

Brief Report: Schema Consistent Misinformation Effects in Eyewitnesses with Autism Spectrum Disorder

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Abstract A number of studies have demonstrated schema-related misinformation effects in typical individuals, but no research to date has examined this with witnesses with autism spectrum disorder (ASD), despite their impaired ability to generate core elements that define everyday events. After witnessing slides depicting a bank robbery, 16 adults with ASD and 16 matched comparison individuals were exposed to post-event misinformation that was either schema typical or atypical. Consistent with previous work, the comparison group went onto report more schema typical misinformation than atypical misinformation. However, so too did the ASD group, suggesting that individuals with ASD do have understanding of the causal links between events, persons and actions, an important finding from both theoretical and applied perspectives.

Keywords Autism spectrum disorder · Schema · Typicality · Misinformation · Eyewitness · Memory

Event schemas are general event representations containing schematically organised knowledge and sequences of actions within particular spatial–temporal contexts; useful in organising information in memory and understanding different events (Schank and Abelson 1977). However these schemas can have a negative effect such as when

eyewitnesses spontaneously use them to aid their memory for a previously witnessed event of a particular type, and erroneously recall typical details even when the details were not actually seen (Holst and Pezdek 1992).

Schema-related misinformation (e.g. Hekkanen and McEvoy 2005; Luna and Migueles 2008; Roediger et al. 2001) and false memory effects (e.g. Garcia-Bajos and Migueles 2003; Holst and Pezdek 1992; Tuckey and Brewer 2003a, b) have been demonstrated in eyewitness paradigms with typical individuals. However no research to date has examined this with witnesses with high-functioning autism, despite their well-documented difficulties in event memory and memory organisation. Individuals with autism spectrum disorder (ASD) have reduced generalisation and global understanding of the meaning of an event; reduced influence of schematic expectations on spontaneous attention is evidenced by their slower response in detecting scene unrelated objects (Loth et al. 2008). They also show reduced generalised event knowledge in narratives (Loveland and Tunali 1993) and impaired ability to spontaneously generate core elements defining everyday events including going to a restaurant or the cinema (Volden and Johnston 1999). The ASD participants in that study were nevertheless able to predict what would happen next in these events when given a number of choices.

The perceptual schema model (Biederman 1981) and the priming model (Friedman 1979) both explain the facilitating effect of context in typical individuals by the priming of the presentation of contextual scenes with stored representations of schema-consistent information. Previous research using the cognitive interview (Fisher and Geiselman 1992; Geiselman 1984), which involves the re-statement of contextual details experienced at the time of encoding, found that this technique not only failed to increase the number of correct details reported by

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individuals with ASD, but also significantly reduced their accuracy (Maras and Bowler *in press*). It is possible that individuals with ASD qualitatively differ from typical individuals in how they store representations of an event, which would go some way to explaining the damaging effect of this interviewing technique on recall accuracy. However, if individuals with ASD rely less on typical schemas to organise event details in memory, they may be less susceptible to schema-related post-event misinformation than are typical individuals. We aimed to examine this possibility by introducing schema typical and atypical post-event misinformation for a previously witnessed bank robbery, an event for which most individuals are likely to have well-established schemas, before examining how witnesses with ASD compare to a typical matched comparison group in subsequently reporting this misinformation erroneously. We predicted that the ASD group would be less susceptible to accepting typical post event misinformation than the comparison group, and that whilst the comparison group would make significantly more schema-typical than atypical intrusions, there would be no such difference in the number of typical versus atypical intrusions made by the ASD group. We also examined participants' free recall for details from the event, and in line with previous research (e.g. Bowler et al. 2000) predicted that the ASD group would recall significantly fewer correct details than the comparison group.

Method

Participants

Sixteen individuals with ASD (14 male, 2 female) and 16 typical individuals (12 males, 4 females) took part in this study. Comparison participants were individually matched to the ASD participants within 7 points of Verbal IQ as measured by the WAIS-R or WAIS-III UK (Wechsler 1981), and groups did not differ on Performance IQ, Full Scale IQ, or age. One-way ANOVAs (Group \times Interview) for chronological age, verbal IQ, performance IQ, and full-scale IQ found no significant main effects or interactions. Table 1 summarises these data.

