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## **Eyewitness Testimony in Autism Spectrum Disorder: A Review**

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Running Head: ASD eyewitness review

## **Abstract**

Autism spectrum disorder (ASD) is estimated to affect around 1% of the population, and is characterised by impairments in social interaction, communication, and behavioural flexibility. A number of risk factors indicate that individuals with ASD may become victims or witnesses of crimes. In addition to their social and communication deficits, people with ASD also have very specific memory problems, which impacts on their abilities to recall eyewitnessed events. We begin this review with an overview of the memory difficulties that are experienced by individuals with ASD, before discussing the studies that have specifically examined eyewitness testimony in this group and the implications for investigative practice. Finally, we outline related areas that would be particularly fruitful for future research to explore.

Key Words: Autism Spectrum Disorder, Eyewitness, Memory, Suggestibility,  
Interviewing, Credibility

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## **Introduction**

Eyewitness testimony is central to the criminal justice system, and often includes that given by individuals with autism spectrum disorder (ASD). People with ASD comprise approximately 1% of the population (e.g., Baird et al., 2006), however research identifying a number of ‘risk’ factors, such as social naivety, diminished insight into what others are thinking (leading to exploitation by others) and repetitive and stereotyped interests, suggests that they may be over-represented within the criminal justice system as victims, witnesses or even perpetrators of crime (e.g., Browning & Caulfield, 2011; Hall, Godwin, Wright & Abramson, 2007; Petersilia, 2001; Scrag & Shah, 1994; Siponmaa, Kristiansson, Jonson, Nydén & Gillberg, 2001; Woodbury-Smith et al., 2005). In addition to their potentially inflated representation in the criminal justice system, people with ASD also have rather specific memory difficulties (see Boucher & Bowler, 2008). Understanding their eyewitness capabilities and how best to interview them is, therefore, essential. This article begins by reviewing some of the literature on memory in ASD to consider how the memory difficulties associated with the disorder might impact on their abilities to recall an eyewitnessed event, before discussing the research to date that has examined how such memory impairments actually translate in eyewitness scenarios (relevant literature searches were performed using ISI Web of Knowledge and PsychINFO databases, to December 2011). Finally implications for policy and future research directions are discussed.

## **Memory in ASD**

ASD is characterised by impairments in the areas of social functioning and communication, and by the presence of stereotypic and repetitive behaviours (American Psychiatric Association, 2000). Consistent evidence has also accumulated over the last 50 years showing that individuals with ASD experience specific difficulties with their memory, impacting on the ways in which they perceive, understand, interpret, and reconstruct the world around them. Some have argued that these difficulties may even account for some of the diversity of behavioural features that characterise the disorder (see Boucher & Bowler, 2008). Individuals with ASD have a unique memory profile, with peaks and troughs in their abilities. Some memory processes such as cued recall (e.g., Bennetto, Pennington & Rogers, 1996), priming (e.g., Gardiner, Bowler & Grice, 2003), recognition (e.g., Bowler, Gaigg & Gardiner, 2008; Minshew & Goldstein, 1993; Minshew & Goldstein, 1993) and memory for facts (e.g., Bowler & Gaigg, 2008) are consistently reported to be intact, whilst others such as source monitoring (e.g., Bowler, Gardiner & Berthollier, 2004) episodic recollection and the recall of personally experienced events (e.g., Bowler, Gardiner & Gaigg, 2007; Russell & Jarrold, 1999) tend to be impaired. These

memory difficulties provide empirical and practical motivation for examining how eyewitnessed events are encoded, stored and retrieved by individuals with ASD. We next briefly consider some of the memory processes that are known to be impaired in ASD, and how these may, theoretically, affect their eyewitness testimony.

#### Episodic memory and personally experienced events

Episodic memory involves engaging in mental time travel in order to re-experience the spatio-temporal context of the event in question. Episodes in one's memory are characterised by the co-occurrence of elements of experience (e.g., having dinner in a particular place with a particular friend at a particular time), and are defined individually by the specific combination of these attributes that are unique to that episode. For an episode to be retrieved, its components need to be marked in such a way that their retrieval is in a bound unit. Early accounts of memory in ASD suggested impaired episodic memory in the disorder (e.g., Boucher, 1981; Boucher & Warrington, 1976) and these accounts still hold today (see Lind & Bowler, 2008 for a review). For example, Goddard, Howlin, Dritschel, and Patel (2007) found that adults with ASD recalled fewer specific memories from their past than their matched comparison participants, and took significantly longer to retrieve the ones that they could remember. Similarly, over two experiments Bruck, London, Landa and Goodman (2007) reported that children with ASD also recalled fewer episodes from their past, and fewer details than typically developing children for a previously participated in staged event.

Findings of impaired episodic recollection in ASD also indicate that people with the disorder have particular difficulties retrieving specific events. Indeed, Bowler et al. (2007) have shown that individuals with ASD place a greater reliance on 'knowing' or semantic memory - which is relatively unimpaired in ASD (e.g., Crane & Goddard, 2008), and are less likely to experience the type of conscious recollection - known as *autonoetic awareness* - that is the hallmark of episodic remembering (Tulving, 1985). As such, when prompted about an event that occurred in their past people with ASD tend to report knowledge the event, but fail to demonstrate the *autonoetic awareness* of 'reliving' it in its full spatio-temporal context in a manner that involves the self as the centre of the experience (see Lind & Bowler, 2008 for a review). Indeed, it has been argued that these episodic memory impairments reflect a failure in ASD to use self-involvement to facilitate their memory (e.g., Crane, Goddard & Pring, 2009; Goddard et al., 2007; Klein, Chan & Loftus, 1999; Toichi et al., 2002). This leads to deficits in recalling events that were personally experienced (e.g., Hare, Mellor & Azmi, 2007). For example, in contrast to typical individuals who are better able to recall events that were self-

performed than events that were performed by another person, children with ASD have been shown to recall events that they themselves performed less well than events that they observed being performed by a peer (e.g., Boucher & Lewis, 1989; Farrant, Blades & Boucher, 1998; Russell & Jarrold, 1999; but see Lind & Bowler, 2009b, and Williams & Happé, 2009). These findings suggest that if an individual with ASD finds themselves as a participant in a crime, be it as an active witness, victim or perpetrator, they may find it difficult to recall what happened. Moreover, as we discuss next, a number of facets of memory that contribute to this episodic deficit in ASD might also specifically shape the eyewitness testimony that they provide.

