Journal of Autism and Developmental Disorders

A preliminary study of gender differences in autobiographical memory in children with an autism spectrum disorder

--Manuscript Draft--

Manuscript Number:	JADD-D-13-00683R1
Full Title:	A preliminary study of gender differences in autobiographical memory in children with an autism spectrum disorder
Article Type:	Article
Keywords:	autobiographical memory, gender, autism spectrum disorder
Corresponding Author:	Lorna Goddard London, UNITED KINGDOM
Corresponding Author Secondary Information:	
Corresponding Author's Institution:	
Corresponding Author's Secondary Institution:	
First Author:	Lorna Goddard
First Author Secondary Information:	
Order of Authors:	Lorna Goddard
	Barbara Dritschel
	Patricia Howlin
Order of Authors Secondary Information:	
Abstract:	Autobiographical memory was assessed in 24 children (12 male, 12 female, aged between 8 & 16 years) with autism spectrum disorder (ASD) and a comparison group of 24 typically developing (TD) children matched for age, IQ, gender and receptive language. Results suggested that a deficit in specific memory retrieval in the ASD group was more characteristic of male participants. Females in both the TD and ASD groups generated more detailed and emotional memories than males. They also demonstrated superior verbal fluency scores; verbal fluency and autobiographical memory cueing task performance were significantly positively correlated in females. Results are discussed in light of recent research suggesting gender differences in the phenotype of ASD
Response to Reviewers:	Dear Professor Volkmar, Thank you for forwarding the reviewers comments on our manuscript 'A preliminary study of gender differences in autobiographical memory in children with an Autism Spectrum Disorder'. We detail our response to the reviewers' comments below and have amended the script as outlined. Reviewer 1 Abstract: We have amended the script so that it more accurately reports the results. Introduction. -We refer now to an article by Bolte et al. (page 4, end of first paragraph.) -We have now mentioned the fact that ASD may go under diagnosed in female and have included a reference to this effect (end of page 3.) -References have been corrected to read Crane & Goddard 2008 (third paragraph, page 4). -A reference to Lind et al. has now been included (top of page 5).

-Reference to Crane et al. now included (Page 6 – first paragraph).
-As requested a sentence has been added to clarify that participants were part of a larger sample (Page 7, last line of participant section.)

Method
-Page 7 – a footnote has been added regarding the use of DSM IV-R (see p. 7).

Results
-Page 12 – we have changed the wording here to clarify the text (see verbal fluency section, now page 11).
-Page 12 – the correlations within gender are presented in Table 4.
Discussion
-Page 13 – Correlations within group are now also reported (see page 12).
-Page 13 – The sentence has been amended to clarify that accessing and sharing specific memories facilitates social interaction (see page 13, bottom of first paragraph).
-Page 14 – A sentence has been added to highlight the similarity between the tasks in terms of a time constraint (see bottom of page 13).
-Page 14 – While there is evidence of gender differences in several aspects of AM retrieval (as described in the intro), we are not aware of any studies that have examined gender differences in cueing task performance in children.
-Page 15 – Reference to lower SCQ scores in females is made (see p.16).

Reviewer 2

Changes have been made to the statistical analyses to enhance clarity: descriptions of the overall MANOVA of the cueing task have been eliminated (see bottom page 9/10) and results of the Recent & Remote task, re-organised (see pages 10/11) so that they are more succinct. The introduction has also been shortened and reference to the implications that the findings have for treatment is now included (see page 15).

We are grateful to the reviewers for their very helpful comments. We look forward to hearing from you.

Kind regards
Lorna Goddard

A preliminary study of gender differences in autobiographical memory in children with an Autism

Spectrum Disorder

Lorna Goddard¹, Barbara Dritschel², & Patricia Howlin³

¹ Department of Psychology, Goldsmiths College

University of London

New Cross, London SE14 6NW

Tel. 020 7919 7908

Fax. 020 7919 7883

E-mail: l.goddard@gold.ac.uk

² Department of Psychology, University of St. Andrews, Fife KY16 9AJ

³Institute of Psychiatry, Kings College, London SE5 8AF

Abstract

Autobiographical memory was assessed in 24 children (12 male, 12 female, aged between 8 & 16 years) with autism spectrum disorder (ASD) and a comparison group of 24 typically developing (TD) children matched for age, IQ, gender and receptive language. Results suggested that a deficit in specific memory retrieval in the ASD group was more characteristic of male participants. Females in both the TD and ASD groups generated more detailed and emotional memories than males. They also demonstrated superior verbal fluency scores; verbal fluency and autobiographical memory cueing task performance were significantly positively correlated in females. Results are discussed in light of recent research suggesting gender differences in the phenotype of ASD.

Keywords: Autobiographical memory & gender in ASD

A preliminary study of gender differences in autobiographical memory in children with an Autism

Spectrum Disorder

It is well established that females are much less likely to be diagnosed with an autism disorder (ASD) than males, with an approximate ratio of 5:1 (e.g., Centers for Disease Control and Prevention, 2012) despite manifesting equivalent levels of autistic traits as assessed by the Childhood Autism Spectrum Test (Dworzynski, Ronald, Bolton & Happé, 2012). Recent research suggests that the phenotype of females with ASD may differ from males (cf. Rivet and Matson, 2011) with evidence that, compared with boys, girls with ASD engage in more pretend play (Knickmeyer, Wheelwright & Baron-Cohen, 2008), are more able to imitate social actions (Attwood, 2007), are more likely to have one special friend and have interests more aligned to those of typically developing females (cf. Gould & Aston-Smith, 2011). However, other research has either found few gender differences in the behavioural phenotype (Rivet & Matson, 2011) or that females have poorer social functioning than males (e.g., McLennan, Lord & Schopler, 1993).