Individuals with ASD were diagnosed by clinicians using a range of approaches, and a review of records and/or assessment with the Autism Diagnostic Observation Schedule (Lord et al. 1999) confirmed that all met DSM-IV criteria for ASD excluding the requirement for absence of clinically significant delay or abnormality of language development. Clinical diagnoses were checked against the DSM-IV criteria, and diagnoses were accepted only if explicit information on the criteria were present in the letter of diagnosis. ASD participants were recruited from

Table 1 Age and IQ scores for the ASD and comparison groups (standard deviations in parentheses)

	ASD ($N = 16$)	Comparison ($N = 16$)
Age (years)	37.25 (12.59)	45.00 (10.67)
VIQ ^a	110.06 (13.00)	111.38 (15.43)
PIQ ^b	108.31 (13.64)	106.75 (15.43)
FIQ ^c	110.06 (13.65)	110.00 (16.36)

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

autism support groups and societies, and an extended network of autism adults via internet forums and advertisements in the Greater London and South East of England area. The comparison group was recruited from an existing database via local newspaper advertisements and none had a history of neurological or psychiatric illness. All participants were British-born. Participants were paid standard university fees for their participation.

Materials

The witnessed event comprised a slide sequence of stills taken from a video of a staged bank robbery previously used by Tuckey and Brewer (2003b). A total of 27 slides were presented on a 17" monitor at a rate of 4 s per slide. They depicted two robbers wearing balaclavas approaching and entering a bank. One of the robbers approached the counter and demanded money from a female member of staff. The robber took the money and approached the door of the bank to leave, and as it opened looked up at the camera. Both robbers exited the bank and were seen running away. Misinformation was presented in the form of a mock newspaper extract (available from the first author on request). The extract contained an account of the bank robbery together with some related but irrelevant information (the rise in robberies over the past year in the UK and abroad). The extract also reported ten incorrect details that were not seen in the slides, five of which were schema typical (the robbers stuffed the money into a bag; one was carrying a gun; the customer was forced to the floor; the cashier was forced to put her hands up; one of the robbers kept watch), the other five were schema atypical (they removed their balaclavas; they held the door open for a customer before entering the bank; one the robbers had a can of cola in his hand; the cashier initially laughed at the robbers; one of the robbers poked his tongue out at the CCTV camera). To disguise this misinformation manipulation, we also included details that were correctly reported as having been seen in the slides. Typicality of items was determined by previous normative work (Garcia-Bajos et al. 2009; Tuckey and Brewer 2003a, b), and from a small pilot study by the present authors. Items were then rated by

a second independent rater who was blind to the first rater's coding. The second rater scored each detail in the final transcription according to whether they were schema typical, atypical, or schema irrelevant. An inter-rater reliability analysis using the Kappa statistic was performed to determine consistency among raters. The inter-rater reliability for the raters was found to be $Kappa = 0.74$ ($p < 0.0001$), 95% CI (0.60, 0.87).

Filler tasks comprised of two questionnaires ('attitudes to crime and punishment'). The recall questionnaire contained 19 questions, ten of which pertained to the misinformation details. The other nine questions were filler questions and were used to again disguise the critical questions. Filler questions only referred to information seen in the slide sequence (e.g. "what was the name of the bank?"), whereas the critical misinformation questions referred to details that were only read in the extract (e.g. "what did the robbers do with the money?") referred to the misinformation "stuffed the money into a bag").

Procedure

Participants were tested individually and informed that they would view a series of still slides taken from a video of a bank robbery before answering some questions relating to their attitudes toward crime and punishment (to maintain the cover story for the experiment and persuade participants that we really were interested in their attitudes to crime and punishment). Following presentation of the slides participants completed one of the filler tasks lasting around 20 min.

They were then exposed to misinformation and told they were to read an extract from a newspaper clipping about the bank robbery they had previously viewed slides of. Participants were allowed to read through the narrative at their own pace. Following completion of this and the other filler task (again lasting approx. 20 min) participants were given the surprise memory test and asked to write down in as much detail as they could recall everything they remember from the slides. Participants were explicitly warned at this point to only report what they had seen in the slides. Following free-recall participants were presented with the recall questions and again warned to only answer with information they actually saw in the slides. After each question participants were asked to indicate how confident they were that their answer was correct on a 7-point Likert-scale (1 not at all; 7 very confident).

Free Recall Coding

Each detail provided by participants in their free recall was coded against the original transcript for the slides as being correct or incorrect, and whether it was schema typical,

atypical, or irrelevant. Subjective statements of opinion (e.g. "he looked a bit shifty") were ignored, and details were only scored the first time that they were reported. Accuracy scores were also calculated by dividing the number of correct details reported by the total number of details reported (i.e. correct + incorrect).

Misinformation Questions Coding

Answers to each of the five typical and five atypical misinformation-related questions were scored as intrusions if the critical item of misinformation was incorporated.

