had a single delayed recall reported a mean number of 113–120 details (with a standard deviation around 33 details), also depending on the group condition . This difference where the witnesses in Study III reports more information is surprising, since both studies used the same beverage groups (control group vs. a higher alcohol dosage group),

the same stimulus (a film depicting a kidnapping), and the same retention interval (one week delay). One possible explanation is that the interviews varied slightly across the two studies. The number of questions differed since it was seven questions in Study II and ten questions in Study III. In both studies, the witnesses were asked to tell everything they remembered about the criminal event, the kidnapped women, the main perpetrator, the second perpetrator, the car, and other people in the surrounding area, and they were also asked to provide any additional information that could be of value to the investigation. In Study III, the participants were also asked about whether there were any witnesses to the actual kidnapping, the place where the crime took place, and about the persons present in the car. As a consequence, the interview was slightly shorter in Study II (5–10 minutes) than in Study III (around 15 minutes). In summary, the more extensive interview used in Study III may explain the difference.

An important conclusion from the present thesis work is that it appears to be most beneficial to interview witnesses both immediately and after some time has elapsed, if such opportunities are presented.

Accuracy

In Study II, there were no differences in the accuracy rates as a function of alcohol dosage. One explanation for this may be that the intoxicated individuals omitted details they were not sure about. In Study III, the intoxicated witnesses were slightly less accurate in their testimonies, as compared with their sober counterparts. This finding may be explained by the line of reasoning introduced by Nash and Takarangi (2011); that intoxicated persons may use strategies to fill in the gaps in their memory, which may reduce the accuracy rate. Although this may serve as an explanation for the reduced accuracy seen in Study III, it is important to note that the intoxicated witnesses were only some percentage points less accurate than the sober witnesses. The conclusion might be drawn that the police should not hesitate to interview witnesses who have a BAC <0.10%, since these witnesses might be as accurate in their recollections as sober witnesses.

As shown in Table 3, the accuracy rates were relatively high in both Study II (around 80%) and Study III (around 85%), which is very much in line with previous research (e.g., van Oorsouw & Merckelbach, 2012; Yuille and Tollestrup, 1990). Furthermore, Study III showed that witnesses who were interviewed twice had an accuracy rate of around 80% with respect to the new information they reported at the delayed recall. This was true for both the sober and intoxicated

witnesses. This suggests that new information introduced at a second interview can be trusted to a relative high extent, even when provided by intoxicated witnesses. In contrast, when witnesses altered certain details between the first and second interview, the changed details were more likely to prove to be incorrect than correct. It is noteworthy that only very few of the details were changed, and not all the witnesses changed their details.

Recall vs. Recognition

Whereas there was a lack of difference between the sober and intoxicated eyewitnesses in the line-up (recognition task), a difference was found between these groups in the interview (recall task). One possible explanation is that the line-up was too difficult and that the witnesses were poor at recognising unfamiliar faces, even when sober. This could have caused floor effects.

Research suggests that recognition and recall are two different processes (e.g., Robinson et al., 2000; Pozzulo et al., 2009). This means that if a witness performs poorly in a line-up, it does not necessarily mean that this same witness will perform poorly with respect to recall. The converse may also be true, that a witness does not report much or accurately during the interview but that he or she may still be able to identify the culprit. Previous research has shown that witnesses may be discredited in court if they were intoxicated at the time of the crime (Evans & Schreiber Compo, 2010). The present thesis shows that this picture is perhaps a bit more complicated, in that a moderate dosage of alcohol had a small negative effect on the accuracy of recall but had no effect on recognition. Therefore, when assessing the memory of an intoxicated eyewitness it might be beneficial to distinguish between recall and recognition.

In terms of going beyond the distinction of recall and recognition, one may expect that the complexity of the task moderates how alcohol affects eyewitnesses' memory. Research has showed that complex tasks are more vulnerable to the effect of alcohol intoxication than simpler tasks (see Hindmarch, Kerr, & Sherwood, 1991). For example, previous research has found that alcohol intoxication have a larger negative effect on effortful processing (free recall of learned word lists from episodic memory) than on more automatic processing (estimation of word frequency from word list) (Tracy & Bates, 1999). The same pattern has been found in a literature review examining how alcohol affects the operation of motor

vehicles. The review found that the complexity of the driving task influenced to which extent alcohol affected the persons driving ability, where alcohol had a larger negative effect on high complexity tasks (Martin et al., 2013).

