Recall of a live and personally experienced eyewitness event by adults with autism spectrum disorder

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Running Head: Experienced eyewitness events in ASD

ABSTRACT

The aim of the present study was to a) extend previous eyewitness research in autism spectrum disorder (ASD) using a live and personally experienced event; b) examine whether witnesses with ASD demonstrate a facilitative effect in memory for self- over other-performed actions; c) explore source monitoring abilities by witnesses with ASD in discriminating who performed which actions within the event. Eighteen high-functioning adults with ASD and 18 age- and IQ-matched typical counterparts participated in a live first aid scenario in which they and the experimenter each performed a number of actions. Participants were subsequently interviewed for their memory of the event using a standard interview procedure with free recall followed by questioning. The ASD group recalled just as many correct details as the comparison group from the event overall, however they made more errors. This was the case across both free recall and questioning phases. Both groups showed a self-enactment effect across both interview phases, recalling more actions that they had performed themselves than actions that the experimenter had performed. However, the ASD group were more likely than their typical comparisons to confuse the source of self-performed actions in free recall, but not in questioning, which may indicate executive functioning difficulties with unsupported test procedures. Findings are discussed in terms of their theoretical and practical implications.

Key words: autism spectrum disorder; eyewitness; self-enactment effect; source monitoring; memory

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Autism Spectrum Disorder (ASD) is a developmental disorder that is characterised by a triad of impairments in social interaction, communication and flexible imagination (American Psychiatric Association, 2000). It affects how an individual makes sense of the world around them and how they communicate with and relate to other people. Memory difficulties are also well-documented in the disorder (discussed in more detail below) allowing novel predictions to be made regarding the capabilities of individuals with ASD as eyewitnesses. Moreover, a number of 'risk' factors indicate that people with autism may be more highly represented in the Criminal Justice System than their 1% representation in the general population, as a victim, witness, or even perpetrator of a crime (e.g., Allen et al., 2008; Howlin, 1997; Petersilia, 2001; Woodbury-Smith et al., 2005, but see Woodbury-Smith, Clare, Holland & Kearns, 2006). It is therefore important to understand not only how well individuals with ASD recall events that they have passively observed, but also how well they recall events in which they played an active role.

ASD is associated with an uneven memory profile: rather than having a poor memory *per se*, some functions, including semantic memory (e.g., Bowler & Gaigg, 2008), recognition memory and cued recall (e.g., Bennetto, Pennington & Rogers, 1996) tend to be preserved, at least in high-functioning individuals with the disorder. Other memory abilities on the other hand, such as recalling the source of memories (e.g., Bowler, Gardiner & Berthollier, 2004), the spontaneous employment of organisational strategies to aid memory (e.g., Gaigg, Gardiner & Bowler, 2008) and the episodic recollection of personally experienced events (e.g., Crane & Goddard, 2008; Crane, Goddard & Pring, 2009; Klein, Chan & Loftus, 1999; Millward, Powell, Messer & Jordan, 2000), are often reported to be

diminished in ASD compared to their typical counterparts, at least when unsupported test procedures are used. Several studies have now explored how this patterning of memory affects eyewitness testimony in ASD (see Maras & Bowler, in press, for a review), however the pattern of findings is mixed. Some studies report that witnesses with ASD freely recall fewer correct details (Bruck, London, Landa & Goodman, 2007; Maras & Bowler, 2011; Maras, Gaigg & Bowler, 2012; McCrory, Henry & Happé, 2007; North, Russell & Gudjonsson, 2008, but see Maras & Bowler, 2010, 2012), and some report they make more errors or are less accurate (Maras & Bowler, 2011, Maras et al., 2012, but see Bruck et al., 2007; Maras & Bowler, 2010, 2012, McCrory et al., 2007; North et al., 2008).

Two studies to date have explored eyewitness testimony by children with ASD using a live event, although the event in these was passively observed rather than enacted. McCrory et al. (2007) used a live classroom event and reported that whilst children with ASD freely recalled around a third less information than typically developing children did, they were no less accurate with regards to the proportion of errors or incorrect details that they reported. Bruck et al. (2007) also reported that ASD children reported fewer correct details than comparison children in response to both free recall and specific questions about a previously witnessed magic show. Of the studies with adults, none to date have used a live eyewitness event, or an event in which the witness has actively participated. This is pertinent given that it is now well established that individuals with ASD experience difficulties in reflecting on the self (e.g., Crane et al., 2009, and see Lind, 2010), which extend to impairments in episodic memory (e.g., Crane & Goddard, 2008; Klein et al., 1999). Indeed, a number of studies have demonstrated that individuals with ASD experience particular difficulties recalling specific and personally experienced autobiographical events (e.g., Bruck et al., 2007; Goddard, Howlin, Dritschel & Patel, 2007). This impairment is in the absence of a personal semantic

memory deficit (Crane & Goddard, 2008), indicating that it is a deficit related to episodic memory and *autonoetic* awareness, rather than simply a poor memory *per se* (Bowler, Gardiner & Gaigg, 2007; Bowler, Gardiner & Grice, 2000). These findings have led a number of researchers to suggest that deficits in self-awareness in ASD lead to impairments in episodic memory and a failure to use self-involvement to facilitate their memory (e.g., Crane et al., 2009; Klein, 2001; Millward et al., 2000; Powell & Jordan, 1993). If correct this has important implications for the eyewitness abilities of individuals with ASD.

The role of the self in facilitating memory in typical individuals is purported to be due to more effective encoding by use of a highly organised structure of self-concept (Symons & Johnson, 1997). The self-enactment effect refers to better memory for actions that are self-performed than actions that are observed being performed by another person (e.g., Baker-Ward, Hess & Flanagan, 1990). Whilst self-concept inevitably plays a role in enhancing encoding, it has also been suggested that a self-enactment effect results from the additional *motoric* component of self-performed actions leading to more salient memory traces (Engelkamp & Zimmer, 1985, 1989). Given the motor difficulties (e.g., Ming, Brimacombe & Wagner, 2007) coupled with diminished self-awareness in ASD (see Lind & Bowler, 2010), it may come as little surprise that a number of researchers have reported a diminished or absent self-enactment effect in ASD (e.g., Dunphy-Leli & Wellman, 2012; Farrant, Blades & Boucher, 1998; Hare, Mellor & Azmi, 2007; Millward et al., 2000; Russell & Jarrold, 1999; Wojcik, Allen, Brown & Souchay, 2011). Russell and Jarrold (1999), for example, asked children with ASD, children with moderate learning difficulties (to act as IQ matches for the ASD group) and typically developing children to remember whether they or the experimenter had placed a picture card on a grid, either on their own behalf or on behalf of a doll partner. The children with ASD were worse than both the typically developing children and children

with learning disabilities at recalling whether they or the other person had placed a card onto the grid. Moreover, the children with ASD were actually worse at recalling which cards they had placed themselves compared to cards that were placed by the experimenter.

It has been argued that individuals with ASD may not benefit from memory enhancement for self-performed actions because they fail to fully integrate visual and sensori-motor signals (Wilson, Rojas, Reite, Teale & Rogers, 2007). However, Williams and Happé (2009) adapted a previously used paradigm by Russell and Hill (2001) to include a more specific test of the action monitoring deficit hypothesis. In this task, participants held a computer mouse and either moved it intentionally themselves, or kept hold of it whilst the experimenter moved it. Some of the different coloured squares on the screen moved consistently with the movements of the mouse, and some were moved randomly by the computer and thus the mouse movements on these trials were unrelated. If self-performed actions do not result in better encoding then individuals with ASD should show no difference in identifying which of the different coloured squares had moved when they intentionally moved the mouse themselves or whether the experimenter moved the mouse that they held. It was predicted that typical individuals, by contrast, who have a well-developed experienced of the self as an agent, should find the 'other' condition significantly more difficult. However, both groups found it easier to identify the target square when they were in control of the movement than when they simply felt the experimenter move it. In a second experiment, Williams and Happé (2009) failed to replicate Russell and Jarrold's (1999) findings of an absent self-enactment effect and reported that the ASD group, as was the case with their typical comparisons, found it easier to monitor and recalled more of their own actions than those of another person.

