Episodic and Semantic Autobiographical Memory in Adults with Autism Spectrum Disorders

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Abstract Episodic and semantic autobiographical memories were examined in a group of adults with autism spectrum disorders (ASD) and a control group matched for age, gender and IQ. Results demonstrated a personal episodic memory deficit in the ASD group in the absence of a personal semantic memory deficit, suggesting a deficit dissociation between these two components of memory in ASD. Further analysis of memories across different lifetime periods revealed the adolescent and early adult lifetime periods to facilitate memory recall in the control group, but not in the ASD group. These findings suggest a distinctive pattern of remembering in ASD.

Keywords Autism · Autobiographical memory · Episodic · Semantic

Introduction

Autobiographical memory comprises both personally experienced events (personal episodic memories) and self-related information (personal semantic memories). It serves several important social functions, aiding in solving social problems (Goddard et al. 1996), in the formation and maintenance of social relationships (Pillemer 1992) and in providing information for social communication and interaction (Cohen 1989). Considering these pertinent social aspects of autobiographical memory, it is of strong theoretical interest to examine autobiographical memory in autism spectrum disorders (ASD), neurodevelopmental disorders characterised by impairments in the social domain.

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There is a growing body of literature demonstrating a personal episodic memory deficit in ASD. Millward et al. (2000), for example, examined memory for personally experienced events and memory for events that happened to another child in children with ASD and two control groups (a group of typically developing children and a group of children with learning disabilities). Although involvement of the self usually facilitates memory processing (as found in the control groups), the opposite pattern was observed in the ASD group; involvement of the self actually had a detrimental effect on memory in the children with ASD, suggesting a personal episodic memory impairment in this group. Likewise, in one of the few studies of autobiographical memory in adults with ASD, Goddard et al. (2007) examined personal episodic memory using a cueing methodology (cf. Crovitz and Schiffman 1974) in which participants were required to generate memories of specific autobiographical events in response to cue words at speed. Results demonstrated that the adults with ASD recalled significantly fewer specific autobiographical memories and took considerably longer to do so than an age, gender and IQ-matched control group. Taken together, these two studies suggest that an autobiographical memory deficit is characteristic of ASD and that this deficit persists across the lifespan.

Bowler et al. (2000) suggest that the episodic memory difficulties in ASD may be due to problems in effectively encoding material for long-term retention. They examined episodic memory in a group of adults with and without ASD on a word recognition task. Although overall recognition performance was equivalent between the two groups, the type of conscious awareness at encoding differed; whilst recognition in the control group was characterised by 'remembering' (whereby contextual details associated with the presentation of the word were recalled), recognition in

the ASD group was more dependent on 'knowing' (an awareness of knowledge in the absence of contextual information regarding knowledge acquisition). As remembering is characteristic of a functional episodic memory system, these findings further suggest an episodic memory deficit in ASD.

The first aim of this research was to examine the personal episodic memory deficit in adults with ASD in greater depth, using a wider range of methodologies. To date, only one study (Goddard et al. 2007) has examined memory for personally experienced events in a group of adults with ASD and a matched control group, and just one methodology (a cueing task) was used. Therefore, the present study aimed to assess personal episodic memory using three independent tasks (an autobiographical fluency task, a structured interview and a memory narrative task) to provide a more comprehensive assessment of episodic autobiographical memory in adults with ASD. A related, subsidiary aim of this research was to assess memories from different time periods. Previous research assessing episodic memory in ASD has only assessed very recent memories (e.g. Bowler et al. 2000; Millward et al. 2000) and the cueing task used by Goddard et al. (2007) typically biases retrieval of recent life events (Rabbitt and Winthorpe 1988). Therefore, this study aimed to sample memories from across the lifespan to ascertain whether or not certain time periods are particularly vulnerable to memory deficits in ASD.

