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Running head: Past and future thinking in ASD

Title: Remembering the past and imagining the future in autism spectrum disorder

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Abstract

Recent research has revealed that episodic memory (remembering past experiences) and episodic future thinking (imagining future experiences) rely on the same underlying neuro-cognitive system. Consistent with this suggestion, individuals with autism spectrum disorder (ASD) have been shown to experience difficulties in both domains. In the present study, 18 adults with ASD and 18 typical adults performed sentence completion tasks assessing the ability to generate past and future events. Contrary to previous research findings, results demonstrated that adults with ASD performed at an equivalent level to typical adults when generating both past and future events; generating a higher number of specific events when recalling past (relative to simulating future) events, and a higher number of semantic associates when simulating future (relative to recalling past) events. Results are discussed with respect to methodological factors affecting task performance in ASD including the social nature of the research, the need to verbalise memories to the experimenter, and whether or not the specific memory request is explicit.

Keywords

autism spectrum disorders; autobiographical memory; episodic memory; episodic future thinking; prospection; mental time travel

Introduction

Autism spectrum disorder (ASD) is a lifelong developmental disorder in which individuals present with social interaction and communication difficulties, alongside the presence of restricted and repetitive interests, activities and behaviours. Although ASD is currently divided into discrete diagnostic categories (e.g., autistic disorder, Asperger's disorder) (American Psychiatric Association, 2000), the concept of a single autism spectrum (appreciating that the same core symptoms vary in severity between individuals) will replace these individual categories in the forthcoming DSM-V (see www.dsm5.org, for details).

Using a variety of experimental tasks, and participants of varying ages and abilities, several studies have reported episodic memory difficulties (i.e., difficulties in remembering the past) in individuals with ASD. These difficulties span both laboratory-based memory tasks (including free recall and recognition of previously presented word lists; Bowler, Gardiner, & Gaigg, 2007), as well as the focus of this paper, autobiographical memory tasks (assessing the ability to recall personally experienced events and personal semantic facts; Crane & Goddard, 2008). On the latter, individuals with ASD consistently generate fewer specific events than their typical counterparts and take significantly longer to do so (e.g., Adler, Nadler, Eviatar, & Shamay-Tsoory, 2010; Crane & Goddard, 2008; Crane, Goddard, Jukes, & Pring, in press; Crane, Goddard, & Pring, 2009, in press; Goddard, Howlin, Dritschel, & Patel, 2007; Lind & Bowler, 2009). Such difficulties are related to a reduction in autonoetic awareness (the conscious re-experiencing of a past event) in this group that is compensated for by an increase in noetic awareness (an awareness of information in the absence of the recollection of the acquisition of that knowledge) (Bowler et al, 2007; Tanweer, Rathbone, & Souchay, 2010). Autobiographical memory difficulties have also been linked to problems in relation to self-referential cognition in this group (e.g., Crane et al., 2009; Lind, 2010). In particular, adults with ASD do not appear to use information pertaining to the self to organise their database of personally experienced events (Crane et al., 2009).

As well as being defining properties of episodic memory, autonoetic awareness and self-referential cognition are crucial for episodic future thinking (imagining future events). Not only are these two cognitive skills thought to be supported by the same underlying cognitive process (Atance & O' Neill, 2001; Schacter, Addis, & Buckner, 2007; Suddendorf & Corballis, 1997; Wheeler, Stuss, & Tulving, 1997), they are known to share the same core neurocognitive system (Addis, Pan, Vu, Laiser, & Schacter, 2009; Buckner & Carroll, 2007; Spreng, Mar, & Kim, 2009). Evidence for this hypothesis stems from research that demonstrates similar characteristics of both past and future thinking. For example, the specificity of both past and future events has been found to decrease with age (Addis, Wong, & Schacter, 2007), and both types of mental time travel are strongly linked to characteristics of the self (D'Argembeau & Van der Linden, 2004; Rathbone, Conway, & Moulin, 2011). Further, impairments in one of these systems are typically associated with impairments in the other, as demonstrated in a range of clinical conditions (e.g., Brown et al., forthcoming; D'Argembeau, Raffard, & Van der Linden, 2008; Williams et al., 1996). Given the episodic memory difficulties displayed by individuals with ASD, it appears likely that episodic future thinking would also be compromised in this group.