With respect to core autism features, Lai, Lombardo, Pasco, et al. (2011) examined adults with ASD and average IQ and found no gender differences in the severity of childhood autism symptoms as measured by the Autism Diagnostic Interview (ADI-R, Lord, Rutter & Le Couteur, 1994). However when assessed on the Autism Diagnostic Observation Schedule, (ADOS, Lord, Rutter, Goode et al., 1989), socio-communication difficulties were less evident in females compared with males. In contrast, on the Autism Spectrum Quotient (AQ, Baron-Cohen, Wheelwright, Skinner et al, 2001), females reported more autistic traits than males. Lai et al. (2011) hypothesized that greater self-awareness or improved self-referential processing may enable females to have greater insight. Moreover the development of more effective compensatory strategies may lead to a different developmental trajectory making ASD more difficult to detect in females than in males (Dworkzinski et al., 2012), and result in clinicians under diagnosing ASD in females (cf. Kothari, Skuse, Wakefield & Micali, 2013).

Research into cognitive phenotypic differences is sparse, but a recent study demonstrated that while males with ASD showed poorer perceptual attention to detail than typically developing males, females with and without ASD did not differ (Lai, Lombardo, Ruigrok et al., 2012).

Conversely, males with ASD exhibit superior block design performance, while females with ASD have demonstrated superior performance on the trail making test (Bolte, Duketis, Poustka, & Holtman, 2011).

These inconsistencies in findings may be due to the heterogeneity of samples used, with females more likely to be of low intellectual ability (Dworzynski et al., 2012). Clarification of the nature of gender differences in the cognitive and behavioural phenotypes of ASD is important for accurate diagnosis and for understanding the impact of ASD on females. One area that has recently received considerable attention in autism research, and in which gender differences in the typical population have been reported, is autobiographical memory (Andreano & Cahill, 2009). Autobiographical memory refers to memory for information relating to the self and consequently requires self-referential processing; a mechanism suggested as underlying compensatory strategies in females with ASD (Lai et al., 2011). The self-memory symbiosis is elucidated in Conway and Pleydell-Pearce's self-memory system (2000) as memories are encoded, organized and updated in accordance with the current model of the working self (i.e., the set of personal goals and needs that are active and relevant for the individual). In turn the working self is updated in light of information in the autobiographical memory knowledge base.

There is a substantial body of evidence demonstrating that both children and adults with ASD and average IQ have an impaired access to autobiographical memory as characterized by a difficulty in retrieving specific memories of events contextualized in time and place (Goddard, Dritschel, Robinson & Howlin, 2013, Goddard, Dritschel, Patel, & Howlin, 2007, Crane & Goddard, 2008, Crane, Goddard & Pring, 2009). Autobiographical memory impairments are also evident in relation to both recent and remote past events (Bruck, London, Landa & Goodman, 2007). Autobiographical narratives are characterised by fewer details (Goddard, et al., 2013, Bruck et al., 2007), less complex syntax (Losh & Capps, 2003) and less internal state language (Brown, Morris, Nida & Baker-Ward, 2012). Deficits in autobiographical memory have been explained as the result of a variety of cognitive deficits in areas including executive function (Goddard et al, 2013), self referential processing (Powell & Jordan, 1993, Lind, 2010), autonoetic consciousness (Bowler,

Gardiner & Grice, 2000), memory binding (Lind, 2010) and scene construction (Lind, Williams, Bowler & Peel, 2014).

In the typical population, gender differences in autobiographical memory are frequently reported. In children, girls elaborate more on memory conversations with their mothers than boys (Haden, Haine & Fivush, 1997, Farrant & Reese, 2000). In adults, research has shown that on word cueing tasks, where participants are required to generate specific memories to cues, males are more likely to offer generalised memories (i.e., summaries of events) (Goddard, Dritschel & Burton, 1998). Compared with females, males also report less detailed, vivid, and emotional memories (Pillemer, Wink, DiDonato & Sanborn, 2003), fewer relationally oriented narratives (Buckner & Fivush, 2000) and they report fewer childhood memories and are slower to access them (Davis, 1999). Given the very small number of females generally included in autism studies the question arises as to whether autobiographical memory deficits are as prevalent among females with ASD as among males, or whether their retrieval style is more in line with females without ASD. We aimed to answer this question by examining an IQ and age-matched sample of males and females with and without ASD.

Several suggestions have been advanced regarding the underlying mechanisms of autobiographical memory in females. The "affect intensity" hypothesis states that females' superior skill in this area is due to enhanced emotional processing at encoding (cf. Andreano & Cahill, 2009). Accordingly, females have been found to rate their memories as more emotional and to use more internal states in their life narratives than males. Additionally, the well-established superiority in verbal processing is also a possible key to females' enhanced autobiographical memory (cf, Andreano & Cahill, 2009). Enhanced verbal and emotional processing may also underlie gender differences in autobiographical memory in ASD since these factors have been demonstrated as important correlates of performance in this group. Goddard et al. (2013) demonstrated deficits in the ability to recall both semantic and episodic autobiographical memories across the lifespan in children with ASD. Performance on these indices was predicted by verbal fluency and cognitive

flexibility. Memory for recent events was relatively intact and related to an increased frequency of emotional references within memories.

Little is known about the autobiographical memories of females with ASD since previous research samples have typically been biased towards males. One exception is the study by Crane, Goddard and Pring, (2013) in which they failed to find gender differences in autobiographical memory in adults. However, the post hoc nature of the analysis meant that important variables such as IQ and age were not controlled. The aim of the present study was to report data on a sample of children with and without ASD with equal numbers of males and females, in order to conduct a preliminary exploration of gender differences in autobiographical memory. We also aimed to identify whether gender differences might be attributed to different strategies for retrieving memories. We used two different methodologies for examining memory retrieval. First, a word cueing methodology was employed that required specific autobiographical memories to be retrieved at speed to emotional and neutral word cues. Second, a semi-structured interview task was utilized that consisted of richer, more detailed cues with which to assess memory for recent events (i.e. occurring over the previous week) and remote events.