Sex Differences

Studies of sober individuals have suggested that women have an advantage over men with respect to facial recognition, and that women tend to recall a person's appearance more accurately (e.g., Areh, 2011; Horgan et al., 2004; Lovén et al., 2012). However, some previous findings also suggest that alcohol may affect men and women differently, also with respect to memory (e.g., Mumenthaler et al., 1999; Rose & Grant, 2010; Yonker et al., 2005). This thesis did not find any sex differences with respect to line-up performance or the completeness and accuracy of recall. Thus, intoxicated female and male witnesses were equally good as witnesses. This outcome is something that practitioners within the legal system may want to consider: female and male witnesses with approximately the same levels of BAC will likely be equally capable of remembering the crime. However, if the female witness and the male witness have consumed approximately the same amount of alcohol, then it is possible that the female witness will have a higher BAC (e.g., Graham et al., 1998). Thus, the female might than have a poorer memory.

Limitations

The experiments were conducted in a laboratory, and this entails some limitations. First, due to ethical reasons, the extent of intoxication was limited a maximum BAC of 0.12 % (with a mean of 0.05% and standard deviation of 0.02), whereas witnesses in real life often have higher levels of intoxication (Evans et al., 2009; Schreiber Compo, Evans, Carol, Villalba, et al., 2011). For example, a study estimated BACs (calculated from formulas) based on the amount of alcohol content found in college party mixed drinks, and found that the BACs among both female and male high consumers was above 0.08%. In more detail, the BACs of female high consumers ranged from 0.09%-0.19% and for male high consumers between

0.07%-0.16% (Barnett, Wei, & Czachowski, 2009). Also, in many European countries, the drink and drive limit is higher than the level of intoxication of the participants in the lower alcohol dosage group in the present study. Furthermore, in the United Kingdom, Ireland, Luxembourg, Malta, and some states in the US, the drink- and drive limit is a BAC of 0.08%. This level of intoxication corresponds to the BAC levels achieved by some of the participants in the higher alcohol dosage group in the present study. In other words, some of the participants in the higher alcohol dosage group would, in some European countries, be considered sober enough to drive. This exemplifies the difficulties associated with conducting experiments that are both ecologically valid and ethically sound.

Second, observing a crime in a laboratory setting is different in many respects from witnessing a real crime (Tollestrup, Turtle, & Yuille, 1994). For example, many real crimes cause the eyewitness to experience anxiety and fear (Chae, 2010; Penrod et al., 1995). A limitation of the present work is that our participants were not asked to assess their emotional responses to the criminal event. Therefore, we could not control for this in our analysis. However, for ethical reasons, the degree of violence in the film was not that high. It is therefore unlikely that our participants experienced any high levels of distress while witnessing the crime. That our participants watched a staged crime in a safe environment and that they knew that an event would enfold makes the experiment different from a real-life situation. Future research may employ set-ups with higher ecological validities, to allow generalisation of the findings to a real-life context.

Third, the participants were healthy and highly functional university students. Eyewitness research has found that college students perform better at recall tasks than other parts of the population (Bartlett & Memon, 2006). Thus, the generalizability of the present results may be limited to younger healthy adult witnesses. Future studies may examine how alcohol affects the memory performances of older eyewitnesses. In addition, the participants were screened before they could take part in the study, so as to include only individuals who had some (although not too much) previous experience of alcohol consumption. As a consequence, our findings cannot be generalised to novice drinkers, for whom the negative effects of alcohol may be greater due to their low levels of tolerance. Similarly, our findings cannot be generalised to alcohol-dependent individuals who have a high tolerance for alcohol.