The second aim of this research was to examine personal semantic memory in ASD. Individuals with ASD often display excellent memory in certain areas (e.g. cued-recall, factual information and rote-memory; Bennetto et al. 1996; O'Connor and Hermelin 1988), whilst profound weaknesses exist in other domains (e.g. free-recall, source memory and temporal order memory; Bennetto et al. 1996). One explanation for this paradox is that the memory deficits in autism are linked to the episodic memory system, while the semantic memory system is preserved (Ben Shalom 2003). Preliminary evidence for this suggestion comes from Klein et al. (1999) who reported the single case study of R.J., a 21-year old man with ASD. R.J. had accurate knowledge of his personality traits (his personal semantic memory) in the absence of access to the specific events upon which this knowledge was based (his personal episodic memory), suggesting a dissociation between episodic and semantic autobiographical memory in ASD. However, given the heterogeneous nature of ASD, it is unclear whether the results of this single case study can generalise to autism in general. In addition, the researchers compared R.J.'s performance against a mental age matched control group comprising three 12-year old children; consequently the size and quality of the memory databases of participants was likely to be substantially different.

Overall, more research employing a larger sample with age and IQ matched controls is required.

To summarise, this study aimed to provide a comprehensive examination of autobiographical memory processing in adults with ASD. The first aim was to examine the personal episodic memory deficits in ASD in greater depth, using a wider range of methodologies (an autobiographical fluency task, an autobiographical interview task and a memory narrative task). The second aim was to assess both episodic and semantic aspects of autobiographical memory in order to establish the extent of the autobiographical memory deficit. It was hypothesised that, in line with previous research, a personal episodic memory deficit would be observed in the ASD group, whilst personal semantic memory would be intact. A subsidiary aim of this study was to assess memory across different lifetime periods to ascertain whether certain time periods are particularly vulnerable to memory deficits.

Methods

Participants

Experimental participants comprised 15 adults (12 males, 3 females), aged between 21 and 61. All experimental participants had received a formal diagnosis of ASD from a Clinical Psychologist or Psychiatrist that is experienced in the field of autism. All but one of the participants were diagnosed with Asperger syndrome (one participant had a diagnosis of high functioning autism) and all participants were diagnosed in adulthood. Experimental participants were recruited via the National Autistic Society (UK) and local organisations and social groups for adults with ASD. Control participants ($n = 15$) were recruited from Further and Higher Education colleges and comprised 12 males and 3 females (age range = 18–64). The control group were group matched with the experimental group on the basis of age, gender and IQ (see Table 1).

Measures of Control and Independent Variables

Wechsler Abbreviated Scale of Intelligence

The Wechsler Abbreviated Scale of Intelligence (Wechsler 1999) was used to provide a measure of verbal, performance and full scale IQ for matching purposes.

Episodic and Semantic Autobiographical Memory Interview

An episodic and semantic autobiographical memory interview based on the Children's Autobiographical Memory

Table 1 Demographic data for experimental and control participants

Measures	ASD		Controls		Group differences	
	Mean	SD	Mean	SD	t	p
Age	37.87	12.63	32.73	17.54	0.92	>.05
Verbal IQ	110.87	16.86	106.53	15.03	0.74	>.05
Performance IQ	113.73	13.31	112.93	14.03	0.16	>.05
Full scale IQ	114.33	14.39	111.00	15.83	0.60	>.05

Inventory (CAMI; Bekerian et al. 2001) was used to assess episodic and semantic autobiographical memories from different lifetime periods, specifically pre-school (before the age of five), primary school (ages 5 to 11), secondary school (ages 11 to 16) and up to five years post-school (ages 16 to 21). Questions designed to assess episodic autobiographical memory included: "Can you tell me about something that happened while you were at primary school that stands out in your mind?" and "Do you remember your first day at secondary school? Can you tell me about it?". Retrieved episodic memories were scored using a three-point scale of specificity taken from Kopelman et al. (1989): a memory was rated three points if it referred to an episodic memory that was specific in time and place, a memory was deemed a two-point response if it referred to either a personal but non-specific event, or a specific event with no recollection of time or place, a one-point response comprised a vague personal memory and no points were awarded if the participant failed to provide a response or if the response was based on a semantic memory. Two episodic items were included for each lifetime period, therefore the maximum episodic memory score for each lifetime period was six points. Inter-rater reliability was assessed on the episodic items with one rater blind to group membership. Pearson Product Moment Correlations ranged between .93 and .99 for each lifetime period.