### Source monitoring

As mentioned in the previous section, episodic events comprise a number of perceptual, temporal, spatial, semantic and affective elements (Johnson, Hashtroudi & Lindsay, 1993). These elements need to be linked together at encoding in order to form a bound coherent representation that makes that episode distinct from other episodes (Schacter, Norman & Koutstaal, 1998). However, if these components are not sufficiently bound then source monitoring failures can occur, where one aspect or feature of the episode is retrieved but without the context of the rest of the episode. Thus, one may recall an element of the experience, but not which experience it was from.

In order to recall a specific experience, one also needs to be able to access individual elements of the episode to trigger the broader memory (e.g., Squire, 1995). Given that individuals with ASD often perform poorly on tests of episodic memory, it comes as no surprise that they also show source monitoring impairments in a number of areas. For example, they show impairments in recollecting whether they had performed an action or generated a word themselves or whether an experimenter had performed it (e.g., Farrant et al., 1998; Russell & Jarrold, 1999) and in recalling which of two stimuli were presented more recently (Bennetto et al., 1996). They also make more intrusion errors on recall trials on the California Verbal Learning Test (Bennetto et al., 1996) and show source monitoring failures for the format in which words were previously presented (Bowler et al., 2004).

Based on these empirical observations of impaired source memory in ASD one could tentatively predict that their eyewitness testimony might be affected in a number of ways. First, if an individual with ASD finds it difficult to remember where or when they learnt something, they might be more susceptible to confuse post-event details that, for example, they heard from a co-witness or read in a newspaper account, as being details that they actually witnessed themselves. Second, for the same reason they might be more suggestible to incorporate into their reports

erroneous details that are gained through leading questions (that contain misinformation in the form of the desired answer in the question). Third, if the witness has trouble remembering where or when they learnt something then recall of a specific event might be enmeshed with details from other events. Fourth, if a witness has difficulty pinpointing the source of their memories they may have difficulty in recalling a specific episode of an event that has occurred more than once or is embedded in daily activities, such as a commute into work. Fifth, they may have difficulty recalling the temporal order in which details of an event occurred (e.g., whether the criminal act occurred before or after the suspect had left the scene). In a criminal case this can mean the difference between convincing testimony versus diminished witness credibility.

### Task support hypothesis

Despite the memory difficulties experienced by individuals with ASD when tested using unsupported recall procedures (e.g., Bowler et al., 2008; Smith, Gardiner & Bowler, 2007), an accumulating body of evidence suggests that they can perform at a similar level to their typical counterparts if they are provided with appropriate support during the task. Bowler et al. (2004) coined the term task support hypothesis to account for findings from research utilising priming, recognition and cued recall paradigms showing that such memories are, at least in individuals without accompanying severe intellectual disability, implicitly intact in ASD (e.g., Bennetto et al., 1996; Boucher & Warrington, 1976; Bowler, Matthews & Gardiner., 1997; Bowler et al., 2004; Minshew, Goldstein, Muenez & Payton, 1992). It has been suggested that difficulties in deploying flexible strategies to recall details – caused by impairments in executive functioning (see Hill, 2004 for a review) – mean that there are fewer strategies available to access the information necessary to trigger remembering of the event (e.g., Hughes & Russell, 1993). Therefore the provision of more support for such strategies increases remembering. These findings are important from an eyewitness perspective because they suggest that recall impairments in ASD are more related to retrieval rather than encoding mechanisms, implying that more supportive retrieval mechanisms may help witnesses with ASD to recall more.

### Memory organisation and relational processing

Recent research has found that whilst individuals with ASD demonstrate intact or even enhanced item-specific processing, they experience difficulties in processing relations among elements of an experience. For example, they demonstrate difficulties in processing a stimulus in relation to its context such as the time of day or location (Gaigg, Gardiner & Bowler, 2008), with recalling items in their correct temporal order (e.g., Bennetto et al., 1996; Poirier, Martin, Gaigg

& Bowler, 2011), and fail to spontaneously use categorical relations among items to aid their recall (e.g., Hermelin & O'Connor, 1967; Bowler et al., 1997; Volkmar et al., 1996). Recollective experiences require that information is encoded and stored in relation to spatial and temporal contextual information (e.g., Peters, Daum, Gizewski, Forsting & Suchan, 2009), which might explain why individuals with ASD have problems recollecting episodic events.

Nevertheless, this item-specific and impaired relational processing style might actually be a positive feature of the disorder and enhance their eyewitness testimony if, for example, they are less susceptible to 'filling in the gaps' in their memory with highly plausible but inaccurate details. Indeed, Mottron and colleagues have suggested an enhanced perceptual processing account of ASD (e.g., Mottron, Dawson, Soulières, Hubert & Burack, 2006), whereby individuals with ASD have enhanced low-level processing. A related account is that individuals with ASD have weak central coherence, where their superior focus on details is counterbalanced by a reduced drive to extract overall meaning (see Happé & Frith, 2006 for a review). This increased perceptual expertise might even mean superior eyewitness performance for small but largely unrelated details that typical individuals would simply fail to perceive (see also Loth, Gomez & Happé, 2008; Shah & Frith, 1983). On the other hand, findings of diminished relational processing might mean that witnesses with ASD have difficulty comprehending and remembering the causal chain of events and relationships between persons and agents, and the order in which these details occurred. However, as is the case for other memory processes and in line with the task support hypothesis, if more support is provided, individuals with ASD can exploit the relations amongst items to enhance their recall to a similar level as that of their typical counterparts. Indeed, whilst early work demonstrated that individuals with ASD do not make use of semantic relations among items to aid their memory recall, when cued recall, more support for context, or superordinate category cues are provided their recall is undiminished (e.g., Boucher & Warrington, 1976; Gaigg et al., 2008; Minschew et al., 1992). This has important implications for police interviewing techniques, which we discuss later in this article.