Hypotheses

Consistent with the proposal that females with an ASD develop superior compensatory strategies due to enhanced self-referential processing (Lai et al., 2011) and in-line with research demonstrating a female advantage in autobiographical memory in typically developing groups, we hypothesized that both females with ASD and typically developing females would outperform their male counterparts on all memory tasks. In particular, on an autobiographical memory cueing task, we predicted that females in both groups would a] generate more specific memories and fewer general memories and b] retrieve a greater number of memories than males in both groups. On a semi-structured memory interview task, we predicted that the females in both groups would report more detailed emotional narratives, than both males groups. We also predicted that superior female performance would be related to verbal fluency performance and that emotion versus neutral word cues would facilitate retrieval to a greater extent in females. In accordance with past research demonstrating memory deficits in ASD, we predicted the ASD group would demonstrate poorer performance across all memory tasks compared with the TD group.

Methods

Participants

Participants in the ASD group were 24 children recruited from specialist schools for children with ASD and local autism support groups across London and Scotland. Inclusion criteria were a full scale IQ of 70 or over; a formal diagnosis of ASD based on DSM IV-TR[1] criteria, from a multi-disciplinary diagnostic team that included either a clinical psychologist or psychiatrist and a score of 15 or greater on the Social Communication Questionnaire (SCQ) 'lifetime' version' (see measures section). The comparison group, comprising 24 children recruited from local schools in London and Scotland, was matched with the ASD group on the basis of age, gender, IQ, and British Picture Vocabulary Scale score. Each group (ASD and comparison) consisted of an equal number of males and females who were also matched on the basis of IQ, age and BPVS scores. Participants comprised a subset of a larger sample from a study examining the development of autobiographical memory in ASD (Goddard et al., 2013) and were selected on the basis of matching criteria.

Measures of control variables.

Social Communication Questionnaire (SCQ) Rutter, Bailey & Lord, 2003). The SCQ is a 40-item checklist for completion by parents or carers. A cut-off point of ≥ 15 is recommended for the identification of Autism Spectrum Disorder. The SCQ has been identified as a reliable indicator of ASD (Charman, Baird, Simonoff et al., 2007).

Wechsler Abbreviated Scale of Intelligence (WASI, Wechsler, 1999) A full-scale IQ score was obtained using the 2-subtest version of the WASI (Matrix Reasoning and Vocabulary) in order to reduce testing time.

British Picture Vocabulary Scale (BPVS II, Dunn, Dunn, Whetton & Burley, 1997)[2]. This is a picture-based test of receptive vocabulary that has been used extensively to assess language comprehension in ASD (Mottron, 2004).

---

[1] DSM 5 criteria were not available at the time of the study
[2] The updated version of the BPVS, BPVS3, had not been published at the outset of the study

Memory measures.

Autobiographical memory cueing task (Crovitz & Schiffma, 1974). The task required the retrieval of specific memories in response to 15 word cues (5 positive, 5 negative and 5 neutral). Words were matched for length, familiarity and concreteness using the MRC Psycholinguistic Database (Coltheart, 1981). Participants' understanding of the cue words was checked prior to commencement of the task; the dictionary meaning of words was also provided for them. Practice cues were given in order to ensure that participants understood the specificity instruction and the task did not commence until at least one specific memory had been elicited to practice cues. When participants failed to retrieve a specific memory it was either because they were unable to retrieve any memory or because they provided only a general memory. When a general memory was offered, participants were prompted to think of one particular time. Memories were categorized according to criteria used by Goddard et al, (2007) (i.e. specific memories referred to one particular day; general memories were either 'categoric' [referring to repeated events] or 'extended' [events that occurred over an extended time frame]) and previous research has demonstrated the reliability of these categories (Goddard et al., in press)

Recent and remote memory task. The task consisted of twelve questions designed to elicit memories of events from the past week and events from early childhood. Responses were classified as either specific, general (i.e., did not refer to one particular day) or failures to retrieve. In practice there were few general responses since the cues tended to provide a structure supporting specific memory recall (e.g., Can you tell me everything you did last night from after you ate dinner until you went to bed; Can you tell me about the very first thing that ever happened to you, that you can remember in your whole life.). Therefore specific and general responses were combined. Memory responses were assessed for qualitative aspects. For the current study the number of details reported was calculated by totalling the individual pieces of information within the memory, and the number of references to emotion states. For a full description of this task see Goddard et al. (in press).

Verbal Fluency. A measure of productive vocabulary as assessed by the number of items generated, within 60 seconds, from the category cues of animals, vegetables, clothing and fruit. Scores were derived from calculating the average number of items generated across the four categories that were correct and not repetitions. The mean number of perseverations was also calculated by averaging the number of repeated items.

Procedure

Participants were tested individually at their home or school. Testing took place within the context of a wider project designed to examine the development of autobiographical memory in children with ASD that involved 3 sessions lasting approximately 60 minutes. The order of tasks was fixed with the WASI, BPVS and verbal fluency measures taking place within the first session, the cueing task in the second session and the Recent & Remote Memory Task in the third session.

Results.

Insert Table 1 about here

There were no statistically significant differences in any of the control variables between groups (see Table 1). Levene's test of equality of variances was significant with respect to BPVS score as the ASD group demonstrated greater variance on this measure relative to the controls. There were no significant differences in control variables when analysed by gender (all ps > .7). However, there was a significant gender difference in SCQ scores within the ASD group (t (22) = 2.83, p = .01) with females scoring significantly lower (mean = 20.0, SD = 5.15) than males (mean = 26.5, SD = 5.92).

Autobiographical memory cueing task.