Only recently have Lind and Bowler (2010) provided the first published report demonstrating that both remembering the past and imagining the future are impaired cognitive skills in ASD. Using an interview task in which participants were asked to detail events from a range of time periods (ranging from ‘today’ to ‘10 years ago/in 10 years’), they found that adults with ASD recalled/imagined significantly fewer specific events than typical adults. Both groups performed better when recalling past events, relative to simulating future events (see also Anderson & Dewhurst, 2009), which Lind and Bowler (2010) attributed to the increased cognitive demands inherent in future event simulation (see also Anderson, Dewhurst, & Nash, 2012). One key difference did emerge between the performances of each group though – scores on the episodic memory and episodic future thinking tasks were significantly and positively correlated in typical adults, but no relationship between past and future task performance was observed in the adults with ASD. This could reflect the fact that adults with ASD may be less likely than typical adults to utilise elements of their personal past to aid in the simulation of future experiences (Lind & Bowler, 2010). Given the clinical and cognitive heterogeneity associated with even high-functioning groups of individuals with ASD (Jones & Klin, 2009), it is important to ascertain the robustness of the findings demonstrating impairments in both past and future oriented thinking in this group, especially using a task that reflects habitual levels of memory specificity (Raes, Hermans, Williams, & Eelen, 2007). Therefore, the aim of the current study was to replicate and extend the results of Lind and Bowler (2010) using an alternate methodology.

The Sentence Completion of Events from the Past Test (SCEPT) (Raes et al, 2007) is an adaptation of traditional sentence completion tasks in which participants are presented with the start of a sentence (e.g., *‘I still remember well how…*’) and are asked to provide memories of past events to complete the stems. As participants are not explicitly instructed to retrieve memories of specific autobiographical events (i.e., memories pertaining to one specific day, opposed to a general occurrence) on this task, as is standard in other measures of personal event memory (Dritschel, Williams, Baddeley, & Nimmo-Smith, 1992; Williams & Broadbent, 1986), the SCEPT provides a measure of a person's natural propensity to access specific or general past events. Greater variation in the scores of healthy adults is therefore observed, with typical adults tending to recall fewer specific events (and a correspondingly higher number of general events) relative to the numbers observed in methodologies that specify the recall of a specific past event. Raes et al. (2007) therefore suggest that typical adults may adopt a more general retrieval style in everyday life (and on assessments that are sensitive to levels of spontaneous overgeneral thoughts), but can override this on tasks in which specific memories are explicitly requested.

A Sentence Completion of Events from the Future Test (SCEFT) was subsequently developed (Anderson & Dewhurst, 2009), in which participants are asked to generate future events in response to a series of stems (e.g., *'Last year…'*). Using this task, Anderson and Dewhurst (2009) found typical adults to generate fewer specific events when simulating future events, relative to when they were asked to recall events from the past. This reduction in future event specificity was compensated for by an increase in the recall of extended events (single events lasting longer than a day) and semantic associates (overgeneral semantic information that does not constitute a memory), but not categoric events (reoccurring events).

Although the same underlying network is thought to support past and future thinking (Addis et al, 2009; Buckner & Carroll, 2007; Spreng et al, 2009), generating specific events on the SCEFT appears to be more cognitively/executively demanding than on the SCEPT. For example, recalling a specific memory on the SCEPT requires a mental search for a unique event, whereas generating a hypothetical future event on the SCEFT can be achieved using an infinite combination of information from various episodic memories (Anderson et al., 2012). This process of mentally reorganising and extracting relevant information from an array of episodic events (while also inhibiting irrelevant events) certainly appears more effortful than recalling a specific past event. However, Anderson and colleagues (2012) found limited evidence to support this suggestion, instead proposing that any differences between recalling the past and imagining the future are very subtle.

There are several advantages of the SCEPT and SCEFT over indices of autobiographical memory that have been used in previous studies on adults with ASD. First, as previously mentioned, both of these tasks do not include a request for a specific event to be retrieved. They therefore index a person’s natural propensity to retrieve specific events. Second, these tasks measure memory/future thinking slightly differently from previous studies. Whilst the majority of previous studies distinguish between specific and general events (i.e., single instances versus more common occurrences), the SCEPT and SCEFT suggest an additional category of error response – semantic associates (i.e., personal semantic information that does not constitute a memory). As such, the SCEPT and SCEFT utilise more sensitive scoring criteria. Third, these tasks do not necessitate face to face testing and are therefore useful methods for assessing past and future thinking in postal/internet studies. This also has the advantage of reducing the social demands of relaying memories to an experimenter (as in other measures of past and future thinking) and is especially pertinent given the social impairments characteristic of individuals with ASD. Indeed, Ozonoff (1995) found that people with ASD were less impaired on a computerised version of the Wisconsin Card Sorting Test, relative to the standard experimenter-administered version.