Questions designed to assess semantic autobiographical memory included: "Can you tell me the names of two of your teachers from primary school?" and "Can you tell me where your secondary school is? Town? Street?". Each question was weighted differently, dependent on the amount of information to be recalled, but the maximum score for each lifetime period corresponded to that in the episodic task (six points).

Autobiographical Fluency Task

An autobiographical fluency task (Dritschel et al. 1992) was used which requires participants to generate (a) events (personal episodic memories) and (b) people's names (personal semantic memories) from specified lifetime periods (which corresponded to those assessed in the episodic and semantic autobiographical interview task). Non-personal semantic memory was also assessed via two letter fluency tasks (words beginning with T, four-letter words beginning with S; from Barnett et al. 2000) and four category fluency tasks (animals, vegetables, US President's names, British Prime Minister's names; from Dritschel et al. 1992). Participants were given a time limit of 90 s per category and were instructed to generate as many items as possible. This task enabled further assessment of autobiographical memories across the lifespan with the added demand of a speed component. It also assessed volume of memories, opposed to the quality of the memories (which was assessed in the episodic and semantic autobiographical memory interview task).

Episodic Memory Narrative Task

Personal episodic memories were examined further using a short interview task adapted from Han et al. (1998). This episodic memory narrative task was an exploratory measure designed to elicit detailed memories of recent and remote autobiographical events. It also examines earliest autobiographical memories and enables a more qualitative examination of personal memories than the episodic and semantic memory interview and the autobiographical fluency task. Questions were presented in a fixed order and participants were instructed to answer in as much detail as possible (see Appendix 1). Memory narratives were coded for volume of narrative by a) counting the total number of words spoken in response to the interview questions and b) counting the total number of details within each response. Various qualitative aspects of memory narratives were also assessed to provide a more sensitive examination of personal episodic memory:

Specificity

A specific autobiographical memory (a memory of an individual event usually pertaining to one particular day; cf. Conway and Rubin 1993) was assigned a score of 1, whilst a general memory (a memory of a repeated event in which no particular occasion is indicated) or a failure to retrieve a memory was assigned a score of 0.

References to Emotion

As ASD is associated with impairments in emotional processing (Hill et al. 2004) and considering that previous research has found emotion to facilitate memory in control, but not ASD, participants (e.g. Beversdorf et al. 1998; Goddard et al. 2007), references to emotions within the narratives were assessed. A score of 1 was given to each memory containing an emotional reference (e.g. "I was really happy").

Sensory Elements

References to sensory elements within the narratives were also assessed considering how unusual sensory responses are commonly associated with ASD (Bogdashina 2003). Each response containing a reference to a sensory element (e.g. "the clouds...like a sea of cotton wool", "the sun was beating down") was ascribed a score of 1.

Self Versus Other

The number of references to the self versus references to others was calculated. Previous research has indicated that individuals with ASD have difficulties with processing self-related information (Millward et al. 2000; Toichi et al. 2002). Therefore instances in which participants referred to either themselves or others were categorised individually with a score of 1 being given to any references to (a) the self or (b) others. This was achieved using General Inquirer computer software (Stone et al. 1966), which calculated the occurrence of each self- and other-related word.

Inter-rater reliability was achieved with one rater blind to group membership. Inter-rater reliability proved to be satisfactory with Pearson Product Moment Correlations ranging between .76 and .81.

Procedure

Participants first completed the WASI, followed by the episodic memory narrative task, the episodic and semantic autobiographical memory interview and then the autobiographical fluency task. Total testing time was approximately 90 min, although this was quite variable in both the ASD and control groups (ranging between 60 min and 120 min depending on the amount of detail provided in response to the autobiographical memory tasks).