Insert Table 2 here

Memories retrieved on the cueing task were first analysed with multivariate analysis of variance *(MANOVA)* with dependent variables of a] specific b] categoric c] extended and d] failure

to retrieve, and independent variables of Group (ASD vs. Comparison) and Gender (Male vs. Female). Where overall effects were significant, univariate ANOVAS are reported. As predicted, both Group and Gender main effects were statistically significant for the number of specific memories retrieved: the ASD group retrieved fewer specific memories than the comparison group (Group: $F(1,44) = 9.18$, $\eta^2 = .17$, $p = .004$) and females retrieved more specific memories than males (Gender: $F(1,44) = 5.30$, $\eta^2 = .11$, $p = .026$). These main effects, however, were qualified by a statistically significant interaction ($F(1,44) = 4.24$, $\eta^2 = .09$, $p = .045$). Post hoc tests (Bonferroni t's) indicated that males in the ASD group generated fewer specific memories than males in the comparison group whereas group membership had no significant impact on female performance. Moreover males in the ASD group performed (as predicted) more poorly on average than their female counterparts whereas, contrary to prediction, males and females in the comparison group did not differ (ps < .05).

Follow-up univariate tests also demonstrated a significant Group x Gender interaction for extended general memories ($F(1,44) = 4.75$, $\eta^2 = .1$, $p = .035$). Pairwise comparisons, with Bonferroni t adjustment, revealed a gender difference in the ASD group. In line with our predictions, males generated significantly more extended general memories to cues than females ($p < .05$). All other univariate tests were non significant. See Table 2

Recent/Remote memory task

Insert Table 3 about here

Three 2 (Time: recent vs. remote) x 2 (Group) x 2 (Gender) mixed analyses of variance were conducted in order to examine a] the number of memories retrieved b] the mean number of details within memories and c] the number of emotion references.

With respect to a] the number of memories retrieved, all main effects were statistically significant: significantly more memories were retrieved for the recent vs. remote Time period ($F(1,44) = 4.09$, $p = .049$, recent: mean = 5.63, $SD = .73$ vs. remote mean = 4.14, $SD = 1.27$);

individuals with ASD retrieved fewer memories overall than those in the comparison group ($F(1,44)$ = 4.39, p = .042, ASD mean = 10.50, SD = 1.87 vs. comparison mean = 11.38, SD = 1.01) and females overall generated more memories than males (Gender: $F(1,44)$ = 5.27, p = .027, female mean = 11.42, SD = 1.21 vs. male mean = 10.46, SD = 1.72). There were no statistically significant interactions (ps > .05).

Analysis of b] the mean number of details in memories, revealed a statistically significant main effect of Time ($F(1,44)$ = 40.25, η^2= .48, p < .0001) indicating that recent memories were more detailed than remote memories. The remaining main effects were not significant although females tended to produce more detailed memories than males (9.09 vs. 7.35 ; $F(1,44)$ = 3.46, η^2 = .07, p = .07)). The analysis also produced a statistically significant 3-way interaction (see Figure 1). Pairwise comparisons indicated that this was due to the females in the ASD Group generating significantly more detailed recent than remote memories.

With respect to c] the number of emotion details in memories, we predicted females to produce more emotion details in memories than males. This was supported; the main effect of Gender was statistically significant ($F(1,44)$ = 4.17, $\eta^2 = p$ = .047, female mean: 9.02 vs. male mean: 6.62). Significant main effects of Time ($F(1,44)$ = 6.61, η^2= .13, p = .01) and Group ($F(1,44)$ = 4.35, $\eta^2 = p$ = .043) were qualified by a 2-way interaction ($F(1,44)$ = 4.34, $\eta^2 = p$ = .04) that was due to the ASD Group generating significantly more emotion details in their recent compared to remote past (5.25 vs.). The remaining 2-way and 3-way interactions were non-significant (p > .05).

Verbal fluency task

A 2 (Group) X 2 (Gender) *MANOVA* with the dependent variables of a] the mean number of items generated and b] the mean number of perseverations, revealed one overall significant main effect: Gender (Wilks Lambda = .85, $F(2,43)$ = 3.69, η^2= .65, p = .03). Inspection of the univariate *ANOVAS* revealed a statistically significant difference in the number of items generated, with females out-performing males (see Table 3). All remaining effects and interactions were non-significant (p > .05).

Relationship between memory variables and verbal fluency

Insert Table 4 about here

Support for the hypothesis that superior access to memory in females would be related to enhanced verbal fluency, emerged from a series of correlational analyses. Two indices of memory were selected: specific memory retrieval on the cueing task and the number of memories retrieved on the Recent and Remote Memory Task. We selected the number of items generated for our verbal fluency correlate since this was the index that highlighted gender differences. Correlations were examined within gender in order to establish whether verbal fluency differentially related to performance. Table 4 displays these correlations and demonstrates a highly significant positive correlation between specific memory retrieval on the cueing task and verbal fluency performance for females. In males, this correlation was non-significant but was in the same positive direction; the correlations between memory and verbal fluency did not significantly differ between gender ($z = .85$, $p > .3$, two-tailed). Within group correlations also indicated significant positive correlations between cueing task performance and verbal fluency in both ASD and control groups.

Discussion

Previous research (e.g., Crane et al., 2009) has concluded that difficulties in accessing autobiographical memories are characteristic of individuals with ASD. Our data emerging from a sample of children and adolescents, suggests that this conclusion is more typical of males with ASD than of females. In this study, females with ASD, on average, demonstrated intact access to specific memories as they out-performed their male counterparts in cueing task performance and performed at an equivalent level to both males and females in the comparison group. There was also evidence of enhanced recall of recent events in females with ASD as their recent memories were more detailed than their remote memories. Males did not show this pattern. Varying the emotionality of cue word did not affect memory performance. However, the memories of females in both groups contained more references to emotion states than the memories of males. Evidence for the role of verbal fluency in female's enhanced access to autobiographical memory was demonstrated as females across both groups showed superior performance relative to males.

Females also showed a significant positive correlation between specific memory access and verbal fluency; this correlation showed a trend towards significance in males.