In summary, the aim of the current research was to explore past event recollection and future event simulation in adults with ASD, relative to a typical adult comparison group, using methodologies that have not previously been utilised in this group (the SCEPT and SCEFT). This is especially important given the key methodological differences between measures of past and future thinking in previous studies, relative to the current investigation (as previously discussed). In particular, it may provide further insights into the nature of the social impairments characteristic of ASD. It may also inform theories concerning the links between past and future thought (as this network appears to be disrupted in ASD, cf. Lind & Bowler, 2010).

Given previous reports of impaired past and future thinking in ASD, it was predicted that adults with ASD would remember/simulate fewer specific events than typical adults on both the SCEPT and SCEFT (reflecting impairments in episodic memory and episodic future thinking, respectively). However, considering the methodological differences between the tasks used in the current research, relative to existing studies (i.e., the reduced social and cognitive requirements, as well as more sensitive scoring criteria), this prediction was tentative. It was also predicted that performance on the SCEPT and SCEFT would be significantly positively correlated in the typical adults (reflecting interconnectedness between these two cognitive capacities), but that there would be no relationship between past and future event generation in the ASD group. Again, this prediction was made tentatively. Although research using other paradigms generally reveals strong positive correlations between past and future thinking in typical individuals (e.g., Busby & Suddendorf, 2005; D'Argembeau, et al., 2008; Lind & Bowler, 2010), comparable findings are not consistently observed using the SCEPT and SCEFT (Anderson, personal communication).

Method

Participants

Ethical approval for the study was obtained from the Senate Research Ethics Committee at City University, London. All participants gave their informed consent to take part and were given a gift voucher to thank them for their time. A total of 36 adults participated in this study: 18 adults with a formal diagnosis of ASD (13 males) and 18 typical adults (13 males). The adults with ASD were recruited from an existing database of research volunteers held by the Autism Research Group at City University, London. All participants in the clinical group had previously received a formal diagnosis of Asperger disorder from a clinical professional. None of the participants had received co-morbid psychiatric diagnoses. Diagnoses were confirmed by a member of the Autism Research Group using the Autism Diagnostic Observation Schedule-Generic (ADOS-G) (Lord et al., 2000). The ADOS-G is a semi-structured, standardized assessment of social interaction, communication, play, and imaginative use of materials that is widely considered to be a "gold standard" ASD diagnostic instrument. In all cases, the schedule was administered by a fully trained assessor who had established reliability with the developers of the instrument. All participants in the clinical group met the ASD cut-off (7 points) on the Social + Communication Total Score of the ADOS-G, and 9/18 met the more stringent "autism" cut-off (10 points).

As a further diagnostic check and to ensure that no comparison participants exhibited clinically significant levels of autistic traits, all participants completed the Autism-spectrum Quotient (AQ) (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001), a 50-item self-report ASD screening questionnaire. Woodbury-

Smith, Robinson, and Baron-Cohen (2005) recommend a cut-off of 26 points to distinguish between individuals with and without ASD on this measure, with 83% specificity. In line with the reported specificity of this measure, two participants in the clinical group failed to meet the AQ cut-off (each scoring 22). However, these participants both met criteria for autism on the ADOS-G (obtaining total scores of 11 and 16 respectively). None of the participants in the comparison group exceeded the AQ cut-off (maximum score: 23).

Participants were also screened for current mood state using the Beck Depression Inventory (Beck, Ward, & Mendelson, 1961); a 21-item self-report questionnaire. This measure was included given that depressed mood adversely affects the specificity of past and future thought (Williams, et al., 1996) and in view of the high incidence of depressed mood in adults with ASD (Hill, Berthoz, & Frith, 2004). The group difference in BDI scores was non-significant with a small effect size (see Table 1). BDI scores were not significantly correlated with performance on either the SCEPT or SCEFT (proportion of specific events generated), within either group, all rs < ±.19, all ps > .48.

Participant characteristics are presented in Table 1.

[place Table 1 about here]

IQ was assessed using the Wechsler Adult Intelligence Scale – Third UK Edition (Wechsler, 1999). The ASD and comparison groups were matched on the basis of age, gender, and verbal, performance and full-scale IQ. Effect sizes for group differences on each of these measures were all small, indicating close matching.