Statistical Analyses

Initially, we examined the data for distribution of normality and outliers. Three ASD participants were identified as outliers due to a high rate of correct details, high rate of incorrect details, and low accuracy respectively. Analyses were carried out with and without these participants and findings changed only marginally. For this reason, in line with the diversity inherent in ASD, they were included in the analyses. Analyses examined free-recall in relation to correct and incorrect details, and accuracy scores overall, before examining proportions of the incorrect details given in terms of whether they were previously read in the extract or new errors, and whether they were schema typical or atypical. Analyses then examined whether participants erroneously reported details that were only read in the extract (and not seen in the slides) in response to specific questions, and whether these differed depending on whether they were schema typical or atypical. Estimates of effect size, Cohen's d , are reported.

Results

Free Recall

Accuracy of Free Recall

Mean numbers of correct and incorrect details recalled by the two groups and their accuracy scores are set out in Table 2. Inspection of the means shows that the ASD group recalled fewer correct details but more incorrect details than the comparison group, and also had a lower overall accuracy rate. This impression was confirmed by a one-way ANOVA, which showed that the ASD group were significantly less accurate than the comparison group, $F(1, 30) = 7.91$, $p < 0.05$, Cohen's $d = 0.99$, and that this was indeed reflected by the ASD group reporting significantly fewer correct details, $F(1, 30) = 8.02$, $p < 0.05$, Cohen's $d = 1.00$, and marginally significantly more

Table 2 Mean number of correct and incorrect details, and accuracy scores for free recall by ASD and comparison groups (standard deviations are in parentheses)

	Correct ^a	Incorrect ^b	Accuracy ^a
ASD	19.00 (10.37)	2.56 (2.94)	0.90 (0.10)
Comparison	27.50 (6.04)	1.00 (1.03)	0.97 (0.03)

^a Significant between group difference $p < 0.005$

^b $p = 0.054$

incorrect details, $F(1, 30) = 4.02$, $p = 0.054$, Cohen's $d = 0.70$ than the comparison group. Thus, the ASD group were significantly worse in terms of both quantity and quality of recall.

Source of Errors

Read Versus New Errors

In order to examine whether, compared to the comparison group, the ASD group were reporting a higher proportion of inaccurate details that they had read in the extract, or whether they were erroneously reporting more new errors not previously read, we conducted a one-way ANOVA with proportions of errors that were for details previously presented in the extract, and proportions of errors for details that were new. These proportions were calculated by dividing by the total number of errors each participant had made. Inspection of the means in Table 3 and subsequent ANOVA confirmed that the ASD and comparison

Table 3 Mean proportion of errors made in free recall for details that had been previously read in the extract, details that were neither seen in the slides nor read, details that were typical, and details that were atypical for ASD and comparison groups (standard deviations are in parentheses)

	Source of errors			
	Read	New	Schema typical	Schema atypical
ASD	0.32 (0.41)	0.68 (0.41)	0.42 (0.42)	0.09 (0.13)
Comparison	0.32 (0.46)	0.68 (0.46)	0.32 (0.46)	0.05 (0.15)

Table 4 Mean numbers of intrusions made by ASD and comparison groups and mean confidence with which they were made (standard deviations are in parentheses)

	Schema typical intrusions		Schema atypical intrusions	
	Mean intrusions	Mean confidence	Mean intrusions	Mean confidence
ASD	1.75 (1.34)	4.87 (1.47)	0.31 (0.79)	3.11 (2.83)
Comparison	1.31 (1.14)	5.05 (1.54)	0.25 (0.45)	4.75 (2.22)

group did not differ in the proportion of errors they made for details that they had previously read in the extract. Nor did they differ for the proportion of their errors that were new details that were neither seen in the slides nor presented in the extract, all F 's < 1.00 , *ns*.

Typical Versus Atypical Correct and Incorrect Details

We also examined typicality of correct and incorrect details. As can be seen by inspection of the means in Table 3, and confirmed by a one-way ANOVA, there was no difference between groups for the proportion of correct details that were typical, $F(1, 30) = 1.08$, $p = 0.31$, Cohen's $d = 0.37$, or atypical, $F(1, 30) = 0.02$, $p = 0.90$, Cohen's $d = 0.04$. There was also no difference between groups for the proportion of errors that were typical, $F(1, 20) = 0.31$, $p = 0.59$, Cohen's $d = 0.23$, or atypical, $F(1, 20) = 0.60$, $p = 0.45$, Cohen's $d = 0.28$. A 2 (group: ASD vs. control) \times 2 (schema: typical vs. atypical) mixed ANOVA did however reveal a main effect of schema typicality, $F(1, 20) = 8.87$, $p < 0.01$, Cohen's $d = 0.94$. A significantly higher proportion of errors were for details that were schema typical (Mean = 0.37, SD = 0.43) than details that were atypical (Mean = 0.07, SD = 0.14). There was no group \times typicality interaction, $F(1, 20) = 0.08$, $p = 0.78$, indicating that both groups similarly made more schema typical than atypical errors (due to floor effects, we were unable to analyse within read only and new errors for typical and atypical details).