Fourth, the present thesis investigated anterograde alcohol-induced memory impairments. In real-life cases, it may be so that a crime is committed during the time the witnesses are consuming alcohol, or that alcohol is consumed shortly after witnessing a crime; this would then be related to retrograde alcohol-induced amnesia. Therefore, it is important to reiterate that the studies presented in this

thesis primarily generalise to cases that concern anterograde impairments, hence, to cases where alcohol has been consumed shortly before the criminal event.

Future Directions

Future research may profit from examining intoxicated witnesses who perceive both visual and auditory information. Studies of sober earwitnesses have found that they are rather poor at voice identification. However, they are rather good at remembering the main content of overheard conversations, which might be useful in criminal investigations (Öhman, 2013). This line of research could be of relevance for intoxicated witnesses, since it is frequently the case that witnesses both hear and see critical information.

This thesis did not aim to examine whether the alcohol myopia theory can be applied to intoxicated witnesses' memory. However, future studies may profit from examining whether the theory can be generalised to intoxicated witnesses. For example, one could code and analyse the number of central and peripheral details that sober and intoxicated witnesses report during an interview, as has been done in some previous studies (e.g., Schreiber Compo, Evans, Kemp, et al., 2011; van Oorsouw & Merckelbach, 2012). In addition, following the example of Harvey et al. (2013a), eye tracking could be used to examine with precision which details the witnesses focus their attention on during a criminal event, which would be useful for testing the alcohol myopia theory.

Many real-life crimes evoke strong emotional responses in the viewer. There is however only a limited amount of research that has investigated whether emotional engaging events have a better resistance to alcohol than more neutral events (Spinetta et al., 2008). In a relatively recent doctoral dissertation, Knowles (2005) examined the matter and found that alcohol-intoxicated persons remembered emotional engaging stimulus better than neutral stimulus. However, the participants in the studies were instructed to learn simple stimulus (e.g., words), which has limited generalizability to real-life contexts. As previously mentioned, witnessing a violent crime can lead to negative emotions such as fear and anxiety (Chae, 2010; Penrod et al., 1995). Also as earlier noted, alcohol is a drug with both stimulant and sedative effects. One of the sedative effects is the anxiolytic effect, which means that consumers of alcohol may experience anxiety reduction (Hendler et al., 2013). Hence, it is not difficult to understand the need of further research which examines how witnesses under the influence of alcohol remembers an emotionally engaging crime as compared to a less emotionally engaging crime.

Furthermore, it is important to conduct studies that more closely examine how eyewitness memory is impaired in relation to the level of alcohol intoxication, since the risk of memory impairments can be expected to be increased at higher levels of intoxication (e.g., Lee et al., 2009; Wetherill & Fromme, 2011). In a laboratory environment, a set up with high intoxication levels would be difficult to establish due to ethical considerations. One possible solution could be to conduct studies in real bars, as in the studies reported by Dysart et al. (2002) and van Oorsouw and Merckelbach (2012). Although such studies might have higher ecological validity, there are also disadvantages with such set-ups (e.g. reduced control of manipulations). It is important to conduct studies with different methods, so as to arrive at results that are relevant in different contexts (Chae, 2010; Memon, Mastroberardino, & Fraser, 2008).

Final Remarks and Legal Implications

A commonly held belief is that alcohol negatively affects memory. A consequence of this, as noted by Schreiber Compo, Evans, Carol, Villalba, et al. (2011), is that intoxicated eyewitnesses often have a bad reputation. As indicated by Evans and Schreiber Compo (2010), intoxicated witnesses may be discredited by representatives of the criminal justice system. However, this thesis shows that the picture may be more complex, and that several factors are important when assessing the testimonies of intoxicated eyewitnesses. Based on the results of the present studies, four recommendations are presented. Before outlining these recommendations it is important to acknowledge that the recommendations only relates to witnesses who have a BAC <0.10%. For the understanding of those results; a BAC of 0.10% equals a per mille of 1.0 ‰, which is a more commonly used unit in some countries, for example in Sweden.