Access to autobiographical memory is believed to play an important role in social functioning, providing a database for social problem-solving (Goddard et al., 1996, 2001), developing intimacies (Nelson, 1993), and enabling a sense of self extended in time (Levine, 2004). In our study, the females with ASD demonstrated relatively intact access to specific autobiographical memories; they also exhibited fewer social and communication impairments than males, as indicated by their SCQ scores. This is consistent with Lai et al.'s (2011) findings that adult females showed fewer socio-communication problems than males on the ADOS. They suggested that females were better at compensating for their socio-communication deficits and that conscious learning through observation of the rules of social interaction may be one mechanism underlying their compensatory skills. While learning to mirror others' behaviour may play some role in females' better socio-communication skills, our data suggest that females also develop the building blocks of good social interaction, i.e., the ability to access and share specific memories with others. This skill is unlikely to be acquired through conscious learning and instead is more likely driven by innate cognitive skills such as verbal fluency. In this respect, our females with ASD showed a cognitive profile more similar to females without ASD who also showed improved specific memory and verbal fluency relative to their male counterparts.

In contrast to the cueing task, gender differences in ASD on the Recent and Remote Memory task were less apparent, although there was evidence that females showed greater detail in their recent versus remote memory narratives. Furthermore, performance on the Recent and Remote Memory task was not associated with verbal fluency performance. Verbal fluency is likely to be important in cueing task performance relative to the Recent and Remote Memory Task because the cueing task places greater constraints on the memory required and provides a less rich cue. Thus, efficient organization of memories and effective search strategies are likely to be more important on this type of task. Moreover, the verbal fluency task and cueing task share similar properties, with a time constraint placed on the retrieval of cue exemplars in both tasks. A

relationship between verbal fluency and specific autobiographical memory retrieval has frequently been found both in conditions associated with autobiographical memory deficits, (e.g. depression, Dalgleish et al, 2007, Alzheimer's, Greene, Hodges & Baddeley, 1995, epilepsy, Barnett, Newman, Richardson, Thompson & Upton, 2000), and in control groups with no such deficits (e.g., Dalgleish et al., 2007). All of these studies have used a variant of the cueing task. There is less evidence of how verbal fluency relates to other measures of autobiographical memory or to involuntary memory recall which occurs often in real life (Schlagman & Kvavilashvili, 2008). Verbal fluency is a multifaceted measure (Barnett, 2000) involving generation, set-shifting, inhibition and self-monitoring and these components may be involved in the autobiographical memory cueing task to a greater degree than the Recent and Remote memory task.

With respect to gender differences in the comparison group, this study failed to replicate adult studies (e.g. Goddard et al., 1998) that have demonstrated a specific memory advantage in females when memories are elicited with a cueing task. However, as in other studies using semi-structured interviews (e.g. Davis et al., 1999), data from the Recent and Remote Memory Task, demonstrated that females produced more memory responses than males over both recent and remote time periods, indicating superior autobiographical memory. Previous findings (e.g., Pillemer et al., 2003) reporting more emotional memories in females were also replicated. However, manipulating the emotionality of the cue word had no significant impact on memory access for either gender. Gender differences in autobiographical memory may therefore depend on the nature of the retrieval task; it has also been suggested that different mechanisms may underlie autobiographical memory in males and females (St. Jacques et al., 2011). Our data are inconclusive in this respect since the relationship between verbal fluency and autobiographical memory in males did not differ significantly from that in females.

Although sample size is small, this study suggests that the pattern of gender difference in autobiographical memory found in typically developing samples is also characteristic of individuals with ASD. The Extreme Male Brain theory of autism (Baron-Cohen 2002) predicts a more masculinized cognitive style in females with ASD. Our data suggest that in some aspects of

cognitive function, notably verbal fluency and access to autobiographical memory, this prediction may not hold. Further research is required to explore whether the finding of superior autobiographical memory of females with ASD in the current study, is also related to better socio-communication skills[3]. Previous research has suggested less symbiosis between autobiographical memory and social function in ASD. For example, there is evidence to suggest that individuals with ASD are less likely to extract meaning from the memories they denote as 'self-defining' and this may suggest a more static self-memory system (Crane, Goddard & Pring, 2010). Moreover, there is evidence to suggest that they are less likely to use past experience for generating solutions to problems (Goddard et al. 2007). Revisiting these findings with a focus on gender could provide further insight into the profile of autobiographical memory and social function in females with ASD. While access to specific autobiographical memory is one ingredient of good social function, there are also other key elements. For example, extracting appropriate knowledge from past experiences and applying it to current social problems and for gaining insight is vital for well-being. Good access to autobiographical memory may increase the likelihood of both self-reflection and in engaging in social interactions but if this is in the context of poor use of memory, low mood and increased social problems could result. Indeed, Crane et al. (2013) reported higher levels of self-reported depressed mood in females than males with ASD. The current study has several implications for interventions. First our results suggest that perhaps memory interventions should be designed differently for males and females. With respect to males, memory specificity training (MEST, Raes, Williams, & Hermans, 2009) may be the first step.   This technique is effective in improving memory specificity in depressed populations (Neshat-Doost et al., 2013). Memory interventions that capitalize on females' superior access to autobiographical memory and focus on the links between memory and social processes, may therefore be the most effective intervention for females with ASD. Males who are successful with MEST could subsequently benefit from this training as well.

---

[3] Post hoc correlational analysis indicated an association between SCQ scores and number of specific memories retrieved ($r=-.37$, $p = .04$, one-tailed).

Strengths and weaknesses of the study

This study provides novel and important findings regarding memory deficits in ASD, suggesting that females, unlike males, have autobiographical memories that are emotional and detailed, in-line with females without ASD. Improved access to autobiographical memory (relative to males) was also related to superior verbal fluency performance. While these findings highlight the need for more gender difference research in ASD, the study has some limitations. First, sample size was small and findings need to be replicated in larger and more heterogeneous groups (e.g. with respect to age and IQ) to test the reliability and generalizability of the results. Second, autobiographical memory was assessed with tasks requiring an explicit search of autobiographical memory structures for appropriate responses. Thus, the findings may not generalize to everyday memories that are involuntarily activated or cued in other ways e.g., by sensory cues. Finally, it remains a possibility that females in the ASD group were less 'autistic' than their males counterparts and that the gender differences found reflected milder symptoms of ASD. Time constraints prevented reconfirmation of diagnoses with standardised observational methods such as the ADOS (Lord et al.1989). Nevertheless, while females had lower SCQ scores overall than males, they still obtained scores in excess of the cut-off indicating the presence of an ASD while demonstrating no observable deficit in autobiographical memory.