Materials

Measures of past and future episodic thinking

In the Sentence Completion for Events of the Past Test (SCEPT) (Raes, et al., 2007), participants are provided with the start of a sentence (e.g., *"I still remember well how…"*) and are asked to recall a memory of a past event to complete the sentence. In total, 11 sentences are presented to participants. A corresponding Sentence Completion for Events from the Future Test (SCEFT) (Anderson & Dewhurst, 2009) involves participants completing 11 sentence stems about events that are likely to happen in the future (e.g., *'Next year...'*). Although participants were not explicitly instructed to recall a specific event in response to each stem, each sentence produced was coded according to degree of specificity. In line with previous research, five scoring categories were used: omissions; semantic associates (personal overgeneral semantic information that does not constitute a memory, e.g., *'I will never forget my house'*); extended events (single events lasting longer than a day, e.g., *'I am going on holiday soon*); categoric events (reoccurring events, e.g., *'when I go to work'*); and specific events (single events lasting no longer than a day, e.g., *'I have a job interview next week'*). All participants completed the SCEPT prior to the SCEFT.

All responses were coded by two raters who were blind to participant diagnoses and the hypotheses of the experiment. The raters were provided with short descriptions of each type of scoring category, along with numerous examples of responses that would be coded in each category. Raters were instructed to choose the category that they felt best reflected each response provided by participants, acknowledging that some responses may be classed in more than one category, for example due to ambiguity or brevity of responses provided by participants (e.g., '*starting to play the piano again*' could be classed as a 'specific event' if they were referring to the day that they started to play the piano again, or a 'categoric event' as regular playing is implied). Nevertheless, inter-rater reliability was found to be acceptable, Kappa = .70, p <.001, 95% CI = .66 -.74. This represents "substantial agreement" (Landis & Koch, 1977). Any disagreements were resolved by discussion.

Procedure

Participants completed measures of intelligence and the ADOS-G as part of previous unrelated studies conducted at the Autism Research Group at City University, London. As part of the current study, participants were sent a booklet containing the AQ, BDI and SCEPT/SCEFT, which they returned electronically. Participants were informed that they could contact the research team if they had any questions; none of the participants did.

Results

Following Anderson and Dewhurst (2009), firstly the numbers of omissions as a proportion of the total number of sentence stems in each task were calculated. Secondly, the numbers of specific events, categoric events, extended events, and semantic associates were calculated as a proportion of the number of responses within each task (i.e., excluding omissions). The mean proportions of each response category across groups and task types are presented in Table 2.

[Table 2 here]

A series of five 2 (Group: ASD/comparison) x 2 (Task: SCEPT/SCEFT) mixed model ANOVAs were conducted to explore possible differences in proportions of (1) specific events, (2) categoric events, (3) extended events, (4) semantic associates, and (5) omissions. None of these analyses revealed any significant main effect of Group, all *F*s < 1.88, all *p*s $> .17$, all Cohen's *d*s < 0.32; or significant interaction between Group and Task, all *F*s < 0.66, all *p*s $> .42$. There was no significant main effect of Task on proportions of categoric events, extended events, or omissions, all *F*s < 2.50, all *p*s $> .11$, all Cohen's *d*s < 0.38. However, there were significant main effects of Task on proportions of specific events, $F(1,34) = 15.50$, $p < .001$, Cohen's $d = 0.81$, and semantic associates, $F(1,34) = 26.80$, $p < .001$, Cohen's $d = 0.96$. This reflected the fact that (a) the proportion of specific events produced in the SCEFT (future events) was significantly *lower* than in the SCEPT (past events), and (b) the proportion of semantic associates produced in the SCEFT was significantly *higher* than in the SCEPT.

In order to test the prediction that episodic past and future thinking would be related within the comparison group only, Pearson's correlation analyses between proportions of specific events generated on the SCEPT and SCEFT for each of the groups were conducted. Neither the correlation within the comparison group, $r = -.09$, $p = .72$, nor the correlation within the ASD group, $r = .43$, $p = .07$, reached statistical significance. A Fisher's Z statistic was subsequently calculated to establish whether the strength of the correlations significantly differed between the groups. The difference in the strengths of the correlations was found to be non-significant, $Z_{r1-r2} = 1.51$, $p = .13$.