Results

Episodic and Semantic Autobiographical Memory Interview (Bekerian et al. 2001)

Episodic and semantic personal memories were examined individually on a short structured interview task. With regards to the personal episodic memory indices, a 2 (group) × 4 (lifetime period) mixed-design ANOVA yielded no statistically significant main effect of group, $F(1, 28) = 2.25$, $p > .05$, however there was a significant main effect of lifetime period, $F(3, 84) = 9.63$, $p < .05$. This was qualified by a significant group × lifetime period interaction, $F(3, 84) = 2.79$, $p < .05$. Post-hoc analysis using a series of Bonferroni corrected ANOVAs and t-tests revealed this to be due to a characteristic pattern of recall in the control group where more memories were recalled in the secondary school and five-years post-school lifetime categories (i.e. the most recent time periods), relative to the other time periods ($ps < .05$). In contrast, no such pattern was found in the ASD group. The mean episodic memory specificity ratings for the ASD and control groups are illustrated in Fig. 1.

Regarding the personal semantic memory questions, the mean scores obtained by the ASD and control groups are illustrated in Fig. 2. A Greenhouse-Geisser correction was applied to this data since assumptions of sphericity were violated. A 2 (group) × 4 (lifetime period) mixed-design ANOVA revealed a non-significant main effect of group, $F(1, 28) = 0.28$, $p > .05$. There was, however, a statistically significant main effect of lifetime period, $F(1.94, 54.44) = 13.14$, $p < .05$. This was qualified by a statistically significant group × lifetime period interaction, $F(1.94, 54.44) = 3.93$, $p < .05$. Post-hoc analysis using a series of Bonferroni corrected ANOVAs and t-tests revealed this pattern to be the same as observed with regards
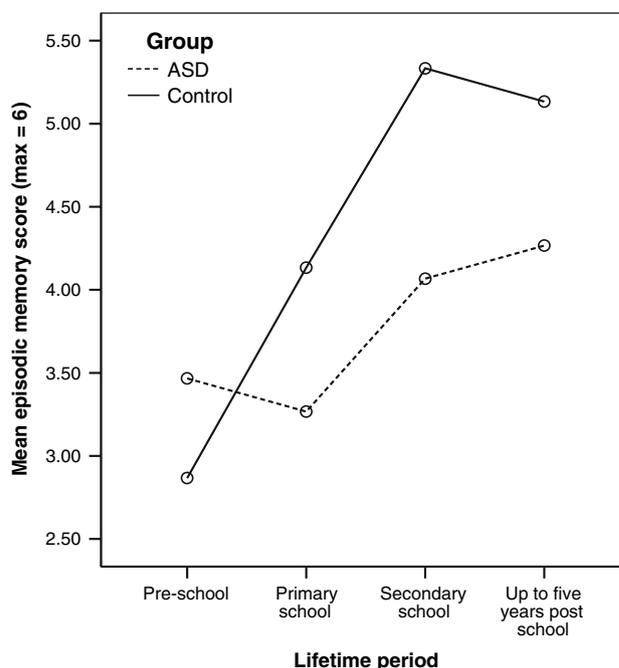

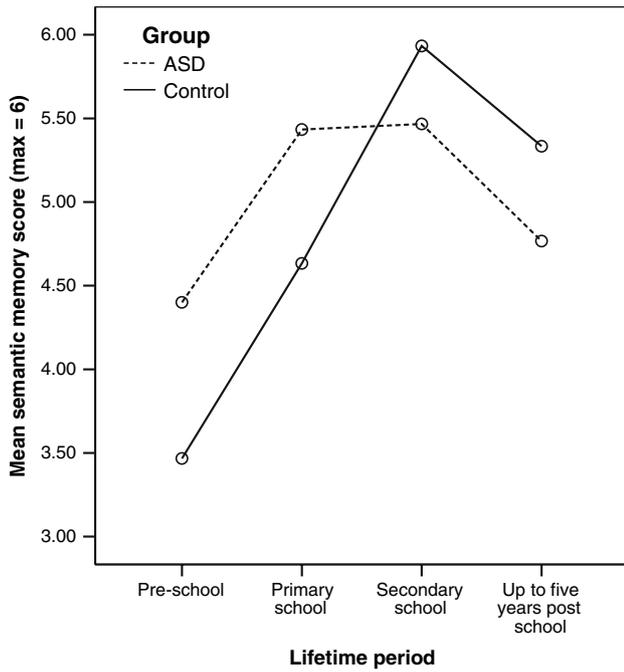**Fig. 1** Mean specificity scores on the personal episodic memory interview task