Specific Questions

Mean numbers of typical and atypical intrusions made in response to the questions by the two groups are set out in Table 4. Inspection of the table shows that the ASD and comparison groups both made more typical than atypical intrusions, but the groups did not appear to differ from one another on the number of intrusions they made for each type. This impression was confirmed by a 2 (group: ASD vs. comparison) \times 2 (schema: typical vs. atypical) mixed ANOVA, which revealed a significant main effect of type of intrusions, $F(1, 30) = 22.43$, $p < 0.001$, Cohen's $d = 1.27$; participants made more typical intrusions

(Mean = 1.53, SD = 1.24) than atypical ones (Mean = 0.28, SD = 0.63). There was not a significant interaction between typicality of intrusions and group, $F(1, 30) = 0.51$, $p = 0.48$; the groups were similar in that they made more schema-typical intrusions than they did atypical ones. Next we examined whether confidence differed for typical vs. atypical intrusions, and whether both groups reported these intrusions with similar rates of confidence in the accuracy of their answers. There was no main effect of confidence between typical and atypical intrusions, $F(1, 4) = 2.37$, $p = 0.20$, Cohen's $d = 0.45$, nor was there a significant group \times typicality interaction for confidence, $F(1, 4) = 1.40$, $p = 0.30$; both groups reported typical and atypical intrusions with similar rates of confidence (see Table 4).

Discussion

Our study examined free-recall and schema-related misinformation effects in witnesses with ASD. We found that the ASD group recalled fewer correct details and were less accurate than their matched comparison group in their free recall for a previously witnessed event, which is in line with some previous research (e.g., Bennetto et al. 1996; Bowler et al., 2000) but inconsistent with others (e.g. Maras and Bowler *in press*; Renner et al. 2000). Coupled with previous research showing that individuals with ASD can recall as much and as accurately as typical individuals when support is provided at test (Bowler et al. 2004), this finding highlights the need for future work to assess effective retrieval strategies for use in investigative eye-witness contexts to increase both the quantity and quality of details that they recall. That the ASD group did not differ from the comparison group in the types of errors that they made (typical, atypical, read, or new) suggests that individuals with ASD equally erroneously report schema typical details, and are as susceptible to confuse source from a post-event extract as are typical individuals. Both groups made more schema typical than atypical errors, suggesting that individuals with ASD do use existing schemas to aid their memory leading them to erroneously report schema-consistent but inaccurate details.

We also found that both ASD and typical individuals were more likely to go onto report previously presented misinformation that was schema typical than information that was atypical, and that both groups did so with similar rates of confidence. This is at odds with some previous research (e.g. Loveland and Tunali 1993; Volden and Johnston 1999), while other work suggests that higher functioning ASD individuals do use event schemas and that this is related to factors such as theory of mind (Loth et al. 2008). This suggests that individuals with ASD do have

some understanding of the causal relationship between events, persons and actions, and previous findings of an impairment for these types of details when interviewed with a cognitive interview (Maras and Bowler *in press*) highlights the necessity for further examination as to why this is.

Our finding of no difference between groups for schema-related intrusions appears to pose problems for the weak central coherence account (WCC, Frith 1989) in that a local processing style might not necessarily mean global processing impairments and reduced susceptibility to schema-related misinformation effects. However the latest version of the WCC account (Happé and Frith 2006) argues that individuals with ASD have a detail-focussed cognitive style which does not necessarily lead to a difficulty in 'seeing the bigger picture'. The present study did not specifically assess local versus global processing of details per se, and we acknowledge that some of the details may have reflected more global elements central to the event schema (e.g. robbers carrying a gun in a bank robbery), whilst others may have reflected more local elements not central to the story (e.g. the cashier being forced to stick her hands up) however a full examination of this was beyond the scope of this paper. We do however acknowledge the limitations of the present study, including the modest sample size, the fact that the sample was restricted to high-functioning individuals with ASD, and the close to ceiling effect for accuracy score for the typical group. Nevertheless the present study is the first of its kind to examine schema-related misinformation effects in witnesses with ASD. That they are just as susceptible to these misinformation effects as are typical witnesses is important from both theoretical, in terms of WCC, and applied perspectives. Findings indicate that practitioners should be aware that witnesses with ASD are as susceptible to schema-related misinformation effects as typical witnesses are.

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