Discussion

Using sentence completion tasks indexing the specificity of past and future events, the present research aimed to replicate and extend previous research that demonstrated impairments in both past and future thinking in adults with ASD, relative to a well-matched group of typical adults. Contrary to previous findings (e.g., Lind & Bowler, 2010), results indicated that the ASD group performed at an equivalent level to typical comparison adults when generating events from both the past and future. Similar patterns of performance were observed in both groups: participants produced specific events to a lesser degree when simulating future events (relative to recalling past events), and also produced a higher number of semantic associates when simulating future events (relative to recalling past events); findings that are broadly consistent with previous research on this topic (Anderson & Dewhurst, 2009).

One explanation for the non-significant group differences is that they are an accurate reflection of habitual levels of episodic memory and episodic future thinking in ASD. Such an interpretation would be in direct contrast to the results of Lind and Bowler (2010), and numerous previous studies documenting impairments in episodic recall in adults with ASD. In support of this suggestion, the current study included a respectably sized sample of adults, whose diagnoses were confirmed on the basis of gold standard criteria and were compared to a well matched group of typical adults. In addition, the mean scores of the ASD and comparison groups were very similar (as reflected by the small effect sizes for all group differences) with no indication of even a subtle impairment in past or future thinking in adults with ASD.

To account for the discrepancy between the results of the current study and a vast body of previous research, it is important to take into account the differing methodological approaches to studying episodic past and future thinking. One such difference regards the scoring criteria employed by the SCEPT/SCEFT (i.e., the inclusion of the ‘semantic associate’ category). However, the key variable of interest in this research is the measure of memory specificity, which is comparable between studies. A more pertinent difference regards how previous studies have explicitly asked participants to try to recall/imagine *specific* events, whereas the current study imposed no such constraints. In the present study, not asking participants to concentrate on specific memories may have resulted in the comparison group producing more general memories than under the Lind and Bowler (2010) procedure. This aspect of the method may have driven down the proportion of specific events generated by the comparison participants to a level comparable to that of the participants with ASD, thereby masking difficulties in episodic memory and episodic future thinking in the ASD group. Indeed, previous studies (Raes, et al., 2007) have established that typical adults report fewer specific events on the SCEPT and SCEFT, relative to other indices of personal event memory. Given that levels of specific recall for past and future events in this sample (for both the ASD and comparison groups) were comparable to those of the participants in Anderson and Dewhurst’s (2009) study, it does appear that the lack of a group difference in the current study was due to a reduction of specificity in the comparison sample, rather than unusually high levels of memory specificity in the ASD group.

It should, however, be noted that Anderson and Dewhurst (2009) imposed a six minute time limit in which the SCEPT and SCEFT needed to be completed, whereas there was no time limit in the current study (nor was time taken to complete the task measured). This might have allowed for greater compensation in our sample (especially in the adults with ASD, who have previously been shown to display impairments in the specificity of past and future events), thereby potentially obscuring difficulties in spontaneous event retrieval/simulation. However, the participants in this research were not made aware that a specific response was more “desirable” than an alternative response (e.g., semantic associate) and would therefore have been unlikely to consciously attempt to recall/simulate a specific past or future event. Further, when previous studies have removed the time constraints from assessments of past event recall, impairments are still observed in groups with ASD (e.g., Crane & Goddard, 2008; Crane, Goddard, & Pring, 2010; Lind & Bowler, 2010).

An alternative explanation for these discrepant findings concerns the social demands of the task. To our knowledge, this is the first study of past and future thinking in adults with ASD in which participants have been asked to write their responses, rather than verbalising them to an experimenter. It is plausible that the ASD group performed better than expected because the social anxiety associated with reporting personal memories verbally was reduced. A direct comparison of performance on past and future thinking tasks that require a verbal, social interaction with an experimenter, versus tasks that remove these social contingencies, would therefore be of interest. A limitation of the present research is that there was no direct comparison between performance on the SCEPT/SCEFT and traditional measures of past and future thinking (e.g., interview tasks, cueing tasks) (as in Raes et al., 2007). This would indicate whether a dissociation in performance occurs (predicting intact performance on the SCEPT/SCEFT, but not on alternate methodologies, in samples with ASD).