In conclusion, this study adds to recent findings documenting gender differences in the cognitive phenotype of ASD. In particular, females demonstrated improved access to memories, more detailed memories and better verbal fluency than males. Further research is required to determine whether females' relative superiority in these areas allows the development of strategies to compensate for the social-communication difficulties that are core impairments in ASD.

Table 1. Mean Age & IQ for ASD and Control Matched Sample

		ASD (n=24)	Control (n=24)		
		Mean SD	Mean SD	*t*	*p*
Age (months)	Male	155.2 (23.9)	152.8 (24.2)		
	Female	154.2 (27.8)	148.6 (25.1)		
	Overall	154.7 (25.0)	150.8 (24.2)	.46	.62
Full Scale IQ	Male	104.3 (12.4)	106.6 (11.2)		
	Female	107.4 (13.5)	106.0 (11.1)		
	Overall	105.9 (12.8)	106.3 (10.8)	.12	.94
BPVS	Male	96.4 (21.1)	103.2 (14.3)		
	Female	95.3 (23.0)	102.3 (14.0)		
	Overall	95.8 (21.6)	103.7 (13.9)	1.3	.24

Table 2.   Mean number of memories generated on the cueing task

		ASD (n=24)		Control (n=24)		Gender overall	
		Mean	SD	Mean	SD	Mean	SD
Specific	Male	7.5	(2.35)	11.0	(1.65)	9.25	(2.67)
	Female	10.5	(3.26)	11.17	(1.95)	10.83	(2.65)
	Group overall	9.0	(3.18)	11.08	(1.77)		
Extended	Male	1.75	(.97)	.92	(1.08)	1.33	(1.09)
	Female	.67	(.65)	1.00	(.95)	.83	(.82)
	Group overall	1.21	(.98)	.96	(.99)		
Categoric	Male	2.92	(2.11)	1.75	(1.42)	2.33	(1.86)
	Female	2.25	(1.42)	1.83	(1.34)	2.04	(1.37)
	Group overall	2.58	(1.79)	1.79	(1.35)		
Failures	Male	2.83 (2.62)		1.33 (1.44)		2.08 (2.20)	
	Female	1.58 (2.64)		1.00 (.95)		1.29 (1.97)	
	Group overall	2.21 (2.65)		1.17 (1.20)			

Figure 1. Recent and remote memory task (RRMT): Mean number of details within memories
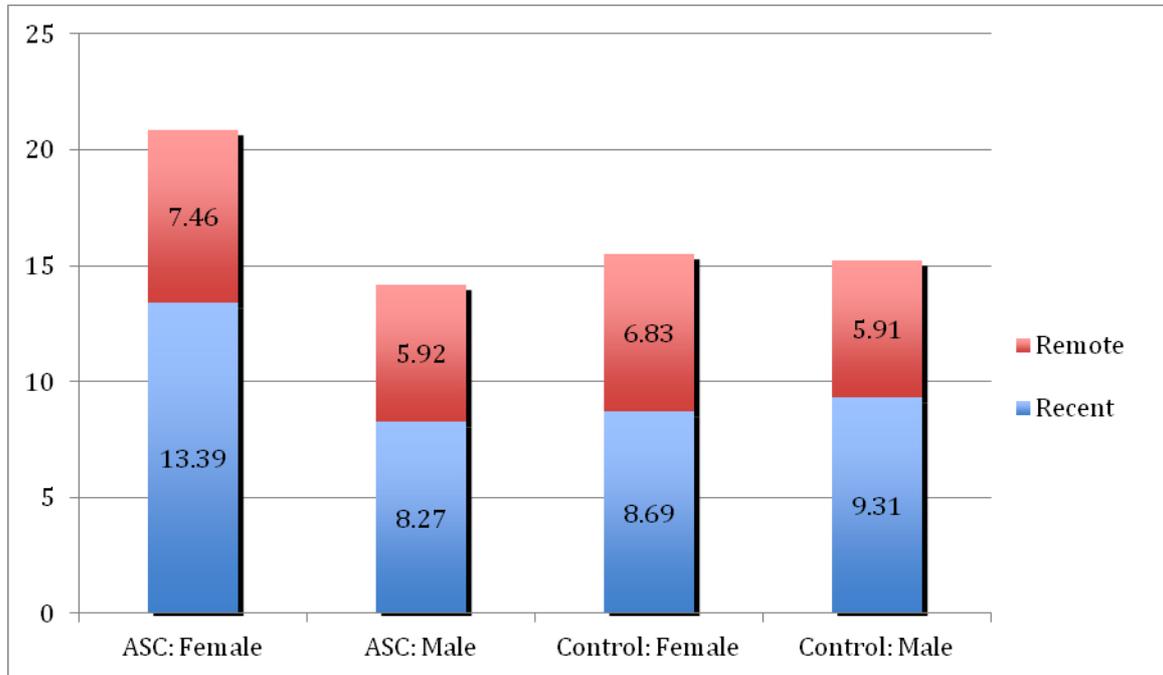

Figure 1. Mean number of details within memories

Table 3.   Performance on Verbal Fluency Task

		ASD (n=24)		Control (n=24)		Gender Overall	
		Mean	SD	Mean	SD	Mean	SD
Mean number of	Male	.78	(1.05)	.08	(.15)	.43	(.81)
Perseverations	Female.	.36	(.39)	.22	(.41)	.29	(.64)
	Overall	.57	(.80)	.25	(.31)		
Mean number of	Male	15.83	(3.45)	15.94	(2.84)	15.89	(3.09)
Items	Female	19.62	(6.24)	17.84	(3.15)	18.72	(4.92)
	Overall	17.72	(5.29)	17.30	(4.31)		

Table 4. Correlations between verbal fluency and memory performance

	Verbal Fluency			
	Cueing task: Specific memories		RRMT: Number of memories	
	r	*p*	*r*	*p*
Males (n=24)	.40	.053	.29	.16
Females (n=24)	.60	.002*	-.02	.91
ASD (n=24)	.67	.001*	.23	.29
Control (n=24)	.56	.004*	.31	.14

- p < .05, 2-tailed

Acknowledgements

Andreano, J. M., & Cahill, L. (2009). Sex influences on the neurobiology of learning and memory. *Learning & Memory*, *16*(4), 248-266.