Fig. 2 Mean scores on the personal semantic memory interview task
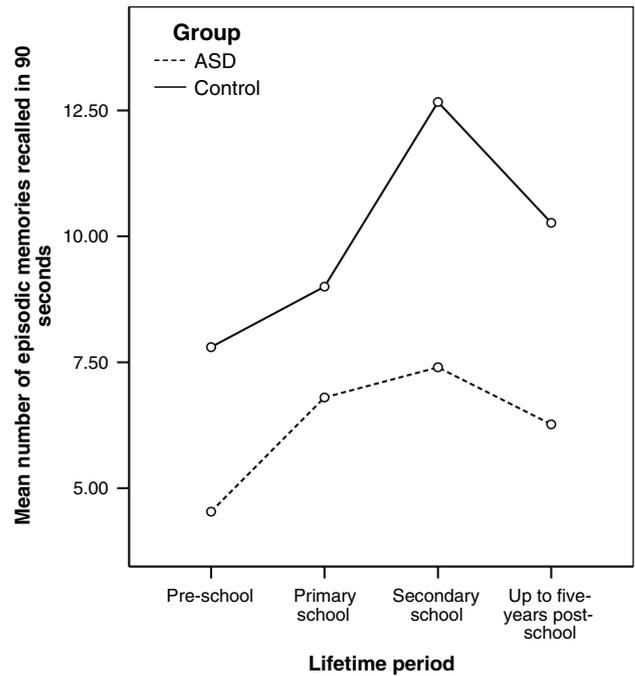

Fig. 3 Mean number of episodic memories recalled in the autobiographical fluency task

to the personal episodic memory task, with the control group recalling significantly more semantic information for the secondary school and five-years post-school time periods, compared to the other lifetime periods ($ps < .05$). In contrast, this pattern of responses was absent in the ASD group.

Autobiographical Fluency Task (Dritschel et al. 1992)

An autobiographical memory fluency task was used to assess the volume of personal episodic and semantic memories recalled within a specified lifetime period. Regarding personal episodic memories, the mean number of items recalled by individuals with and without ASD is illustrated in Fig. 3. A 2 (group) × 4 (lifetime period) mixed-design ANOVA revealed a statistically significant main effect of group, $F(1, 28) = 7.82$, $p < .05$; the ASD group generated fewer episodic memories than the control group overall (ASD mean = 6.25, SD = 2.71; Control mean = 9.93, SD = 4.32). There was also a statistically significant main effect of lifetime period, $F(3, 84) = 6.42$, $p < .05$; Bonferroni corrected post-hoc analysis revealed this to be due to participants overall reporting significantly more episodic memories for the secondary school time period, relative to the pre-school period, $t(29) = -4.10$, $p < .05$ (pre-school mean = 6.17, SD = 4.78; secondary school mean = 10.03, SD = 6.05). There was no statistically significant group × lifetime period interaction, $F(4, 128) = 1.22$, $p > .05$.

For the personal semantic memory tasks, the mean number of items recalled by individuals with and without ASD is illustrated in Fig. 4. A 2 (group) × 3 (lifetime period) mixed-design ANOVA revealed a non-significant main effect of group, $F(1, 28) = 0.19$, $p > .05$, however
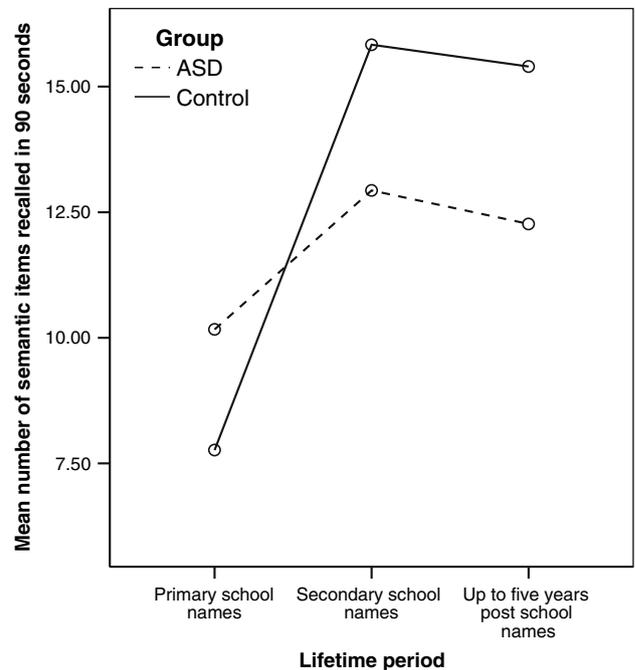