It may potentially be argued that the present study was merely underpowered to detect genuine, substantive group differences in performance on the SCEPT and SCEFT. However, the effect sizes associated with each of the group contrasts were negligible (all *d*s < 0.32), indicating that any underlying differences between the groups were of minimal clinical significance. Indeed, the effect size associated with the main effect of Group on the key variable of interest (proportion of specific events generated) was only $d = 0.22$. A retrospective power calculation using G*Power 3 (Faul, Erdfelder, Lang, & Buchner 2007) revealed that the study would have required a sample size of 1608 participants in order to achieve a $p < .05$ for this variable (with an associated power of .80, as recommended by Cohen, 1992).

Contrary to our (tentative) predictions (and previous research utilising other methods), we did not observe a significant relationship between past and future thinking amongst typical adults. This suggests that performance on the SCEPT and SCEFT may rely on largely independent processes – participants were not drawing on the same cognitive resources when generating past and future events. Although the correlation between performance on the SCEPT and SCEFT did not reach statistical significance in the ASD sample either, there was a trend towards a positive correlation between past and future event generation in this group ($p = .07$). It is important for future research to confirm these results in a larger sample and to bear in mind the statistical limitations of the present study, with respect to the correlational analyses, but these findings may indicate that the SCEPT and SCEFT rely on a different set of cognitive processes to those invoked by more traditional cuing and interviewing methods.

A final point of note concerns the scoring system adopted in the current study (and that used in the original papers documenting the development of the SCEPT and SCEFT, i.e., Anderson & Dewhurst, 2009; Raes et al., 2007). An all-or-none system was adopted in which each response generated by participants was labelled as either fully belonging to a particular scoring category (e.g., specific event, semantic associate) or not. However, there is some variability in the specificity of the events within each category; for example, an extended event that lasted two days is more ‘specific’ and less ‘extended’ than an event taking place over an entire month (yet the current procedure would not distinguish between these two extended events). A finer-grained coding system (perhaps rating levels of specificity on a continuum) may therefore be more sensitive at detecting group differences in future research. However, it is important to stress that there was no indication at all of even a marginal group difference in the current study (whereas previous studies using a similar coding system have consistently revealed group differences between adults and children with and without ASD).

Overall, this study stresses the need for a mixed-methods approach to assessing episodic past and future thinking in ASD, taking into account the social nature of the research, the need to verbalise memories to an experimenter, and whether or not the specific memory request is explicit. Episodic memory and episodic future thinking appear to be very sensitive to the way that they are measured and more complex designs are needed to untangle this. Further research (which is currently underway; Lind, Bowler, & Williams, in preparation) is also needed to assess cognitive processes such as “scene construction” (Hassabis & Maguire, 2007) and “self-projection” (Buckner & Carroll, 2007) that are hypothesised to underlie past and future thinking, and to explore whether they are impaired or intact in this group and to determine whether or not episodic and future thinking are genuinely compromised in individuals with ASD.

Table 1: Participant characteristics

	ASD (n = 18)		Comparison (n = 18)						
Characteristic	*M*	*SD*	*M*	*SD*	*t*	*df*	*p*	*r*	Cohen's *d*
VIQ	109.94	19.14	111.72	14.48	0.31	34	.76	.05	0.10
PIQ	109.06	21.10	106.61	15.25	0.40	33	.70	.07	0.13
FSIQ	107.81	10.30	110.27	15.72	0.40	32	.69	.09	0.19
Age (years)	40.12	13.94	44.80	11.59	1.09	34	.28	.18	0.37
AQ	34.67	6.89	13.72	5.67	10.00	34	< .001	.86	3.32
ADOS-G	10.33	2.95	-	-	-	-	-	-	-

Note: VIQ = verbal IQ; PIQ = performance IQ; FSIQ = full scale IQ; AQ = Autism-spectrum Quotient; ADOS-G = Autism Diagnostic Observation Schedule-Generic

Table 2: Mean (*SD*) proportions of the different response categories across task type and group

		Task	
Response category	Group	SCEPT	SCEFT
Specific	ASD	.36 (.18)	.22 (.17)
	Comparison	.32 (.10)	.19 (.17)
Categoric	ASD	.23 (.12)	.20 (.14)
	Comparison	.23 (.10)	.26 (.16)
Extended	ASD	.21 (.14)	.18 (.12)
	Comparison	.21 (.11)	.15 (.11)
Semantic Associate	ASD	.20 (.16)	.40 (.21)
	Comparison	.23 (.12)	.40 (.22)
Omission	ASD	.02 (.05)	.02 (.05)
	Comparison	.01 (.02)	.01 (.02)

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