Attwood, T. (2007). The Complete Guide to Asperger Syndrome. London, UK: Jessica Kingsley Publishers.

Baddeley, A., Della Sala, S., Papagno, C., & Spinnler, H. (1997). Dual-task performance in dysexecutive and nondysexecutive patients with a frontal lesion. *Neuropsychology, 11,* 187–194.

Baio, J. (2012) Prevalence of Autism Spectrum Disorders – Autism and Developmental Disabilities Monitoring Network, 14 Sites, United States, 2008. *Morbidity and Mortality Weekly Report, Survelillance Summaries March 302012/61 (ss03);* 1-19

Barnett, M.P., Newman, H.W., Richardson, J.T.E., Thompson, P. & Upton, D., (2000). The constituent structure of autobiographical memory: Autobiographical memory in people with chronic epilepsy. *Memory, 8, 6*, 413-424

Baron-Cohen S (2002) The extreme male brain theory of autism. Trends in Cognitive Science 6: 248–254.

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.

Bolte, S., Duketis, E., Poustka, F. & Holtman, M (2011). Sex differences in cognitive domains and their clinical correlates in higher functioning autism spectrum disorders, *Autism, 15,* 497-511.

Bowler, D.M., Gardiner, J. & Grice, S.J. (2000). Episodic memory and remembering in adults with Asperger syndrome. *Journal of Autism and Developmental Disorders, 30,* 295-304.

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.

Brown, B.T., Morris, G., Nida, R.E., Baker-Ward, L. (2012) Brief Report: Making experience

personal: Internal states language in the memory narratives of children with and without Asperger's disorder. *Journal of Autism and Developmental Disorder, 42, 441-446*

Buckner, J & Fivush, R. (2000) Gendered themes in family reminiscing. *Memory, 8,* 6, 401-412.

Burgess, P.W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp.81–116). Hove, UK: Psychology Press.

Charman, T., Baird, G., Simonoff, E., Loucas, T., Chandler, S., Meldrum, D., Pickles, A. (2007). Efficacy of three screening instructions in the identification of autism spectrum disorders. *British Journal of Psychiatry, 191,* 554-559.

Conway, M.A. & Pleydell-Pearce, C.W. (2000) The construction of autobiographical memory in the self-memory system. *Psychological Review, 107 (2),* 261-288

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.

Crane, L., Goddard, L., & Pring, L. (2009). Specific and general autobiographical knowledge in adults with autism spectrum disorders: The role of personal goals. *Memory*, *17*(5), 557-576.

Crane, L., Goddard, L. & Pring. L. (2010). Brief Report: Self defining memories and everyday autobiographical memories in adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 40, 3,* 383-391.

Crane, L. Goddard, L. & Pring, L. (2013) Autobiographical memory in adults with autism: the role of depressed mood, rumination, working memory and theory of mind. Autism: *The International Journal of Research and Practice, 17 (2)* 205-219.

Crovitz, H.F. & Schiffma, H. (1974). Frequency of episodic memories as a function of their age. *Bulletin of the Psychonomic Society (4),* 517-518.

Dalgleish, T., Williams, J.M.G., Perkins, N., Golden, A.J., Barnard, P.J., Au-Yeung, C., Murphy, V., Elward, R., Feldman-Barrett, L., Tchanturia, K., & Watkins, E. (2007**).** Reduced specificity of autobiographical memory and depression: The role of executive processes. *Journal of Experimental Psychology: General, 136*, 23-42

Davis, P. J. (1999). Gender differences in autobiographical memory for childhood emotional experiences. *Journal of Personality and Social Psychology*, *76*(3), 498.

Dunn, L.M., Dunn, L.M., Whetton, C. & Burley, J. (1997). British Picture Vocabulary Scale: Second Edition. NFER-Nelson.

Dworzynski, K., Ronald, A., Bolton, P., & Happé, F. (2012). How Different Are Girls and Boys Above and Below the Diagnostic Threshold for Autism Spectrum Disorders? *Journal of the American Academy of Child & Adolescent Psychiatry*.

Farrant K, & Reese E. 2000. Maternal style and children's participation in reminiscing: stepping stones in children's autobiographical memory development. *Journal of Cognitive Development, 1,* 193–225

Fombonne, E. (2009). Epidemiology of pervasive developmental disorders. *Pediatric Research*, *65*(6), 591-598.

Goddard, L., Dritschel, B. & Burton, A. (1996) Role of autobiographical memory in social problem-solving and depression. *Journal of Abnormal Psychology, 105,* 609-615

Goddard, L. Dritschel, B., & Burton, A. (1998) Gender differences in dual task effects of autobiographical memory retrieval on social problem-solving. *British Journal of Psychology, 89, 4,* 611-627.

Goddard, L., Dritschel, B., Robinson, S. & Howlin, P. (in press) Development of autobiographical memory in children with an autism spectrum disorder: Deficits, gains and predictors of performance. Development & Psychopathology.

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.

Gould, J. & Ashton-Smith, J. (2011). Misdiagnosis or missed diagnosis: girls and women on the autism spectrum. *Good Autism Practice, 12 (1),* 34-41.

Haden, C.A., Haine, R.A., & Fivush, R. (1997). Developing narrative structure in parent–child reminiscing across the preschool years. *Developmental Psychology, 33,* 295–307.