### Emotion and memory

Individuals with ASD demonstrate marked abnormalities in emotional behaviours and do not process emotional stimuli such as faces and social scenes in the same way that typical individuals do (e.g., Norbury, Brock, Cragg, Einav, Griffiths & Nation, 2009; Spezio, Adolphs, Hurley & Piven, 2007). It has been argued that that people with ASD are relatively insensitive and inattentive to their social environment because of an abnormality of the amygdala – a limbic structure that plays a central role in responses to affective or emotionally charged stimuli (e.g.,



Baron-Cohen et al., 2000; Shultz, 2005). The amygdala is involved in the modulation of memory consolidation (e.g., Cahill & McGaugh, 1995, 1998; Canli, Zhao, Brewer, Gabrieli & Cahill, 2000) and in typical individuals, emotionally arousing events are both better remembered and forgotten less than neutral, non-arousing events (Bradley, Greenwald, Petry & Lang, 1992; Burke, Heuer & Reisberg, 1992; Cahill & McGaugh, 1998; Heuer & Reisberg, 1990; Kensinger & Corkin, 2003). Despite the role of the amygdala in ASD, only four empirical studies to date have specifically examined whether arousing events are also better remembered by individuals with ASD. Three of these studies have reported reduced enhancement effects for emotionally arousing words or visual scenes on memory in this group (Beverdors et al., 1998; Deruelle, Hubert, Santos, & Wicker, 2008; Gaigg & Bowler, 2008), and the other has reported typical modulation of arousing words to enhance recall (South et al, 2008). Given these findings, it might be tentatively predicted that individuals with ASD may not show memory enhancement effect for, or attenuated forgetting of, emotionally arousing events. Given that most criminal events will be, in some part at least, emotionally arousing, this is an important implication.

#### Implications of the memory profile of ASD for eyewitness testimony

Taking into account the findings on memory in ASD, it is often the case that two contrasting predictions can be made as to how individuals with ASD will fare as eyewitnesses. On the one hand, a number of findings would suggest that their testimony might be less complete and less accurate than that of their typical counterparts. Take, for example, a personally experienced event that involves a strong social element, and the recall of which requires understanding of the actions that occurred between people in a specific temporal order, in addition to being emotionally arousing. Most ASD researchers would agree that any of these elements could cause problems in remembering for an individual with ASD. Indeed, memory difficulties aside, sensory differences such as heightened sensitivity to noise, touch and light (e.g., Crane et al., 2009; Dawson & Watling, 2000) might mean that a witness with ASD will have difficulty screening out sensory stimuli, particularly in new situations. Therefore if either the witnessed event itself (at encoding) or the retrieval environment such as the police suite is noisy, echoes, or has fluorescent or buzzing strip lighting (as is often the case with police stations), a witness with ASD may find it difficult to attend to the speaker and give testimony to the best of their ability.

On the other hand, if an individual with ASD witnesses an event as part of their obsessive interests and where the event is non-social in nature (e.g., involving online activities such as IT fraud), with arbitrary details (as is the case with a lot of crimes that are briefly witnessed where

the ‘bigger picture’ is not always available), they may in fact make an excellent witness, over and above that of their typical counterparts. Similarly, if individuals with ASD rely less on context and follow more of an item-specific processing style they may be less likely to substitute gaps in their memory with details that fit with their ‘schemas’ for that type of event. On the same basis they might also be less susceptible to post-event misinformation, and if they have a diminished theory of mind then they may not pick up on the implicit demands of a questioner’s suggestive questions.

Either way, the specific and distinctive memory profile of individuals with ASD suggests that they may make a rather different type of witness than their typical counterparts. Moreover, if their memories are encoded, stored and/or retrieved in a different way from those of typical individuals, the psychological principles on which current police interviewing techniques are based may simply not be effective for witnesses with ASD. We now turn our attention now to work that has specifically examined this. A summary of these studies can be found in Table 1.

### **Research on eyewitness testimony in ASD**

How well do witnesses with ASD recall a previously witnessed event?

Based on the studies that have explored eyewitness recall in ASD to date, it seems that witnesses with ASD can recall as much and/or as accurately as their typical counterparts, if they are interviewed appropriately. McCrory, Henry and Happé (2007) used a live classroom event to compare eyewitness recall in 11-14 year-old children with ASD and their IQ-matched typically developing counterparts. McCrory et al. reported that whilst the children with ASD freely recalled around a third less information than the typically developing children did, they were no less accurate with regards to the proportion of errors or incorrect details that they reported at this stage. Nevertheless, the ASD group were significantly less likely to mention the most salient or gist elements of the event, indicating that they may be less aware of information that is socially salient in the context of an event. However, the use of guided and specific questioning effectively reduced group differences to the extent that both groups reported a comparable number of event and socially salient details.

Similarly, Bruck et al., (2007) reported that children with ASD recalled fewer details than typically developing children in response to autobiographical (life event) questions. In a second experiment, Bruck et al. set up a staged event in which ASD and typically developing children participated. Again, the ASD group recalled fewer details from the staged event than the comparison group. However in both experiments the details that they did report were

predominantly accurate. This implies that whilst children with ASD are more likely to either forget or fail to retrieve memories of personally experienced events, the details that they do report are just as accurate as those reported by typically developing children. Findings from these studies with children suggest that they are capable of providing valuable eyewitness testimony, although results from other studies with adults have reported that witnesses with ASD make more errors than their typical counterparts in their free-recall of a previously witnessed event (e.g., Maras & Bowler, 2011; Maras, Gaigg & Bowler, in press). It is also important at this point to note that these findings, which are based on research with high-functioning individuals, should be interpreted with caution when formulating conclusions for the wider autism spectrum. Low-functioning people with ASD, who have accompanying intellectual disability, will have broader memory difficulties on top of their ASD-specific memory impairments (Boucher, Mayes & Bigham, 2008). As a result, these individuals are likely to have poorer memory of an event. Research has yet to specifically explore this; therefore, any conclusions that we make about witnesses with ASD at present can apply only to high-functioning people with the disorder.

The question arises as to how effective existing police interviewing techniques are for interviewing witnesses with ASD. The 'Cognitive Interview' (CI) is currently the most widely recommended research-based police interviewing technique. However, in practice police officers often feel ill equipped or under too much time pressure to adequately apply it (Dando, Wilcock & Milne, 2008). When it is used appropriately, it increases the number of correct details reported without compromising accuracy for most witnesses, including children, the elderly and typical adults (see Memon, Meissner & Fraser, 2010 for a review) and increases the reporting of correct details by witnesses with intellectual disabilities (e.g., Milne, Clare & Bull, 1999). Despite the substantial amount of research on the CI with numerous different populations, only one study to date has explored how effective it is for witnesses with ASD (Maras & Bowler, 2010).