Several other researchers have also reported an intact enactment effect for self-performed actions in ASD (e.g., Hare et al., 2007; Lind & Bowler, 2009; Summers & Craik, 1994; Zalla, Daprati, Sav, Chaste, Nico & Leboyer, 2010), which is problematic for an action monitoring deficit account. It is possible that the reported difficulties in utilising the role of the self in facilitating memory may be dependent on the test procedure used. Findings of intact semantic autobiographical memory but diminished personal episodic memory (e.g., Crane & Goddard, 2008) and of an increased reliance on "knowing" alongside diminished autonoetic awareness as measured by "remember" responses in ASD (Bowler et al., 2000), have led Bowler and colleagues to propose the task support hypothesis (Bowler, Matthews & Gardiner, 1997; Bowler et al., 2004). According to this account, difficulties in retrieval by individuals with ASD, as evidenced by their poorer performance compared to typical individuals, are largely eliminated when more support for retrieval is provided at test, such as that in the form of cued recall or recognition tests (cf. environmental support hypothesis, see Craik & Jacoby, 1996). Individuals with ASD tend not to differ from typical individuals in performance on these tests.

Consistent with the task support account, Zalla et al. (2010) reported that high-functioning individuals with ASD did not show the enactment effect for self-performed actions on tests of free recall, however they did show the effect on a recognition test, whereby both ASD and comparison groups had similarly higher correct recognition for enacted than observed items, with no difference between groups. Similarly, Hare et al. (2007) reported that low-functioning individuals with ASD did not show superior free recall for self- over other-experienced events, but that they did show enhanced recall for self-experienced events when recall was cued. Lind and Bowler (2009) also observed an enactment effect in the ASD group when they tested participants using a recognition test. In contrast to the previous suggested

action monitoring deficit account, Lind and Bowler argue their findings indicate that differences observed in ASD are likely to be due to a more general episodic impairment rather than specific self-memory deficit *per se*. Because their task was one of recognition, Lind and Bowler suggested that the ASD group may have been able to utilise their intact semantic memory to compensate for their impaired episodic memory.

Difficulties with monitoring the source of memories are now fairly well established in the ASD memory literature (see Boucher, Mayes & Bigham, 2012, for a review). With regards to monitoring the source of self-other memories (whether the action was self-performed or performed by the experimenter), however, research to date paints a mixed picture. Some have reported diminished self-other source memory in ASD (Hala, Rasmussen, & Henderson, 2005; Lind & Bowler, 2009; Russell & Jarrold, 1999), whilst others have reported that individuals with ASD perform comparably to typical participants (Farrant et al., 1998; Hill & Russell, 2002; Williams & Happé, 2009; Zalla et al., 2010). These discrepant findings may be attributable to two factors. First, as mentioned above and accountable by the task support hypothesis, performance in ASD tends to be diminished on free recall but unimpaired on recognition tests. Since the self-other source monitoring paradigms involve tests of recognition ("did you pick this card up or did the experimenter pick this card up?"), invariably the ASD group's performance will often be better than had they been asked to freely recall both the action and who performed it. This type of more supportive recall test also reduces demand on cognitive load and executive functions, with which individuals with ASD are often reported to show impairments (see Hill, 2004). Second, as Lind and Bowler (2009) note, because of the marked difference between "self" and "other", self-other source judgements are more distinct and thus easier to make than internal (whether an action was imagined or actually performed) or external (which of two individuals performed an action)

source judgments (Hashtroudi, Johnson & Chrosniak, 1989). This means that studies that have reported unimpaired self-other source monitoring may have simply lacked power or sensitivity to detect a significant difference.

The purpose of the present study is to extend this to-date inconsistent work on monitoring the source of actions and the self enactment effect in ASD using a live eyewitness scenario. No research to date has examined how well adults with ASD recall live eyewitness events in which they actively participated, which is particularly important given the literature suggesting that this might be problematic for them. Moreover, if individuals with ASD are at increased risk of victimisation (e.g., Howlin, 1997; Petersilia, 2001) recall of self actions and actions that others perform is critical. Thus, the aim of the present study is threefold: to examine 1) how well adults with ASD recall actually experienced eyewitness events in which they personally participated; 2) whether adults with ASD show a facilitative effect of self- over other-performed actions of an eyewitness event, as typical individuals do; 3) whether they show impaired source monitoring for who performed which actions.

Adults with ASD and their typical counterparts participated in a live eyewitness scenario whereby they assisted the experimenter in carrying out some first aid on a manikin-victim. Within this scripted scenario there were a number of actions that the experimenter always performed, and a number of actions that the participant always performed. Participants were later asked to freely recall what happened, before being questioned further about what happened. Based on the aforementioned pattern of findings to date, we predicted that the ASD group would show a diminished self-other enactment effect on the free-recall memory phase of the interview, but that there would be no difference between groups on the questioning phase, which is analogous to a cued recall test procedure. Given that free-recall provides no cues and therefore no task support for memory recall, we also expected the ASD

group to make more source misattributions for whether they or the experimenter had performed the actions in their free recall, but not in the more supported questioning phase.

Method

Participants

Eighteen participants with ASD (16 males and 2 females) who were formally diagnosed by qualified clinicians were recruited predominantly in London and the South East of the UK from autism support groups and societies, and from word of mouth. All ASD participants were diagnosed by experienced clinicians with local health authorities according to DSM-IV (American Psychiatric Association, 2000) criteria for Autistic Disorder or Asperger Disorder and diagnoses were confirmed for all participants by assessment with the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore & Risi, 1999).

Eighteen comparison participants were recruited through local newspaper advertisements and comprised 15 males and 3 females who were pairwise matched within 7 points of verbal IQ as measured by the WAIS-R or WAIS-III UK (Wechsler, 1997) to the ASD participants. They had no known psychiatric, developmental or neurological disorders. Groups did not significantly differ on age, VIQ, PIQ or FIQ (all *t*s < 1.15, *p*s > .26). Table 1 summarises these data. Participants also completed the Autism Spectrum Quotient (AQ, Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001). None of the comparison participants exceeded the minimum cut off score for ASD of 32 (M = 16, Range = 4-25), and as expected the ASD group scored significantly higher (M = 33, Range = 21-45) than the comparison group on this measure, t (32) = 8.01, p < .001, Cohen's d = 2.67. Participants

provided their informed consent and were warned before taking part in the first aid scenario that they were about to see a manikin posing as an accident victim so that they were not alarmed. Ethical approval for the study was obtained from the Research Ethics Committees at City University London and Royal Holloway, University of London.

[INSERT TABLE 1]

Materials

The first aid scenario was centred around a manikin, who was a purported car crash victim. The manikin was approximately 180cm in height and made of flexible grey foam, with facial features but no hair or make-up. The manikin was dressed as a professional male in smart trousers, a shirt (with a red biro in the shirt pocket) and tie, and was also wearing a brown belt, wrist watch and socks. In his left trouser pocket were a set of keys, and in the right trouser pocket was a wallet with an ID membership card inside. The manikin-victim had five notable injuries: 1) wounded right hand, which was represented with fake blood on the top of the hand; 2) burn on the left forearm, again denoted using fake blood; 3) broken right arm, which was twisted up into an unusual position; 4) broken left leg, which was crooked at an odd angle; 5) a wound to the right foot, which was visible through a hole in the sock and fake blood on both the sock and the foot.