In the present thesis, in line with other studies that have examined witnesses with a BAC of around 0.10% (e.g., Schreiber Compo, Evans, Carol, Villalba, et al., 2011; Yuille & Tollestrup, 1990), alcohol did not have any large significant negative effects on memory. Thus, the first recommendation is that the police should measure the intoxication level of a witness using a Breathalyzer, as this measurement can function as an indication of how much the level of alcohol intoxication might influence memory performance. The author of the present thesis is aware of the fact that the police sometimes not have the opportunity to be present quite immediately at the scene of the crime in order to objectively measure the witnesses' intoxication level. As noted by Palmer et al. (2013), police officers in the US was primarily informed that a witness had consumed alcohol or another drug when the witness reported this (in 88% of the cases), followed by that the police took a Breathalyzer test (9%), or that the police observed the witness engaging in alcohol or other drug intake (3%). It could also be the case that the police arrives to the scene of the crime but primarily is focused on measuring the BACs of a victim or a potential suspect with a Breathalyzer, instead of the witnesses' BAC. However, as recommended in this thesis, it would be beneficial to also measure the witnesses' intoxication level. If this is not possible, then one solution is obviously to ask the witnesses about the amount of consumed alcohol at the time of the crime. Expert witnesses are sometimes asked to perform retrograde estimation concerning which intoxication level an individual might have reached after a certain drinking event. There are formulas (e.g., the revised Widmark formula) which can be used in order to calculate approximately which BAC an individual had at the time of consumption (Posey & Mozayani, 2007). However, it

is well established fact that many factors (e.g., body weight, tolerance to the drug, sex, rate of alcohol absorption, genetics, mental and physical health) are involved in the relationship between a consumed amount of alcohol and the actual BAC level. Hence, two witnesses consuming the same amount of alcohol could reach different intoxication levels (e.g., Lee et al., 2009; Paton, 2005). Also, self-reports were individuals estimate how many glasses of alcohol they have consumed can be misguiding (Barnett et al., 2009). Therefore, it is more beneficial to objectively measure the BAC of a witness through a Breathalyzer quite immediately if possible, than to reconstruct an approximately intoxication level using formulas.

Alcohol proved to have a somewhat negative effect on the performances of the witnesses during investigative interviews (i.e., the recall task). This is in line with previous research that has shown that alcohol may reduce the accuracy of witnesses' statements. However, the intoxicated witnesses performed only slightly worse than the sober witnesses. Importantly, all witnesses were rather reliable in their statements. Thus, the second recommendation is that the police should not hesitate to conduct investigative interviews with intoxicated witnesses.

The third recommendation is to interview intoxicated witnesses already at the crime scene, if this is possible. This thesis shows that witnesses interviewed immediately after an event remembered more information, and with a higer accuracy rate than witnesses who are interviewed after a delay of one week. However, witnesses who are interviewed twice recall the largest amount of information. Here it should be noted that new information added in a follow-up interview tends to be rather reliable, and this is true also for witnesses who were intoxicated at the time they observed the crime.

In agreement with the majority of the previous studies, the present thesis finds that alcohol-intoxicated witnesses do not perform worse than sober witnesses in a line-up (i.e., the recognition task). Therefore, the fourth recommendation is that the police might arrange line-ups also for intoxicated witnesses, and they should expect that these witnesses will perform at the same level as sober ones. However, it is important to bear in mind that recognition of an unfamiliar face is often a difficult task, even for sober witnesses (Hancock et al., 2000; Johnston & Edmonds, 2009; Leveroni et al., 2000).

In summary, to elucidate fully how alcohol-intoxicated eyewitnesses remember a crime, future studies should focus on vary the intoxication levels, the criminal event, the retention interval, and the type of memory task. The present thesis indicates that alcohol-intoxicated eyewitnesses might be better than their reputation, and that witnesses who have a low to moderate intoxication level (BAC <0.10%) can still be rather reliable sources of information in criminal investigations.

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Appendix

I. Hagsand, A., Roos af Hjelmsäter, E., Granhag, P.A., Fahlke, C., & Söderpalm Gordh, A. (2013). Do sober eyewitnesses outperform alcohol intoxicated eyewitnesses in a lineup? *The European Journal of Psychology Applied to Legal Context, 5,* 23-47.

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