The CI is based on two basic principles of how memory typically operates; that retrieval of an event will be enhanced if the context experienced at recall matches that experienced during encoding (Fisher & Geiselman, 1992; Roediger, Weldon, Challis & Craik, 1989; Tulving & Thompson, 1973), and that memories are stored as interconnected nodes that provide multiple retrieval routes (Tulving, 1974). On the basis of these principles the full CI was constructed to comprise four stages: (a) context reinstatement, (b) imagery-guided questioning, (c) change the order of recall, and (d) change the perspective of recall. In context reinstatement witnesses are encouraged, in a series of verbal instructions by the interviewer, to mentally reconstruct the external (physical) and internal (subjective) states that they experienced during the witnessed event before freely reporting as many details of the event as possible. Recall of trivial or

incomplete details is encouraged (under the 'report all' instruction), since important facts may be elicited that co-occurred with seemingly unimportant events (Geiselman, Fisher, Mackinnon & Holland, 1986). Context reinstatement is followed by imagery-guided questioning, in which witnesses are asked open-ended questions based on what they said during their first free recall attempt. Further details are elicited by asking witnesses to summon and describe mental images of the event, for example focusing on the best image they have of the victim in order to describe their clothing. For the change order stage witnesses are then asked to recall the events in a different order, for example starting with the last thing they witnessed and working backwards in detail until they report the first thing they witnessed. Finally, the witness is asked to recall the event from a different perspective. For example, from the perspective of another person or imagining that they were positioned in a different location (Fisher & Geiselman, 1992). All four of these mnemonic strategies can elicit more detailed descriptions of a recalled event because witnesses are encouraged to access their memory through different routes (e.g., Schank & Abelson, 1977). The effectiveness of this strategy, however, depends on how a person stores and retrieves a memory in the first-place, and a substantial amount of evidence indicates that individuals with ASD may do so rather differently than typical individuals (Bowler & Gaigg, 2008).

Maras and Bowler (2010) compared recall performance of witnesses with ASD and their age- and IQ-matched typical comparisons under either the CI, or a Structured Interview, which had four recall attempts so that recall could be compared to the CI, but without the CI's cognitive mnemonics. Encouragingly, the ASD and comparison groups did not differ in terms of the quantity (number of correct details) or quality (accuracy) of their reports when interviewed with a Structured Interview. However, unlike the comparison group, the CI failed to increase the number of correct details that they reported, and actually made them less accurate relative to their typical counterparts, and this was so across all four stages of the CI. Difficulties with the change order and change perspective stages were expected, given that individuals with ASD have well-documented difficulties with temporal order memory (e.g., Bennetto et al., 1996), in adopting a frame of reference other than their own and on spatial working memory tasks (Minshew, Luna & Sweeney, 1999; Morris et al., 1999; Williams, Goldstein, Carpenter & Minshew, 2005; Williams, Goldstein & Minshew, 2006). Moreover, these last two stages of the CI are rarely used in practice by police officers in any case (Clarke & Milne, 2001; Dando et al., 2008).

What was at first glance surprising considering the task support hypothesis (Bowler et al., 1997, 2004), was that the context reinstatement stage was problematic and failed to elicit an increase in reporting of correct details. The question then arose of whether this stage is ineffective

because people with ASD fail to encode and bind an event with its contextual detail in the first place, or whether the difficulties lie in retrieving it. For example, context reinstatement is based on the exploitation of the relations between context and event details to trigger more details from memory, and individuals with ASD perform poorly on relational processing tasks (Gaigg et al., 2008). However, a number of lines of evidence suggest that the problem that individuals with ASD have with the traditional context reinstatement procedure is a retrieval one. For example, they have difficulties with a number of the cognitive demands of this procedure, including mental time travel (e.g., Lind & Bowler, 2008), following complex linguistic instructions (e.g., Goldstein, Minshew & Siegel, 1994), and integrating these verbal instructions with their visuo-spatial memory for the event (e.g., Kana, Keller, Cherkassky, Minshew & Just, 2006). Moreover, Bowler et al. (2008) reported that whilst ASD participants failed to make use of context to aid their memory on tests of recall, on recognition tests they were able to utilise context words that were presented at study to enhance their memory performance to a similar degree as typical individuals. Taken together, these findings suggest that, by reducing verbal-to-visual integration demands with more visual support, individuals with ASD may be able to draw on contextual details of an event to aid their memory.

In a follow-up study Maras and Bowler (in press) tested this notion by interviewing witnesses with ASD with the context reinstatement procedure either in a different room in which they witnessed the event, or in the same room. In line with the previous study (Maras & Bowler, 2010), the ASD group were significantly less accurate and recalled fewer correct details than their typical counterparts when interviewed with the context reinstatement procedure in a different room from which they witnessed the event. When they were interviewed with context reinstatement but back in the same place in which they had witnessed the event, however, their recall was enhanced to the level of their typical counterparts, suggesting that they can utilise context to facilitate their eyewitness recall if more support for context is provided. This is consistent with an under-connectivity account of ASD (Just, Cherkassky, Keller & Minshew, 2004), where difficulties in ASD are proposed to lie in integrating information from different domains (e.g., verbal and visual); the traditional context reinstatement procedure requires participants to follow a series of verbal instructions to trigger their visual memory for contextual details of the event. Moreover, individuals with ASD are thought to rely more on visual rather than verbal styles of processing, and use their perceptual representation system to facilitate their recall (see Ben Shalom, 2003). This goes some way in explaining why the verbal mental context reinstatement instructions are problematic for people with ASD, and has implications for enhancing the quality and completeness of their eyewitness reports in police interviews. To say

that returning to the scene of the crime would enhance the recall of witnesses with ASD would be somewhat of an overstatement, given that this conjecture is based on one study in a laboratory, but these findings do provide a platform for future work to build upon, which we discuss in more detail in the future research directions section below.

In eyewitness research, particularly that utilising the CI, each detail that a participant reports is often broken down into whether it pertains to a person, action, surrounding or object. A consistent finding across Maras and Bowler (2010) and Maras and Bowler (in press) is that participants with ASD report fewer person and action details. This is not surprising when one considers the social impairments that characterise ASD, coupled with previous findings of diminished attention to social cues by individuals with ASD when observing social situations (e.g., Klin, Jones, Schultz, Volkmar, & Cohen, 2002a, 2002b; Norbury et al., 2009). ASD and comparison participants do not, however, differ in their reporting of details relating to surroundings and objects. These findings are again not surprising; individuals with ASD would not be expected to have difficulty in recalling non-social aspects of an event, particularly given that these can be recalled using more of a rote or item-specific strategy. The practical implications of these findings are that when relying on an ASD witness's report for evidence, details that relate to surroundings and objects are likely to be more reliable than details that pertain to persons and actions. The type of interview did not differentially affect the reporting of these details in Maras and Bowler (2010; in press) however, and future work should examine whether there are more supportive interview techniques that can specifically help to increase the quantity and accuracy of person and action details.