A number of first aid items were present in the same far right-hand corner of the room. A hazard triangle, foil blanket, red cotton blanket and green first aid box were all on the floor next to a table. The first aid kit contained a number of items including some bandages, band aids, a pad, scissors, tweezers, gloves and sterile swabs. On the table was a tea towel, some cling film and a fluorescent high visibility vest. The experimenter always wore the same

clothes and jewellery, including a scarf which she subsequently removed during the scenario to use as a sling. An A2-size photograph print was hung on the far wall opposite the door depicting a car crash, in which two cars were severely damaged following an obvious collision.

Design and procedure

Participants were tested individually, and to avoid spontaneous context reinstatement at interview the first aid scenario was carried out in a different building from the subsequent memory interview. Participants were informed that their task was to help the experimenter carry out some first aid on a manikin-victim, and that the experimenter would instruct them on what they needed to do. On entering the room the experimenter pointed out the picture on the wall and explained that the manikin-victim had been in a car crash and had sustained a number of injuries. The first aid scenario then followed which comprised a series of actions performed by both the experimenter and participant, which were balanced to ensure that the experimenter and participant each carried out both salient and trivial actions (see Appendix 1). In order to control for any potential effects of verbal scaffolding from participants receiving instructions for their own actions, the experimenter provided the same level of verbal description of her own actions as that of the participant's (e.g., participant-performed task: "can you check his pockets"; e.g., experimenter-performed task: "I am just going to check if he is breathing"). During the scenario there were 19 scripted actions performed by the experimenter, and 19 that were performed by the participant (e.g., Other-performed action: the experimenter gets a bandage from the first aid kit; e.g., Self-performed action: the participant rolls the bandage up). The scenario began with an initial assessment and

precautionary measures (e.g., putting a hazard triangle out and checking breathing), before each of the injuries were dealt with in turn. Full details of the actions that occurred in the scenario can be found in Appendix 1.

Event scenarios were videoed through a two-way mirror for quality control purposes to ensure that they all followed the script accurately, and to double-check for any inconsistencies from participants' reports of what happened during their interview. Following the first aid scenario participants were engaged in similar unrelated tasks for around one hour, before being interviewed for their memory of the first aid event by a different experimenter from the one who carried out the first aid event with them.

Interview

Interviews followed the same standard structure recommended by government to professionals who interview witnesses, as outlined by the Home Office (2011) *Achieving Best Evidence* guidance. Interviews began with rapport building, and then the aims and structure of the interview was explained to the participant, where they were given the opportunity to ask questions. The interviewer explained that they should try to recall everything in as much detail as they could about what happened and what they could see during the first aid scenario, and that they should particularly try to recall the finer details of exactly *who did what* during the scenario. Participants were reminded that the interviewer did not know what happened and that their task was to describe the event as accurately as they could.

The free recall (FR) phase then followed, whereby the participant was instructed to take their time and to recall as much as they could from the scenario. Once the participant had finished speaking and was waiting for the next instruction, they were asked "can you

remember anything else?" When they had responded to this and/or indicated that was all they could recall, the questioning phase began. The participant was once again instructed not to guess and that it was ok to say if they did not know the answer to any questions. Questions followed a structured sequence to probe for information pertaining to each of the actions and who performed them, and for descriptions of what things looked like. All participants were asked the same questions, but only if they had already mentioned that topic in their FR or previously in the questioning. For example, where a participant mentioned that they had put a bandage on the manikin, they were asked who had fetched the bandage. However, if no mention was made of using the bandage this question was not asked. Similarly, if a participant had mentioned that the manikin was wearing a tie they would be asked for more information about what the tie looked like. Questions were witness-compatible (i.e. using the witness's own terminology) and were predominantly open-ended. Closed questions were kept to a minimum and leading and misleading questions were avoided. All interviews were video and audio-recorded for subsequent transcription and coding.

Coding and preliminary analyses

Interviews were transcribed and each detail that the participant mentioned was coded against a coding template of actions and descriptions of items and people that were present in the scenario. The script contained a total of 19 Self-performed and 19 Other-performed actions (Appendix 1). Details were only coded the first time they were mentioned. However, where a participant mentioned an action in free recall but failed to specify at the time who had carried out the action (e.g., "we put a bandage on"), this was followed up in the

questioning phase, and their answer to this prompting (e.g., "I put the bandage on") was coded as having been mentioned in the free recall phase.

Each detail reported was coded as "correct" (e.g., "the victim's shirt was blue"), incorrect (e.g., "his shirt was red"), or confabulated (e.g., "the victim was wearing a hoody"), with the exception of the 19 Self- and 19 Other-performed actions, which were coded as correct or incorrect only (confabulations were scored separately from self and other details). Self errors were coded where a self-performed action was misattributed to having been performed by the experimenter, and Other errors were coded where the participant incorrectly attributed that they performed an action that was actually performed by the experimenter.

In addition to the main scripted items, there were also a number of actions that inevitably always occurred (e.g., removing the band aid from its packaging, the participant and experimenter kneeling down etc.) Actions such as these that always occurred in all participants' scenarios were scored if they were reported correctly, but were not tagged specifically as Self or Other. Actions that occurred only in an individual participant's scenario (i.e., those that went off-script) were not scored, in order to ensure that all participants had an equal number of potential details to score on. In addition to these action details, recall was also scored for details pertaining to people (i.e., what the manikin and the experimenter were wearing and descriptions of the people present in the photograph of the car crash), objects (e.g., the first aid items) and surroundings (e.g., what the room looked like and the location of items). For example, the statement "Anna got the red blanket from the corner and I lifted his leg and put the blanket underneath it" would be coded as 1 Other-performed action correct (got the blanket), 1 Self-performed action correct (lifted his leg), 1 Other-performed action incorrect (saying that the participant had put the blanket under the leg,

when in fact it was the experimenter who had done this) and 3 correct details about the item and its location (it was red, it was a blanket and it was in the corner).

A second independent rater blindly scored eight randomly selected interview transcripts (four in each group) against the event script and the resulting Pearson's correlations between the two raters were good for each type of detail, and importantly also for those specifically pertaining to self and other details: $r_{correct} = .97$, $p < .0001$, $r_{incorrect} = .81$, $p < .05$, $r_{confabulations} = .92$, $p < .001$, $r_{selfcorrect} = .95$, $p < .001$, $r_{self\ incorrect} = .90$, $p < .005$, $r_{other\ correct} = .99$, $p < .001$, $r_{other\ incorrect} = .92$, $p < .001$. We also examined potential differences between groups in interview length, and there was no significant difference between the ASD and comparison groups for interview duration (ASD M = 22 mins 19 secs, SD = 6 mins; comparison M = 19 mins 48 secs, SD = 4 mins), t (34) = 1.36, p = .18, Cohen's d = .51.