Kirkovski, M., Enticott P.B., & Fitzgerald, P.G. (2013) A review of the role of female gender in autism spectrum disorders. *Journal of Autism and Developmental Disorders*, DOI 10.1007/s10803-013-1811-1

Knickmeyer, R. C., Wheelwright, S., & Baron-Cohen, S. B. (2008). Sex-typical play: masculinization/defeminization in girls with an autism spectrum condition. *Journal of Autism and Developmental Disorders*, *38*(6), 1028-1035.

Kopp, S. & Gillberg, C. (1992). Girls with social deficits and learning problems: Autism, atypical Asperger syndrome or a variant of these conditions. *European Child and Adolescent Psychiatry, 1,* 89-99.

Kothari, R., Skuse, D., Wakefield, J. & Micali, N. (2013). Gender differences in the relationship between social communication and emotion recognition. *Journal of the American Academy of Child and Adolescent Psychiatry, 52,* (11), 1148-1158.

Lai, M. C., Lombardo, M. V., Pasco, G., Ruigrok, A. N., Wheelwright, S. J., Sadek, S. A., & Baron-Cohen, S. (2011). A behavioral comparison of male and female adults with high functioning autism spectrum conditions. *PloS one*, *6*(6), e20835.

Lai, M. C., Lombardo, M. V., Ruigrok, A. N., Chakrabarti, B., Wheelwright, S. J., Auyeung, B., Allison, C. & Baron-Cohen, S. (2012). Cognition in males and females with autism. Similarities and differences. *PloS one*, *7*(10), e47198.

Levine, B, (2004) Autobiographical memory and the self in time: Brain lesion effects, functional neuroanatomy and lifespan development. *Brain and Cognition, 55,* 54-68.

Lind, S. (2010). Memory and the self in autism: A review and theoretical framework. *Autism, 14, 4,* 430-456.

Lind, S., Williams, D.M., Bowler, D. & Peel, A. (2014) Episodic memory and episodic future thinking impairments in high functioning autism spectrum disorder: An underlying difficulty with scene construction or self projection? *Neuropsychology, 28 (1),* 55-65.

Lord, C., Rutter, M. & Couteur, A. (1994) Autism Diagnostic Interview Revised: a revised version of the diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism Developmental Disorders, 24:* 659-685.

Lord C, Ruter, M., Goode S, Heemsbergen, J., Jordan, H., Mawhood, L. & Schopler, E. (1989) Autism diagnostic observation schedule: a standardized observation of communicative and social behavior. *Journal of Autism and Developmental Disorders 19* (2): 185–212

Losh, M. & Capps, L. (2003). Narrative ability in high- functioning children with autism or Asperger syndrome. *Journal of Autism and Developmental Disorders,* 33 (3), 239-251.

McLennan, J.D., Lord, C. & Schopler, E. (1993) Sex differences in higher functioning people with autism. *Journal of Autism and Developmental Disorders, 23:* 217-227.

Mottron, L. (2004) Matching Strategies in Cognitive Research with Individuals with High-Functioning Autism: Current Practices, Instrument Biases, and Recommendations. *Journal of Autism and Developmental Disorders, 34 (1),* 19-27.

Nelson, K. (1993). The psychological and social origins of autobiographical memory*. Psychological Science, 4,* 7-14.

Neshat-Doost, H. T., Dalgleish, T., Yule, W., Kalantari, M., Ahmadi, S.J., Dyregov, A., & Jobson, L. (2013). Enhancing autobiographical memory specificity through cognitive training: An intervention for depression translated from basic science. *Clinical Psychological Science 1(1),* 84-92.

Pellicano, E. (2010). Individual Differences in Executive Function and Central Coherence Predict Developmental Changes in Theory of Mind in Autism. *Developmental Psychology, 46*(2), 530-544.

Piefke, M., Weiss, P. H., Markowitsch, H. J., & Fink, G. R. (2005). Gender differences in the functional neuroanatomy of emotional episodic autobiographical memory. *Human Brain Mapping, 24*(4), 313-324.

Pillemer, D., Wink, P., DiDonato, T., & Sanborn, R. (2003). Gender differences in autobiographical memory styles of older adults. *Memory, 11*(6), 525-532.

Raes, F., Hermans, D., & Willaims, J. (2009). Reducing cognitive vulnerability to depression: A preliminary investigation of Memory Specificity Training (MEST) in inpatients with depressive symptomatology. *Journal of Behaviour Therapy and Experimental Psychiatry, 40(1),* 24-38.

Rivet, T. T., & Matson, J. L. (2011). Review of gender differences in core symptomatology in autism spectrum disorders. *Research in Autism Spectrum Disorders*, *5*(3), 957-976.

Rutter, M., Bailey, A. & Lord, C. (2003). Social Communication Questionnaire (SCQ). Western Psychological Services.

Tanweer, T., Rathbone, C. J., & Souchay, C. (2010). Autobiographical memory, autonoetic consciousness, and identity in Asperger syndrome. *Neuropsychologia*.

St. Jacques, P., Conway, M.A. & Cabeza, R. (2011). Gender differences in autobiographical memory for everyday events: Retrieval elicited by SenseCam images versus verbal cues. *Memory, 19, 7,* 723-732.

Schlagman, S. & Kvavilashvili, L. (2008) Involuntary autobiographical memories inside and outside the laboratory: How different are they from voluntary memories? *Memory & Cognition, 36, 5,* 920-936.

Wechsler, D. (1999) *Wechsler Abbreviated Scale of Intelligence.* Psychological Corporation

Authors Note

Lorna Goddard, Goldsmiths, University of London
Barbara Dritschel, University of St. Andrews, Scotland
Patricia Howlin, Kings College, London

Correspondence concerning this article should be sent to Lorna Goddard,
Department of Psychology, Goldsmiths, University of London, New Cross Gate,
London SE14 6NW, Tel. 0044 20 7919 7908, E- mail: l.goddard@gold.ac.uk