How suggestible are witnesses with ASD?

Four studies to date have explored suggestibility in ASD, two with children and two with adults. Following free recall and specific questioning for a previously witnessed staged event, McCrory et al. (2007) asked their child participants a series of leading questions, each of which entailed an incorrect assumption (e.g., "what colour was the man's scarf?" when in fact there was no scarf). McCrory et al. found no difference between groups for suggestibility to misleading information. That is, the use of leading questions increased the reporting of details that did not occur in line with the suggested answer by witnesses with ASD, but no more than was the case for the typically developing children. However McCrory et al. caution against generalising these findings regarding comparable suggestibility between groups to having comparable compliance, and highlight the importance for further research to investigate whether individuals with ASD might be more likely to go along with propositions, whilst not necessarily accepting them as true.

Bruck et al. (2007) also reported no difference in suggestibility between ASD and comparison groups of children. However, in a second experiment where participants completed an autobiographical questionnaire, Bruck et al. included three “silly” items (e.g., “Have you ever helped a lady find a monkey in the park”). These were mixed in with the 12 life event questions in their questionnaire in order to ascertain that answers were reliable. As expected, the typically developing children were less suggestible to the silly questions than to the life event questions. The ASD children, however, were equally as suggestible to both types of questions. Bruck et al. have argued that because the ASD children were only more suggestible than the typical children for the silly questions, but not for the 12 more plausible life event questions, that this effect does not simply reflect a greater compliance to leading or suggestive questioning. Instead, it appears to reflect a constant pattern of compliance across suggestion type, whether it is related to what actually happened or not. Thus, whilst the ASD and typical children were equally as suggestible to questions that were familiar to what actually happened, the typically developing children appeared to use their complete lack of unfamiliarity to never before heard false items to reject suggestions by the interviewer. By contrast, the children with ASD failed to use a lack of familiarity to identify the interviewer’s suggestions as a whole different version of events, meaning they were as suggestible to these questions as they were the more plausible questions. These findings have important implications for legal questioning in real-life cases whereby children with ASD may be more susceptible to acquiesce to biased interviewers who either do not believe the child’s version of events, or wish to elicit an entirely different version of events from them in order to defend or acquit a suspect. Whereas typical individuals appear to be resistant to such an outright change in versions of events, it is possible that children with ASD might be more malleable in their testimony.

In the third study to assess suggestibility in ASD, North, Russell and Gudjonsson (2008) used the Gudjonsson Suggestibility Scales (Gudjonsson, 1997) to measure suggestibility and compliance in high-functioning adults with ASD. North et al. reported that, in line with McCrory et al. (2007) and Bruck et al. (2007), the ASD group were no more or less suggestible to leading questions and negative feedback than their typical counterparts. However, North et al. did report that the ASD group scored higher on a compliance questionnaire than their matched comparison participants, which indicates an increased tendency to accede to propositions put forward by another person, even though privately they disagree with them. This finding of increased compliance in ASD is important because it suggests that in forensic interviewing contexts witnesses or suspects with ASD might be more prone than typical individuals to respond compliantly to the requests and demands of the interviewer, even if they do not actually hold this

information as being true. Moreover, heightened compliance might also mean greater susceptibility to exploitation by others, leading to increased victimisation and bowing to pressure to commit offenses. This has important practical implications and warrants further examination using more ecologically valid compliance scenarios.

In the fourth study examining suggestibility in ASD, Maras and Bowler (2011) explored whether high-functioning individuals with ASD might actually be less suggestible to schema-related misinformation effects. Because individuals with ASD have more of a item-specific processing style (Gaigg et al., 2008), show reduced generalised event knowledge (Loveland & Tunali, 1993) and are impaired in their ability to spontaneously generate core elements defining everyday events, such as going to a restaurant or the cinema (Volden & Johnston, 1999), it was predicted that they may also be less susceptible to incorporating schema-typical post-event misinformation into their subsequent reports than their typical counterparts. Participants were presented with a mock newspaper extract about a previously witnessed slide sequence of a bank robbery. The extract contained some inaccurate items of misinformation that were either typical (e.g., that a customer was forced to lie on the floor) or atypical (e.g., that the robbers held the door open for a customer before entering the bank) with bank robbery schema. Contrary to predictions, ASD and comparison witnesses were equally suggestible, and both groups incorporated more schema typical than atypical post-event misinformation into their subsequent reports. This suggests that high-functioning individuals with ASD do use their existing schemas to aid their memory, leading them to erroneously report schema-consistent but inaccurate details. The ASD group did however recall fewer details and made more errors in their free recall than the comparison group overall.

From these four existing studies exploring eyewitness suggestibility in ASD, one might tentatively suggest that individuals with ASD may freely recall less information from an event, particularly with regards to gist or social salience (e.g., McCrory et al., 2007), but that, high-functioning individuals at least, are no more or less suggestible than their typical counterparts. Future research would be valuable in exploring whether these findings still stand for low-functioning individuals, and when other forms of suggestive influences are encountered. Given the social difficulties that characterise ASD it would be interesting to see if they are as susceptible to co-witness conformity effects if they discuss the event with a co-witness who reports a slightly different version of events (e.g., Gabbert, Memon and Allen, 2003).

Given North et al's findings of heightened compliance in ASD, it might also be interesting to explore whether witnesses with ASD can be made to change their reports as easily as their typical counterparts are under adversarial styles of questioning, such as that used in cross-



examination (e.g., Valentine & Maras, 2011). There are a number of factors that might predict that under such circumstances individuals with ASD would be more suggestible. Executive functioning impairments and difficulties in following complex verbal dialogue may mean difficulties for witnesses with ASD in comprehending the sort of long-winded multiple part questions with complex syntax that barristers tend to favour, even when they are questioning witnesses with intellectual disabilities (e.g., Kebbell, Hatton & Johnson, 2004). It may also be difficult for individuals with ASD to comprehend why they are being challenged on details to which they know the barrister already knows the answer. Even higher-functioning individuals who have ‘bootstrapped’ a theory of mind (e.g., Happé, 1995) are likely to struggle with double negative questions (e.g., “is it not the case that the weapon was not visible before the attack?”), and accusatory styles of questioning for details that they have already clarified in previous interviews and they know that the barrister also knows. This would be an interesting area for future research to explore.