Results

Group differences in completeness and accuracy of recall

Our first step was to examine differences in recall between groups and between the FR and questioning phases. Details were coded as being correct, incorrect or confabulated, and three separate ANOVAs were performed for each detail type, with group as the between participants factor and interview phase as the within participants factor. As can be seen in Table 2, the ASD and comparison groups did not differ in the completeness of their recall (i.e., the number of correct details they recalled), $F < 1$, and there was no group x interview phase interaction, F (1, 34) = 1.62, p = .21, ηp^2 = .05. That is, the ASD group reported just as many correct details as their typical counterparts in both the FR and questioning phases. The

ASD group did, however report significantly more incorrect details than the typical group, F (1, 34) = 11.08, $p < .005$, $\eta p^2 = .25$, and a lack of group x interview phase interaction, $F < 1$, indicated that they did so in both FR and questioning phases. Analysis of confabulations indicated that groups did not significantly differ in the number of confabulations made, F (1, 34) = 3.16, $p = .08$, $\eta p^2 = .09$, and there was no interview phases x group interaction for confabulations, $F < 1$. Thus, the ASD group made significantly more errors (e.g., reporting that the first aid box was on the table, when actually it was on the floor) than their typical counterparts in both FR and questioning phases, but there were no significant group differences in the tendency to confabulate about details (e.g., reporting that they performed emergency resuscitation techniques on the manikin, when in fact this did not occur at all).

[INSERT TABLE 2]

There was a main effect of interview phase for the number of correct details recalled, F (1, 34) = 11.30, $p < .005$, $\eta p^2 = .25$, whereby more correct details were recalled in the first FR phase (M = 49.32, SD = 19.41) than in the second questioning phase (M = 39.21, SD = 13.72). This finding is unsurprising given that coding was only for new items. Interview phase also had an effect on the number of incorrect details reported, F (1, 34) = 41.65, $p < .001$, $\eta p^2 = .55$, with significantly fewer incorrect details reported in FR (M = 3.69, SD = 2.49) than in questioning (M = 8.75, SD = 4.17). A similar pattern emerged for confabulations, where more confabulations were made in questioning (M = .69, SD = .95) than in FR *(*M = .31, SD = .75), F (1, 34) = 4.86, $p < .05$, $\eta p^2 = .13$.

Recall of Self versus Other performed actions

In order to assess the pattern of recall for Self- versus Other-performed actions, we conducted two mixed ANOVAs for correct details for each free recall and questioning phase, where group (ASD vs. Comparison) was the between-participants factor, and detail type (Self vs. Other) was the within-participants factor. There was a main effect of detail type in FR, F (1, 34) = 105.54, $p < .001$, $\eta p^2 = .76$, but no group × detail type interaction, F (1,34) = 1.44, $p = .24$, $\eta p^2 = .04$. In contrast to our prediction that the self-other enactment effect would be diminished in the ASD group relative to the comparison group, both groups similarly reported more correct actions that they had performed themselves than actions that they had watched the experimenter perform in their FR (Table 3). A similar pattern emerged for Self- versus Other-performed actions in the questioning phase, however this difference fell short of traditional statistical significance levels, F (1, 34) = 3.10, $p = .087$, $\eta p^2 = .08$, which may be related to a limited number of Self and Other details left available to be recalled following the FR phase. Again, there was not a group × detail type interaction, $F < 1$. These data can be seen in Table 3.

Source monitoring

Next we assessed source memory for Self- and Other-performed actions. We predicted that the ASD group would make more source confusion errors on the FR, but not in the questioning phase. As reported above, both groups demonstrated the self-enactment effect by reporting significantly more self- than other-performed actions, and here we were interested in whether both groups correctly attributed themselves or the experimenter as having performed each of these types of actions. Thus, we compared differences between

groups in the number of Self and Other errors made within each interview phase. As can be seen in Table 3, the ASD group made significantly more Self errors than the comparison group in the FR phase, F (1, 34) = 15.87, $p < .001$, $\eta p^2 = .32$, but not in the questioning phase, $F < 1$. Groups did not differ in number of Other errors made in either the FR phases, $F < 1$, or in the questioning phase, $F < 1$. Thus, the only difference between groups in terms of source confusions (who performed which actions) was for Self-performed actions in FR. That is, compared to their typical counterparts, the ASD group incorrectly attributed more actions that they themselves had performed as having been performed by the experimenter when they were asked to freely recall what had happened. This difference between groups in source monitoring errors for self-performed actions was diminished, however, in the questioning phase, and there were no differences between groups in the number of source errors made for actions that were performed by the experimenter. Because the number of errors for self-performed actions was quite low overall, we inspected the proportions of individuals in each group who made such errors. All but one of the participants with ASD (i.e., 94%) made at least one source error for self-performed actions. In contrast only six individuals in the comparison group (i.e., 33%) made this type of error.

[INSERT TABLE 3]

Discussion

The present study is the first to examine how well adults with ASD recall a personally experienced live eyewitness event. In recalling this event, we were interested in whether the ASD group demonstrated a self-enactment effect and whether they could successfully

monitor the source of their own and another's actions. To this end, three main findings emerged. First, the ASD group's recall was just as complete as that of their typical comparisons, but they made more errors. Second, both ASD and comparison groups showed an enactment effect: they recalled more actions that they had performed themselves than they did actions that the experimenter had performed. Third, when asked to freely recall what happened, the ASD group made significantly more source confusions than the comparison group in attributing actions that they had actually performed themselves as having been performed by the experimenter. The use of a live event in this study is novel and demonstrates that, from a forensic perspective, if adults with ASD are personally involved in a crime as a witness, victim or perpetrator, they can recall just as many correct details as their typical counterparts, but that their recall may be less accurate (i.e., contain more errors). Moreover, if they are questioned appropriately or provided with environmental support they can provide information about source as accurately as their counterparts. We now consider each of these findings in turn in more detail.

Completeness and accuracy of recall

With regards to the eyewitness abilities of individuals with ASD in recalling a personally experienced event, findings from the present study are positive in that they show that individuals with ASD recall just as many correct details as their typical comparisons in both the FR and questioning phases of interview. However, witnesses with ASD were more prone to making errors when reporting in both stages, despite explicit interview instructions not to guess if they were unsure of anything. As mentioned in the introduction, despite the fact that all previous studies used homogeneous samples of high-functioning adults with ASD, their findings regarding both the completeness and accuracy of eyewitness testimony to date are mixed. Our findings of similar levels of completeness of the reports of witnesses with

ASD to their typical counterparts are consistent with some existing studies (e.g., Maras & Bowler, 2010; Maras et al., 2012) but inconsistent with others (e.g., Bruck et al., 2007; Maras & Bowler, 2011; McCrory et al., 2007). It could be concluded from the present findings that individuals with ASD recall more details if the event is salient, live and personally participated in, but given the inconsistent findings previously reported, future work is needed to clarify and confirm this interpretation. Similarly, the same might be said for errors, where again our findings add to a mixed picture, with more errors reported by some studies (Maras & Bowler, 2011; Maras et al., 2012), but not others (Bruck et al., 2007; Maras & Bowler, 2010; McCrory et al., 2007). That the questioning phase elicited more errors than the FR phase for both groups replicates and extends to witnesses with ASD the finding of the majority of existing studies that show this effect with typical individuals.

Outside of eyewitness research, the pattern of findings remains somewhat mixed, and it is therefore difficult to pinpoint an explanation for the discrepant findings across studies. Studies of story recall by high-functioning individuals with ASD, for example, have reported both unimpaired (e.g., Ambery, Russell, Perry, Morris & Murphy, 2006; Boucher, Cowell, Howard et al., 2005) and impaired performance (Minshew & Goldstein, 2001; Salmond, Ashburner, Connelly et al., 2005; Williams, Goldstein & Minshew, 2006). It is possible that high-functioning individuals are inherently impaired in recalling an event, but that they develop compensatory strategies, for example with an increased reliance on the semantic memory system, to compensate for this deficit (see Boucher et al., 2012, for further discussion), leading to a mixed pattern of findings across studies regarding both the completeness and the accuracy of their reports. Nevertheless, findings from the present study indicate that, from a forensic perspective, victims or suspects with ASD may recall just as

many correct details as their typical counterparts, but that forensic professionals might seek to exercise caution in verifying the details that are given in an account by a witness with ASD.