How well do witnesses with ASD recall emotionally arousing events?

As noted in the memory section above, a substantial body of research shows that ASD is characterised by difficulties in emotional processing domains (e.g., Dawson, Spencer & Galpert, 1990; Hobson, 1991; Kamio, Wolf & Fein, 2006; Kasari, Sigman, Mundy & Yirmiya, 1990; Yirmiya, Sigman, Kasari & Mundy, 1992). Coupled with findings of reduced enhancement effects for emotionally arousing words or visual scenes on memory in ASD (Beverdort et al., 1998; Deruelle et al., 2008; Gaigg & Bowler, 2008), this suggests that individuals with ASD may have difficulties recalling a previously witnessed emotionally arousing event. However, over two experiments using more dynamic eyewitness stimuli (a slide sequence with accompanying narrative in Experiment 1, and a videoed event in Experiment 2), Maras et al. (in press) found that individuals with ASD recalled more details from arousing versions of the events than they did from neutral versions of the same events. Moreover, in contrast to previous findings with word lists (Gaigg & Bowler, 2008), both ASD and comparison groups showed attenuated forgetting of the arousing versions over a one-day and one-week delay, whilst details from the neutral versions were forgotten more over increasing delays. Both groups also appeared to demonstrate enhanced physiological arousal for the arousing over the neutral story versions, suggesting that the event may have elicited an orienting response in arousal (with a decrease in heart rate) and indicating that arousal may typically modulate memory for individuals with ASD for this type of event. A possible explanation for the discrepant findings between Gaigg and Bowler (2008) and Maras et al. (in press) is that the former used word lists whilst the latter used

more dynamic slide sequence/video stimuli, which may have formed more of an interesting narrative than lists of unrelated words. This might have led to more of an orienting response (as opposed to a defensive response) to the stimuli (see Christianson, 1992 for a review). The implication from this is that high-functioning individuals with ASD are similarly affected by arousing events, remembering them equally as well as their typical counterparts and forgetting them less than neutral events. However, this conclusion is tentative given that it is based on the findings from two experiments in the laboratory. Future work should explore this using more real-life eyewitness events that are experienced in real time rather than viewed on a video or in slides. It might also be worthwhile for future work to vary the valence of the arousal by comparing memory for positively versus negatively arousing events, thus manipulating the type of responses (i.e. orienting, which decreases heart rate compared to defensive, which increases heart rate) with different types of eyewitness stimuli.

INSERT TABLE 1 HERE

### **Implications for practice**

From the rather sparse work that has explored eyewitness testimony in ASD to date, it seems that high-functioning witnesses with ASD are capable of providing reliable testimony and are no more suggestible than their typical counterparts, but that the currently recommended police interviewing technique (the CI) is unsuitable for them. Once additional research has replicated and extended this work, it will be important to ensure that findings appropriately inform investigative practice. It has been reported that police officers often feel that they do not receive enough training on interviewing even typical witnesses (ACPO, 2004; Clarke & Milne, 2001; Dando et al., 2008), and a number of researchers have expressed concern that those working within the criminal justice system are ill-equipped to respond effectively to those with ASD (e.g., Allen et al., 2008; Bather, Fitzpatrick & Rutherford, 2008; Browning & Caulfield, 2011; Haskins & Silva, 2006; Mayes, 2003; Murrie, Warren, Kristiansson & Dietz, 2002). Browning and Caulfield (2011) argue that all of those involved in the criminal justice system – from policy makers, the police, intermediaries, the crown prosecution service, the judiciary to probationers – need to receive access to training or have access to trained colleagues who understand and can meet the needs of witnesses, victims or suspects with ASD.

With regards to how the police interview witnesses with ASD, it is one thing to speculate from empirical research about what specific procedure would work best, but quite another to implement that procedure when a busy police officer finds him/herself interviewing a witness

with ASD at short notice. Police forces in England, Wales and Northern Ireland currently have five levels of investigative interviewing training ranging from probationers at Tier 1, uniformed investigators and detectives at Tier 2, specialist interviewers for vulnerable, intimidated and significant witnesses, and suspects in major crimes at Tier 3, supervisors at Tier 4, and interview advisers at Tier 5 who comprise a small number of skilled interviewers who are called in to assist with the planning of major and/or complex interviews (ACPO, 2001). Somewhere towards Tier 5 investigative interviewers could be more informed about the specific memory profile of individuals with ASD and how best to interview them. In conjunction with the UK charity the National Autistic Society, police forces in England and Wales have recently introduced the use of an 'Autism Alert Card', which individuals with ASD can carry at all times to alert the police and other emergency services that they have an ASD. This card will undoubtedly prove useful in raising awareness of ASD amongst investigative professionals and ensure that basic communication is improved, for example by the interviewer asking questions in simple terms without the use of irony or metaphors. Whilst tentative implications might be offered from existing research in terms of appropriate interviewing techniques for witnesses with ASD (e.g., that the CI should not be used – see Maras & Bowler, 2010; Maras & Bowler, in press), at present the relative scarcity of this work means that replication and extension of these findings are needed to justify firmer recommendations.

It is of relevance to investigative practice that ASD often co-occurs with psychiatric or specific clinical conditions such as anxiety (Gillot, Furniss & Walter, 2001), depression (see Stewart, Barnard, Pearson, Hasan & O'Brien, 2006), and Tourette syndrome (Baron-Cohen, Scahill, Izaguirre, Hornsey & Robertson, 1999). ASD can also co-occur with non-specific conditions such as speech and language disorders (Rapin & Dunn, 2003), hearing impairments (Rosenhall, Nordin, Sandström, Ahlsén & Gillberg, 1999) and visual impairments (Pring 2005). Research in ASD generally tends to exclude participants who have other co-occurring disorders in order to strengthen conclusions that any difference between groups is due to the ASD, and not the co-occurring condition or the medication being taken to treat it. Nevertheless, such stringent participant selection may be a drawback to the generalisability of findings to the actual ASD population, of which such individuals with co-occurring disorders comprise a significant part (see Mohiuddin, Bobak, Gih & Ghaziuddin, 2011). For example, depression in itself can have consequences for memory (see Burt, Zembor & Niederehe, 1995, for a meta-analysis), but in addition an individual with co-occurring depression may also be taking an antidepressant such as amitriptyline, which can also produce memory loss (e.g., Spring, Gelenberg, Garvin & Thompson, 1992). Similarly, visual impairments have obvious implications for eyewitness

performance, and a speech and language disorder will affect their understanding of questions and ability to give comprehensible reports in interviews. Indeed, research that excludes individuals with such co-occurring disorders may actually over-estimate eyewitness accuracy. In practice therefore, the whole profile of the individual in question should be taken into account when considering which factors are likely to affect their eyewitness accuracy.