Self-enactment effect

Contrary to our initial predictions, the ASD group showed a similar self-enactment effect to the comparison group in both their FR and questioning. That is, they recalled more actions that they had performed themselves than they did actions that the experimenter had performed. This is an important finding practically because it indicates that if an individual with ASD is the victim or perpetrator of a crime they will be able to recall what happened and what they did. Theoretically this finding is also important because it indicates that individuals with ASD do lay down a stronger memory trace for self-performed actions. Based on previous research (Hare et al., 2007; Zalla et al., 2010) and the task support hypothesis (Bowler et al., 2004) we expected that the ASD group would only demonstrate an undiminished enactment effect on the questioning phase, and not in the unsupported FR phase. It should be noted, however, that not all studies have reported a diminished self-enactment effect in FR for ASD: Summers and Craik (1994) also reported that their ASD group recalled more self-performed tasks, although the comparison task in their study was a list of word items, rather than similar action-related tasks being performed by another person. The conditions in their study could therefore not control for potential scaffolding from the nature of a visual action-related task irrespective of whether it was self-performed or not.

There are two interpretations of the present data. The first, and the interpretation that we favour, is that individuals with ASD genuinely do benefit from self-enactment and that a more general episodic deficit explains previous findings of a diminished enactment effect, whereby differences between groups are quantitative, rather than qualitative in nature (see

Lind, 2010). The second is that the effect is diminished in ASD, but that we failed to detect a difference in the present paradigm. We will briefly consider each of these possibilities in turn. Some have argued that action monitoring is, in fact, intact in ASD and that the difficulties observed in previous studies have reflected a more general episodic memory deficit, as opposed to a specific difficulty with *personally* experienced events (Lind & Bowler, 2009, Williams & Happé, 2009; and see Lind, 2010, for a review). Our overall findings support this interpretation: if it were a deficit specific to personally experienced events, then one would expect the ASD group in the present study to recall fewer details overall than the comparison group from the personally experienced event. Such a difference should be particularly marked given that some previous eyewitness studies that have used event stimuli that were not personally participated in have reported diminished completeness of recall (e.g., Bruck et al., 2007; Maras & Bowler, 2011; McCrory et al., 2007). Yet we found the ASD group recalled just as many correct details overall as their typical counterparts from this personally experienced event. Moreover, several studies have previously reported a self-enactment effect in ASD (Hare et al., 2007; Lind & Bowler, 2009; Summers & Craik, 1994; Williams & Happé, 2009; Zalla et al., 2010), indicating that individuals with ASD do lay down a stronger memory trace for self-performed actions.

A second interpretation is that we failed to detect a diminished enactment effect because of the paradigm and/or high-functioning adult sample that took part. Henderson et al. (2009), for example, reported age-related improvements in self-referenced memory in their sample of 8-16 year-olds with ASD. Thus, one might argue that participants in the present study might have shown diminished self-referenced memory effects earlier in development, but had improved to such an extent by adulthood that it was not detectable in the current study, possibly also because of the narrative structure of the event. Whilst we were cautious

to keep verbal commentary of the task to a minimum and ensured that it occurred equally for self- and other-performed actions, it was nevertheless inevitable in order to instruct participants which actions to perform, which might have enhanced encoding through verbal scaffolding. Williams and Happé (2009) failed to replicate Russell and Jarrold's (1999) findings and reported that their ASD group did, in fact, demonstrate an enactment effect. Williams and Happé suggest that the discrepant findings might be related to the experimenter engaging the participant in more verbal commentary in their study than in Russell and Jarrold's experiment. This, they argue may have led to events being encoded as self-experienced and thus recalled accurately from memory. There is some evidence to suggest that people with ASD tend not to use certain forms of inner speech (e.g., Whitehouse, Maybery & Durkin, 2006; Williams, Bowler & Jarrold, 2012) and thus, Williams and Happé argue, these overt verbal descriptions of the actions at the time may have been a sort of 'outer speech' which served to scaffold performance. This is the major interpretation that we consider of the present data to explain the enactment effect in FR as well as questioning. Finally, it is also worth noting that whilst the experimenter was cautious to perform their actions whilst the participant attending to them, the nature of the event – designed to be more ecologically valid – means that we cannot rule out the possibility that factors relating to attention did not play a role in the enactment effect. In light of our precautions to prevent this happening, coupled with previous work showing that individuals with ASD do show a beneficial effect of self-enactment on memory, we do not believe this to be the case. It is, nevertheless, worth noting that a trade off between experimental control and ecological validity is often inevitable.

Source monitoring of self- and other-performed actions

In line with our predictions, but in contrast to the findings reported above that the ASD group did demonstrate a self-enactment effect in both their FR and in questioning is the finding that they made more source errors for self-performed actions than the comparison group in FR. The ASD group confused more actions that they had performed themselves as having been performed by the experimenter than did the comparison group. This finding is in fact in stark contrast to some previous work (e.g., Lind & Bowler, 2009), which has reported the enactment effect in terms of *better* source monitoring for self- than other-performed actions in ASD. This is somewhat of a paradox within the present findings: Whilst individuals with ASD appear to use their self-involvement to lay down a stronger memory trace for their own actions (and hence recall more self than other actions), in free recall they are more likely than typical individuals to confuse self-performed actions as having been performed by the experimenter. If they are using their self-involvement to strengthen their memory for these actions, then it is difficult to explain why they are more likely to confuse the source of who performed them. However, the ASD group do not show a greater source monitoring confusion than their typical counterparts when questioned, and it appears to be independent of a more general source monitoring deficit, because we did not find the ASD group to be more likely to confuse the source of other-performed actions.

So how do we explain such a finding? We only observed this deficit in source monitoring in FR and not questioning, and one possibility relates to executive functioning, which can be further interpreted within the task support framework. In the FR phase, participants were instructed to recall as much as they possibly could about what happened, without any cues from the interviewer. This requires holding a large amount of information of what they could remember about the event "online" whilst simultaneously switching attention between details in order to select what to verbally recall and in what order. The

instruction to report everything including the finer details of who did what increases this cognitive load on executive functions. Individuals with ASD have been reported to have a number of executive function deficits including working memory, mental flexibility (spontaneously switching attention between different thoughts or actions) and prepotent inhibition (see Hill, 2004, for a review). It is also widely observed that individuals with ASD can show inaccurate production and reversal of pronouns (e.g., Jordan, 1989; Lee, Hobson & Chiat, 1994; Loveland & Landry, 1986; Mizuno, Liu, Williams et al., 2011). The ASD group made more source monitoring errors for self-performed actions in FR ("tell me what happened and who did what"), but not in questioning ("did Anna get the bandage or did you get the bandage?") In contrast to FR, questioning essentially provides task support for executive functions by breaking down the information that is required for recall into smaller segments, hence directing attention to one source, reducing cognitive load and placing less demand on working memory, inhibition and set shifting. Thus, it is possible that the source monitoring errors observed in FR simply reflect executive function deficits triggering pronoun confusion, rather than a genuinely diminished enactment effect.

It is also possible that the ASD group have a more lenient response criterion than their comparisons and hence freely report more details that they are uncertain about. Of course, these are only conjectures, but it is an important area for future research to explore because if correct it has implications for forensic interviews in eliciting information from witnesses with ASD. One of the most widely-reported findings in the eyewitness literature, which police take on board in practice, is that FR is the optimal method of recalling an event to obtain the most reliable reports and that questioning, whilst eliciting more details, also results in a concomitant increase in errors (Home Office, 2011; Loftus, 1996). It may be the case that individuals with ASD, however, need more specific direction in interviews to focus their

recall into smaller segments and minimise demands on executive functions and thus potentially reduce the likelihood of source confusion errors.

Related to an executive function account, the self-source monitoring difficulties in FR displayed by the ASD group might also be partly explained in the context of simulation theories (e.g., Gordan, 1986). These theories posit that understanding of others is achieved through understanding self-representations. Meltzoff (2007), for example, reports that during development social cognition shifts from 'others are like me' to a dual acknowledgement that whilst others can be like us, they can also be different. Recalling who did what requires the simultaneous understanding of the differing viewpoints of others, and might account for the ASD group confusing the source of self-performed actions, whilst still benefitting from an enactment effect in recalling more of the self-performed actions themselves. This interpretation is supported by findings from O'Shea, Fein, Cillessen, Klin and Schultz (2005) who reported that, whilst unimpaired in source monitoring for impersonal items of information, the ASD group had specific difficulties in recalling the source of the person-related detail. If the distinction between self and other is less explicitly distinctive, individuals with ASD may have more specific difficulties with spontaneously teasing apart and accurately reporting the source of person-performed details on tests of FR.

Conclusions

Previous research has reported mixed findings across all three of our research questions. That is, recall of a past event, the self-enactment effect, and source monitoring. Our findings add to this mixed picture, but from our primary objective of the forensic implications regarding the abilities of individuals with ASD in recalling a previously participated-in event, our findings indicate that witnesses, victims or suspects with ASD are

likely to recall just as many details as their typical counterparts. Moreover findings indicate that self-involvement boosts memory for actions that witnesses with ASD perform themselves. However, findings also suggest that forensic professionals might seek to exercise caution in verifying the accuracy of details that are given in an account by a witness with ASD. This is the first study to look at this within an eyewitness context, and findings have implications for the recall of events by victims and suspects with ASD, whom by definition would have played an active role in the event. Of course, a limitation of this study is that, in contrast to a real criminal event, it would have held relatively little emotional valence. It is therefore important for future work to extend this using a negatively valenced event, and with a larger sample. Our data also indicate that, on tests of free recall, individuals with ASD may be more likely to verbally confuse the source of self-performed actions, which may arise from executive function demands. Again, given the forensic implications, this is something that could be followed up.

References

Allen, D., Evans, C., Hider, A., Hawkins, S., Peckett, H., & Morgan, H. (2008). Offending behaviour in adults with asperger syndrome. *Journal of Autism and Developmental Disorders*, *38*(4), 748–758. doi:10.1007/s10803-007-0442-9.

Ambery, F. Z., Russell, A. J., Perry, K., Morris, R., & Murphy, D. G. M. (2006). Neuropsychological functioning in adults with Asperger syndrome. *Autism*, *10*(6), 551–64. doi:10.1177/1362361306068507.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders, Fourth Edition (DSM-IV)*. American Psychiatric Press: Washington DC.

Baker-Ward, L., Hess, T. M., & Flannagan, D. A. (1990). The effects of involvement on children's memory for events. *Cognitive Development*, *5*(1), 55–69. Retrieved from 10.1016/0885-2014(90)90012-I.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*, *31*(1), 5–17.

Bennetto, L., Pennington, B. F., & Rogers, S. J. (1996). Intact and impaired memory functions in autism. *Child Development*, *67*(4), 1816–1835. doi:10.2307/1131734.

Boucher, J., Cowell, P., Howard, M., Broks, P., Farrant, A., Roberts, N., & Mayes, A. (2005). A combined clinical, neuropsychological, and neuroanatomical study of adults with high functioning autism. *Cognitive Neuropsychiatry*, *10*(3), 165–213. doi:10.1080/13546800444000038.

Boucher, J., Mayes, A., & Bigham, S. (2012). Memory in Autistic Spectrum Disorder. *Psychological bulletin*, *138*(3), 458–96. doi:10.1037/a0026869.

Bowler, D.M., & Gaigg, S. B. (2008). Memory in ASD: enduring themes and future prospects. In J. Boucher & D. M. Bowler (Eds.), *Memory in Autism*, pp. 330-349. Cambridge: Cambridge University Press.

Bowler, D. M., Gardiner, J. M., & Gaigg, S. B. (2007). Factors affecting conscious awareness in the recollective experience of adults with Asperger's syndrome. *Consciousness and Cognition, 16*(1), 124–143. doi:10.1016/j.concog.2005.12.001.

Bowler, D. M., Gardiner, J. M., & Berthollier, N. (2004). Source memory in adolescents and adults with Asperger's syndrome. *Journal of Autism and Developmental Disorders*, *34*(5), 533–542. doi:10.1007/s10803-004-2548-7.

Bowler, D. M., Gardiner, J. M., & Grice, S. J. (2000). Episodic memory and remembering in adults with Asperger syndrome. *Journal of Autism and Developmental Disorders*, *30*(4), 295–304. doi:10.1023/A:1005575216176.

Bowler, D. M., Matthews, N. J., & Gardiner, J. M. (1997). Asperger's syndrome and memory: Similarity to autism but not amnesia. *Neuropsychologia*, *35*(1), 65–70. doi:10.1016/S0028-3932(96)00054-1.

Bruck, M., London, K., Landa, R., & Goodman, J. (2007). Autobiographical memory and suggestibility in children with autism spectrum disorder. *Development and Psychopathology*, *19*(1), 73–95. doi:10.1017/s0954579407070058.

Craik, F. I. M., & Jacoby, L. L. (1996). Aging and memory: Implications for skilled performance. In W. A. Rogers, A. D. Fisk, & N. (Ed Walker (Eds.), *Aging and skilled performance: Advances in theory and applications. Rogers*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Crane, L., & Goddard, L. (2008). Episodic and semantic autobiographical memory in adults with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *38*(3), 498–506. doi:10.1007/s10803-007-0420-2.

Crane, L., Goddard, L., & Pring, L. (2009). Sensory processing in adults with autism spectrum disorders. *Autism*, *13*(3), 215–228. doi:10.1177/1362361309103794.

Dunphy-Lelii, S., & Wellman, H. M. (2012). Delayed Self Recognition in Autism: A Unique Difficulty? *Research in Autism Spectrum Disorders*, *6*(1), 212–223. doi:10.1016/j.rasd.2011.05.002.

Engelkamp, J. (1985). Motor programs and their relation to semantic memory. *German Journal of Psychology*, *9*(3), 239-254.

Engelkamp, J., & Zimmer, H. D. (1989). Memory for action events: A new field of research. *Psychological Research*, *51*(4), 153–157. doi:10.1007/BF00309142.

Farrant, A., Blades, M., & Boucher, J. (1998). Source monitoring by children with autism. *Journal of Autism and Developmental Disorders*, *28*(1), 43–50. doi:10.1023/A:1026010919219.

Gaigg, S. B., Gardiner, J. M., & Bowler, D. M. (2008). Free recall in autism spectrum disorder: The role of relational and item-specific encoding. *Neuropsychologia*, *46*(4), 983–992. doi:10.1016/j.neuropsychologia.2007.11.011.

Goddard, L., Howlin, P., Dritschel, B., & Patel, T. (2007). Autobiographical memory and social problem-solving in Asperger syndrome. *Journal of Autism and Developmental Disorders*, *37*(2), 291–300. doi:10.1007/s10803-006-0168-0.

Gordon, R. (1986). Folk Psychology as Simulation. *Mind and Language*, *1*, 158–171. Reprinted in M. Davies and T. Stone (eds.),*Folk Psychology: The Theory of Mind Debate*, Oxford: Blackwell Publishers, 1995.