Whilst no research to date has explicitly explored how the sensory needs of individuals with ASD can be met during police and judicial procedures, what we know about the disorder implies that a distraction free environment together with techniques that avoid that particular individual's triggers to fear, anxiety and panic will help the interview process run more smoothly and ensure the witness can give evidence more effectively. Indeed, the National Autistic Society has recently produced guidance for those working within the criminal system that outlines a number of the sensory difficulties that people with ASD often experience and how this might affect their behaviour in police interviews (National Autistic Society, 2011). It is important that investigators plan interviews ahead to avoid any sensory 'triggers' for witnesses with ASD, for example ensuring that the interview room is not one with strobe lighting, and avoiding noisy and crowded areas. It is a positive step forward that these sensory manifestations are recognised in the information videos for the Autism Alert Card that are shown to police officers.

### **Future research directions**

Several potentially fruitful directions for future research have been mentioned throughout this review. There are, however, a number of particularly pertinent avenues for future research that we have not yet discussed. Firstly, a significant limitation of the studies that have explored eyewitness testimony in ASD to date is that they have recruited relatively high-functioning participants with ASD. High-functioning ASD samples are useful starting points for new research because results reflect the effects of the disorder in what can be argued as its 'pure' form, rather than being confounded by additional intellectual impairments. Since approximately 55% of the ASD population is characterised by developmental delays in global cognitive functioning with an IQ < 70 (Baird et al., 2006), the existing work has serious limitations in its generalisability to the wider ASD population. A next step will be to extend the existing findings to lower-functioning individuals on the autism spectrum. Intellectual disability in itself has consequences for memory (see Lifshitz, Shtein, Weiss & Vakil, 2011, for a meta-analysis), which means that in addition to the specific memory difficulties that are associated with the disorder, lower-functioning witnesses with ASD are also likely to have broader difficulties in remembering an event. Moreover, lower-functioning ASD individuals with ASD often have impaired or delayed language development

(see Boucher et al., 2008), which will undoubtedly affect their ability to understand and comprehensively answer interview questions. The CI's context reinstatement procedure, for example, which has already been shown to be problematic for high-functioning individuals with ASD (Maras & Bowler, 2010; Maras & Bowler, in press), is likely to be particularly difficult for lower-functioning individuals with language impairments, given that it requires the ability to follow a series of verbal instructions in order to reinstate the context.

Research that has examined the abilities of eyewitnesses with ASD to date has also done so from the assumption that the individual is a witness to, rather than perpetrator of, the criminal event. Since findings from several lines of research suggest that people with ASD can also be responsible for committing criminal acts (see, e.g., Allen et al., 2008; Browning & Caulfield, 2011; Howlin, 1997; Woodbury-Smith et al., 2005; Woodbury-Smith, Clare, Holland & Kearns, 2006), future work is needed to explore how people with ASD who have actually perpetrated the act behave when asked to testify. For example, given the difficulties that people with ASD have in incorporating their concept of the self when recollecting episodic events (e.g., Crane & Goddard, 2008; Crane et al., 2009; Lind, 2010; Lind & Bowler, 2009a, 2010), they may struggle to recall such an event where they played an active causal role, particularly when combined with the increased interrogative pressure of being questioned as a suspect.

It might also be fruitful for future work to replicate and extend the findings from Maras and Bowler (in press), which showed that whilst the traditional context reinstatement instructions were problematic for witnesses with ASD, physically returning to the environmental context enhanced their recall to a similar level of their typical counterparts. If the traditional context reinstatement procedure is problematic because of the language (i.e. verbal) to mental imagery (i.e. visual) demands, then it is possible that other, more logistically feasible, interviewing techniques might help. For example, the use of photographs of contextual aspects of the scene of the event in combination with the traditional verbal instructions might also be effective in reinstating context and enhancing recall, by reducing verbal-to-visual integrative demands. Moreover, whilst previous work indicates that the CI and the context reinstatement procedure are ineffective for witnesses with ASD, it will be important to tease apart the exact mechanisms that contribute to this lack of effectiveness. For example, an important component of the CI is 'rapport building', yet attempting to build rapport with a witness who finds small talk difficult may only serve to heighten their anxiety and impair their performance. Further, establishing rapport is also based on an interaction between the interviewer and the interviewee. It may be that people with ASD find social element of the CI difficult, and if this is the case then they may benefit from an adapted technique that removes this social component, such as a Self-

Administered Interview tool (Gabbert, Hope & Fisher, 2009), or by drawing a sketch-plan of the event to supplement and aid their verbal recall (e.g., Dando, Wilcock & Milne, 2009). Indeed, given that people with ASD often show enhanced spatial abilities (e.g., Caron, Mottron, Rainville & Chouinard, 2004), drawing the event may prove a very effective interviewing tool to enhance their recall.

As briefly mentioned earlier, people with ASD have difficulties with remembering the temporal order of details, for example with serial recall of word order (e.g., Poirier et al., 2011) or judging which of two events occurred more recently (e.g., Bennetto et al., 1996). Whilst they tend to remember individual items well, they have difficulty in processing the relations between these items. The coding schemes used in eyewitness research to date have not explicitly scored recall for the order in which details are reported, nor has research utilised questions that specifically probe how well witnesses with ASD recall complex sequences of elements of an event. In forensic investigations, small variations in the sequences of events reported by a witness can have large implications for the investigation. If, as would be predicted by previous empirical work with words and digits, individuals with ASD have difficulty recalling the temporal order of event details, there might be appropriate interview strategies that could help by providing more support with temporally-structured questions or instructions. For example, Hope, Mullis and Gabbert (2011) have recently developed an interview tool in the form of an actual time line to support witnesses sort the details of an event into their correct temporal order. This interviewing tool has been shown to improve temporal order recall by typical witnesses, and it might also be effective for witnesses with ASD.