Hala, S., Rasmussen, C., & Henderson, A. M. E. (2005). Three types of source monitoring by children with and without autism: The role of executive function. *Journal of Autism and Developmental Disorders*, *35*(1), 75–89. doi:10.1007/s10803-004-1036-4.

Hare, D. J., Mellor, C., & Azmi, S. (2007). Episodic memory in adults with autistic spectrum disorders: Recall for self- versus other-experienced events. *Research in Developmental Disabilities*, *28*(3), 317–329. doi:10.1016/j.ridd.2006.03.003.

Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1989). Aging and source monitoring. *Psychology and Aging*, *4*(1), 106–112. doi:10.1037/0882-7974.4.1.106.

Henderson, H. A., Zahka, N. E., Kojkowski, N. M., Inge, A. P., Schwartz, C. B., Hileman, C. M., Coman, D. C., et al. (2009). Self-referenced memory, social cognition, and symptom presentation in autism. *Journal of Child Psychology and Psychiatry*, *50*(7), 853–61. doi:10.1111/j.1469-7610.2008.02059.x.

Hill, E. L. (2004). Evaluating the theory of executive dysfunction in autism. *Developmental Review*, *24*(2), 189–233. doi:10.1016/j.dr.2004.01.001.

Hill, E. L., & Russell, J. (2002). Action memory and self-monitoring in children with autism: Self versus other. *Infant and Child Development*, *11*(2), 159–170. doi:10.1002/icd.303.

Home Office (2011). *Achieving Best Evidence in Criminal Proceedings: Guidance on interviewing victims and witnesses, and guidance on using special measures (third edition).* London: HMSO.

Howlin, P. (1997). *Autism: Preparing for adulthood*. London: Routledge.

Jordan, R. R. (1989). An experimental comparison of the understanding and use of speaker-addressee personal pronouns in autistic children. *International Journal of Language & Communication Disorders*, *24*(2), 169–179. doi:10.3109/13682828909011954.

Klein, S. B. (2001). A self to remember: A cognitive neuropsychological perspective on how self creates memory and memory creates self. In C. Sedikides & M. B. Brewer (Eds.), *Individual self, relational self, collective self*. New York: Psychology Press.

Klein, S. B., Chan, R. L., & Loftus, J. (1999). Independence of episodic and semantic self-knowledge: The case from autism. *Social Cognition*, *17*(4), 413–436. doi:10.1521/soco.1999.17.4.413.

Lee, A., Hobson, R. P., & Chiat, S. (1994). I, you, me, and autism: An experimental study. *Journal of Autism and Developmental Disorders*, *24*(2), 155–176. doi:10.1007/BF02172094.

Lind, S. E. (2010). Memory and the self in autism: A review and theoretical framework. *Autism*, *14*(5), 430–56. doi:10.1177/1362361309358700.

Lind, S. E., & Bowler, D. M. (2009). Recognition memory, self-other source memory, and theory-of-mind in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *39*(9), 1231–1239. doi:10.1007/s10803-009-0735-2.

Lind, S. E., & Bowler, D. M. (2010). Episodic memory and episodic future thinking in adults with autism. *Journal of Abnormal Psychology, 119*(4), 896–905. doi:10.1037/a0020631.

Loftus, E. F. (1996). *Eyewitness Testimony*. Cambridge, MA: Harvard University Press.

Lord, C., Rutter, M., DiLavore, P., & Risi, S. (1999). *Autism Diagnostic Observation Schedule–Generic*. Los Angeles: Western Psychological Services.

Loveland, K. A., & Landry, S. H. (1986). Joint attention and language in autism and developmental language delay. *Journal of Autism and Developmental Disorders, 16*(3), 335–349. doi:10.1007/BF01531663.

Maras, K. L., & Bowler, D. M. (2010). The cognitive interview for eyewitnesses with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 40*(11), 1350–1360. doi:10.1007/s10803-010-0997-8.

Maras, K., & Bowler, D. M. (2011). Brief report: Schema consistent misinformation effects in eyewitnesses with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 41*(6), 815–20. doi:10.1007/s10803-010-1089-5.

Maras, K. L., & Bowler, D. M. (2012). Context reinstatement effects on eyewitness memory in autism spectrum disorder. *British Journal of Psychology, 103*(3), 330–42. doi:10.1111/j.2044-8295.2011.02077.x.

Maras, K. L. & Bowler, D. M. (in press). Eyewitness testimony in autism spectrum disorder: A review. *Journal of Autism and Developmental Disorders*. doi: 10.1007/s10803-012-1502-3.

Maras, K. L., Gaigg, S. B., & Bowler, D. M. (2012). Memory for emotionally arousing events over time in autism spectrum disorder. *Emotion*. doi:10.1037/a0026679.

McCrory, E., Henry, L. a, & Happé, F. (2007). Eye-witness memory and suggestibility in children with Asperger syndrome. *Journal of Child Psychology and Psychiatry*, *48*(5), 482–9. doi:10.1111/j.1469-7610.2006.01715.x.

Meltzoff, A. N. (2007). The "like me" framework for recognizing and becoming an intentional agent. *Acta psychologica*, *124*(1), 26–43. doi:10.1016/j.actpsy.2006.09.005.

Millward, C., Powell, S., Messer, D., & Jordan, R. (2000). Recall for self and other in autism: Children's memory for events experienced by themselves and their peers. *Journal of Autism and Developmental Disorders*, *30*(1), 15–28. doi:10.1023/A:1005455926727.

Ming, X., Brimacombe, M., & Wagner, G. C. (2007). Prevalence of motor impairment in autism spectrum disorders. *Brain & Development*, *29*(9), 565–70. doi:10.1016/j.braindev.2007.03.002.

Minshew, N. J., & Goldstein, G. (2001). The pattern of intact and impaired memory functions in autism. *Journal of Child Psychology and Psychiatry*, *42*(8), 1095–1101. doi:10.1111/1469-7610.00808.

Mizuno, A., Liu, Y., Williams, D. L., Keller, T. A., Minshew, N. J., & Just, M. A. (2011). The neural basis of deictic shifting in linguistic perspective-taking in high-functioning autism. *Brain*, *134*(Pt 8), 2422–35. doi:10.1093/brain/awr151.

North, A., Russell, A., & Gudjonsson, G. (2008). High functioning autism spectrum disorders: an investigation of psychological vulnerabilities during interrogative

interview. *Journal of Forensic Psychiatry & Psychology*, *19*(3), 323–334. doi:10.1080/14789940701871621.

O'Shea, A. G., Fein, D. A., Cillessen, A. H. N., Klin, A., & Schultz, R. T. (2005). Source memory in children with autism spectrum disorders. *Developmental Neuropsychology*, *27*(3), 337–360. doi:10.1207/s15326942dn2703_3.

Petersilia, J. R. (2001). Crime victims with developmental disabilities - A review essay. *Criminal Justice and Behavior*, *28*(6), 655–694. doi:10.1177/009385480102800601.

Powell, S. D., & Jordan, R. R. (1993). Being subjective about autistic thinking and learning to learn. *Educational Psychology*, *13*(3-4), 359–370. Retrieved from 10.1080/0144341930130312.

Russell, J., & Hill, E. L. (2001). Action-monitoring and intention reporting in children with autism. *Journal of Child Psychology and Psychiatry*, *42*(3), 317–328. doi:10.1111/1469-7610.00725.

Russell, J., & Jarrold, C. (1999). Memory for actions in children with autism: Self versus other. *Cognitive Neuropsychiatry*, *4*(4), 303–331. doi:10.1080/135468099395855.

Salmond, C. H., Ashburner, J., Connelly, A., Friston, K. J., Gadian, D. G., & Vargha-Khadem, F. (2005). The role of the medial temporal lobe in autistic spectrum disorders. *The European Journal of Neuroscience*, *22*(3), 764–72. doi:10.1111/j.1460-9568.2005.04217.x.

Summers, J. A., & Craik, F. I. M. (1994). The effects of subject-performed tasks on the memory performance of verbal autistic children. *Journal of Autism and Developmental Disorders, 24*(6), 773–783. doi:10.1007/BF02172285.

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin, 121*(3), 371–394. doi:10.1037/0033-2909.121.3.371.

Wechsler, D. (1997). *Manual for the Wechsler Adult Intelligence Scale (3rd ed).* San Antonio, TX: The Psychological Corporation.

Whitehouse, A. J. O., Maybery, M. T., & Durkin, K. (2006). Inner speech impairments in autism. *Journal of Child Psychology and Psychiatry, 47*(8), 857–865. doi:10.1111/j.1469-7610.2006.01624.x.

Williams, D. M., Bowler, D. M., & Jarrold, C. (2012). Inner speech is used to mediate short-term memory, but not planning, among intellectually high-functioning adults with autism spectrum disorder. *Development and Psychopathology, 24*(1), 225–39. doi:10.1017/S0954579411000794

Williams, D. L., Goldstein, G., & Minshew, N. J. (2006). The profile of memory function in children with autism. *Neuropsychology, 20(1),* 21–29. doi:10.1037/0894-4105.20.1.21.

Williams, D., & Happé, F. (2009). Pre-conceptual aspects of self-awareness in autism spectrum disorder: The case of action-monitoring. *Journal of Autism and Developmental Disorders, 39*(2), 251–259. doi:10.1007/s10803-008-0619-x.

Wilson, T. W., Rojas, D. C., Reite, M. L., Teale, P. D., & Rogers, S. J. (2007). Children and adolescents with autism exhibit reduced MEG steady-state gamma responses. *Biological Psychiatry*, *62*(3), 192–7. doi:10.1016/j.biopsych.2006.07.002.

Wojcik, D. Z., Allen, R. J., Brown, C., & Souchay, C. (2011). Memory for actions in autism spectrum disorder. *Memory*, *19*(6), 549–58. doi:10.1080/09658211.2011.590506.

Woodbury-Smith, M. R., Clare, I. C. H., Holland, A. J., & Kearns, A. (2006). High functioning autistic spectrum disorders, offending and other law-breaking: findings from a community sample. *Journal of Forensic Psychiatry & Psychology*, *17*(1), 108–120. doi:10.1080/14789940600589464.

Woodbury-Smith, M. R., Clare, I. C. H., Holland, A. J., Kearns, A., Staufenberg, E., & Watson, P. (2005). A case-control study of offenders with high functioning autistic spectrum disorders. *Journal of Forensic Psychiatry & Psychology*, *16*(4), 747–763. Doi:10.1080/14789940500302554.

Zalla, T., Daprati, E., Sav, A.-M., Chaste, P., Nico, D., & Leboyer, M. (2010). Memory for self-performed actions in individuals with Asperger syndrome. *PloS one*, *5*(10), e13370. doi:10.1371/journal.pone.0013370.

Table 1

Age and IQ scores for the ASD and comparison groups (standard deviations in parentheses)

	ASD **(N = 18)**	**Comparison** **(N= 18)**
Age (years)	41.11 (13.12)	45.94 (11.99)
	Range: 25-63	Range: 25-61
VIQ[a]	110.94 (11.16)	110.78 (12.46)
	Range: 81-123	Range: 82-128
PIQ[b]	106.89 (13.13)	108.78 (13.57)
	Range: 84-128	Range: 75-136
FIQ[c]	109.83 (12.12)	110.72 (13.55)
	Range: 81-127	Range: 77-135

a Verbal IQ; b Performance IQ; c Full-scale IQ (WAIS-R UK or WAIS-III UK)

Table 2. Group differences in correct, incorrect and confabulated detailed reported in each interview phase (standard deviations are in parentheses).

	Correct	**Incorrect**	**Confabulated**
Free Recall			
ASD	46.44 (21.85)	4.81 (2.67)**	.44 (.98)
Comparison	52.19 (16.76)	2.58 (1.74)	.17 (.38)
Questioning			
ASD	40.17 (16.65)	10.11 (4.78)*	.94 (1.00)
Comparison	38.25 (10.41)	7.39 (2.99)	.44 (.86)

* $p < .05$, ** $p < .01$

Table 3.

Recall of Self- versus Other-performed actions: correct details and source confusions for each interview phase (standard deviations are in parentheses).

	Self Correct	**Self Error**	**Other Correct**	**Other Error**
Free Recall				
ASD	8.78 (3.39)	.78 (.73)	4.00 (3.01)	1.50 (1.50)
Comparison	10.33 (3.45)	.06 (.24)	6.56 (3.20)	1.06 (1.16)
Questioning				
ASD	3.56 (3.13)	.72 (.96)	3.17 (1.79)	.94 (.10)
Comparison	3.17 (1.82)	.50 (.86)	2.17 (1.34)	1.39 (1.65)

Appendix 1: Summary of self- and other-performed actions in scripted first aid scenario. *Self- and other-performed actions are denoted by (S) and (O), respectively.*

Assessing situation /initial actions

The experimenter asks the participant to get (S) and put out the hazard triangle (S) the experimenter takes the fluorescent tabard from table (O) and gives it to the participant to put on (S). The experimenter goes over the manikin and says "Hello, can you hear me?" (O).She then taps the manikin on the shoulders (O).

The participant checks the manikin's trouser pockets (S) and finds keys and a wallet/card. The experimenter takes the card and reads out the name on it (O). The experimenter says "Are you ok, James?" (O) and puts her ear to his mouth to check his breathing (O). The participant loosens his tie (S) and the experimenter undoes his top two shirt buttons (O).

Hand wound

The participant gets a tea towel from the table (S) and holds it on the hand to stop the bleeding (S) whilst the experimenter lifts the arm (O) to reduce blood flow to the area. Once the experimenter indicates that the bleeding has stopped the experimenter gets a bandage (O) from the first aid kit (which is already unravelled). The experimenter then takes the tea towel away (O), and the participant rolls up the bandage (S). The experimenter wraps the bandage around the manikin's hand (O) and the participant ties the knot in the bandage (S).

Burn

The experimenter rolls the manikin's sleeve up (O) and says that he has a burn on his arm that has cooled but needs to be wrapped in cling film. The participant takes off his wrist watch (S) and gets the cling film from the table (S). The experimenter opens the cling film and holds it out over the burn (O) and then the participant takes over and wraps it round the burn (S).

Broken leg

The experimenter says that the manikin's leg looks like it might be broken and gets a cotton blanket from the corner (O). The participant lifts the leg (S) so that the experimenter can place the blanket under (O) to stabilise it. The participant then gets the foil blanket (S) and wraps it around the manikin (S) to keep him warm.

Broken arm

The experimenter explains that the arm may also be broken so they need to put a sling on it. The participant gets a pad from the first aid kit (S). The experimenter takes off her scarf (O), and takes the pad and puts it between the manikin's arm and chest (O). The participant pulls the scarf-sling under the arm (S) and the experimenter ties it in a knot at the end (O).

Foot wound

There is a hole in one of the manikin's socks, so the participant removes it to check for a wound (S). The experimenter takes a band aid from the first aid kit (O), and the participant sticks the band aid on the wound (S).