Finally, whilst the development of interviewing techniques that enhance the eyewitness reports of individuals with ASD is important in increasing the veracity of their reports, this will hold little weight if magistrates and jurors do not perceive the witness to be credible when they come to provide their evidence in court. Moreover, police officers may adopt a more aggressive interviewing style towards a witness who appears dishonest, which could have a particularly detrimental effect on how a witness with ASD responds in return. Individuals with ASD exhibit a number of behaviours that are likely to reduce their appearance of credibility, including a lack of eye contact (see Senju & Johnson, 2009) and repetitive and stereotyped body movements (e.g., Gritti et al., 2003; Lewis & Bodfish, 1998). We know from previous work with typical witnesses, for example, that displays of nervous behaviour (Bothwell & Jalil, 1992) and inappropriate emotions (e.g., Dahl et al., 2007; Kaufmann, Drevland, Wessel, Overskeid & Magnussen, 2003) strongly influence the perceived credibility of the witness. Moreover, whilst the present article has focussed on the abilities of witnesses with ASD to produce factually accurate recall, a large

body of research shows that people with ASD also experience difficulties in organising their narratives (e.g., Losh & Capps, 2003; Loth et al., 2008; Loveland, McEvoy & Tunali, 1990). Previous work with witnesses with intellectual disabilities has shown that ratings of credibility are lower if the communication style of the witness differs from the jury's expectations (Schmidt & Brigham, 1996). This is crucial because jurors who do not believe the witness are less likely to find the defendant guilty (e.g., Bottoms & Goodman, 1994; Myers et al., 1999). It will therefore be important for future work to examine how the behavioural manifestations associated with ASD present to jurors, magistrates and police officers, and to explore whether educating people on the disorder helps to reduce any such biases.

To conclude, findings of the capabilities of witnesses with ASD to date suggest that, high-functioning individuals at least, are capable of recalling as much and as accurately from a previously witnessed event as their typical counterparts. Future work is needed to replicate and extend these findings, particularly to include lower-functioning individuals on the wider autism spectrum and to explore practical interviewing techniques that might be effective in enhancing their recall. Investigative professionals might benefit from planning ahead for interviews for witnesses with ASD in order to optimise the interviewing environment and interviewing protocol to elicit the most detailed, yet accurate, testimony from them.

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Table 1. Summary of studies exploring eyewitness testimony in ASD to date, including samples, measures, and main findings.

<b>Author</b>	<b>Sample</b>	<b>Event</b>	<b>Interview paradigm/recall measures</b>	<b>Main findings</b>
McCrorry, Henry & Happé (2007)	24 ASD (VIQ = 103) and 27 TD (VIQ = 102) children; 11-14 years.	Live classroom event with neutral and socially salient sub-scenes.	Free recall followed by general and specific questions with misleading questions at the end (1 day after event).	Free recall by ASD group less complete (with fewer gist elements), but no less accurate than TD group. No group differences in amount of new details elicited by questions, and no group differences in suggestibility.
Bruck, London, Landa & Goodman (2007)	30 ASD (FIQ = 96) and 38 TD (FIQ = 105); 5-10 years.	Staged event (magic show), where child was recipient of some of the magic activities.	Participants given true and false reminders about event, and leading and misleading questions (8 days after event). Free recall and yes/no questions asked further 4 days later. Autobiographical memory questionnaire also administered in earlier session.	ASD group recalled fewer details from both staged event and autobiographical questionnaire. No groups differences in errors or suggestibility to false reminders, but ASD group more likely to assent to false control questions about show. ASD group also less likely to reject never-before heard 'silly' items on autobiographical questionnaire.
Maras & Bowler (2010)	26 ASD (VIQ = 108) and 26 TD (VIQ = 112) adults.	Video of car park stabbing incident viewed on a large projector screen.	Interviewed with either full Cognitive Interview or a comparison Structured Interview (30-60 mins after event).	No group differences in correct details reported or accuracy when interviewed with Structured Interview. Cognitive Interview failed to increase amount of correct details reported by ASD group, who were less accurate than TD group, particularly for person and action details.
Maras & Bowler (in press)	28 ASD (VIQ = 111) and 28 TD (VIQ = 110) adults.	Photographs of everyday scenes.	Context reinstatement instructions followed by free recall, either in same or different room in which photographs were viewed (1 hour after event).	ASD group recalled fewer correct details and were less accurate than TD group when interviewed in different room, but no group differences when interviewed in same room. ASD group impaired on reporting of person

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				and action details overall.
North, Russell & Gudjonsson (2008)	26 ASD and 27 TD adults (IQs not stated but sample excluded participants with IQ < 70).	Gudjonsson Suggestibility Scales (GSS 2); Gudjonsson Compliance Scale (GCS).	Free recall (immediately and again after 1 hour delay) followed by misleading questions and negative feedback on GSS, and questionnaire measuring compliance on GCS.	No differences between groups on any of GSS measures (free recall or suggestibility). ASD group scored as significantly more compliant on GCS.
Maras & Bowler (2011)	16 ASD (VIQ = 110) and 16 TD (VIQ = 111) adults.	Slide sequence of photographs of bank robbery.	Exposed to schema-typical and atypical post-event misinformation 20 mins after event. Provided written free recall and answered questions relating to misinformation 20 mins later.	Free recall by ASD group less complete and less accurate than TD group. Both groups reported more schema typical than atypical misinformation, and no group differences in amount of misinformation (typical or atypical) reported.
Maras, Gaigg & Bowler (in press)	19 ASD (VIQ = 109) and 19 TD (VIQ = 109) adults (Experiment 1); 24 ASD (VIQ = 113) and 24 TD (VIQ = 111) adults (Experiment 2).	Arousing or neutral versions of a narrated slide sequence (Exp. 1) or video clip (Exp. 2).	Written free recall and forced choice recognition approx. 12 days later (Exp. 1) and written free recall immediately, 1-hour, and 1-day later (Exp. 2). Physiological measures of arousal also taken during viewing of event.	In both experiments, arousing story versions elicited heightened physiological responses and attenuated forgetting rates (more correct details) than neutral story versions, and did so similarly in both groups. Overall, ASD group freely recalled more incorrect details (Exp. 1) and fewer correct details (Exp. 2) than TD group.

Key: ASD = Autism Spectrum Disorders; TD = typically developed comparisons; VIQ = Mean Verbal IQ; FIQ = Mean Full-Scale IQ.