Fig. 4 Mean number of semantic memories recalled in the autobiographical fluency task

there was a statistically significant main effect of lifetime period, $F(2, 56) = 11.13$, $p < .05$. There was also a trend towards a group × lifetime period interaction, $F(2, 56) = 3.07$, $p = .055$. Bonferroni corrected within group repeated measures ANOVAs revealed this to be due to a significant effect of lifetime period in the control group, $F(2, 28) = 13.45$, $p < .05$, who (as in the episodic and semantic autobiographical memory interview) recalled more memories at the secondary school and five-years post school categories ($ps < .05$), whilst the ASD group did not display this characteristic pattern, $F(2, 28) = 1.25$, $p > .05$.

The autobiographical memory fluency task also assessed non-personal semantic memory via a battery of letter and category fluency tasks. Independent samples t-tests revealed no significant group differences between the ASD and control groups on all tasks ($ps > 0.05$), apart from the British Prime Minister category, in which the ASD group recalled significantly more category exemplars than the control group, $t(28) = 2.08$, $p < .05$, possibly reflecting a preference for factual information processing in the ASD group.

Episodic Memory Narrative Task (Han et al. 1998)

An episodic memory narrative task was used to assess detailed accounts of past experience. With respect to the two measures of volume of narrative, there were no significant group differences on these measures ($ps > 0.05$). However, there was a significant group difference regarding memory specificity, $t(28) = -3.08$, $p < .05$; overall the ASD group recalled fewer specific memories than the control group (ASD mean = 5.87, SD = 0.91; Control mean = 6.73, SD = 0.59). Analysis of various other qualitative measures (e.g. references to emotions, sensory elements, self/other references) revealed no significant group differences on these measures ($ps > 0.05$).

Correlations

Between and within subjects correlational analyses revealed no relationship between the autobiographical memory measures and verbal, performance or full scale IQ ($ps > .05$). There was also no relationship between performance on the verbal fluency and autobiographical memory tasks ($ps > 0.05$).

Discussion

This study examined autobiographical memory processing in adults with ASD using three methods of eliciting memories; a fluency task (in which participants generated episodic and semantic memories from different time periods at speed), an episodic and semantic memory interview task (that independently examined episodic and semantic memories across different time periods), and an episodic memory narrative task (in which detailed accounts of personal narratives were analysed for memory specificity and various other qualitative measures, e.g. references to emotions, self/other references and sensory elements). To summarise, a personal episodic memory deficit was observed in the ASD group on both the autobiographical fluency task and episodic memory narrative task. In contrast, examination of personal semantic memory (on a fluency task and an interview task) found no overall group differences. These findings suggest a deficit dissociation between personal episodic and personal semantic memory in ASD. Interestingly, the results from the episodic and semantic memory interview, whilst showing no overall group differences, demonstrated a distinctive pattern of recall in the control group that was absent in the ASD group. This pattern is consistent with theories of memory that link formation of the self with autobiographical memory recall (e.g. Conway and Pleydell-Pearce 2000), as described below.

The finding that episodic autobiographical memory was impaired in ASD despite preserved semantic memory is consistent with the results of previous research in this area (e.g. Klein et al. 1999) that suggests a dissociation between personal episodic and personal semantic memory in ASD. These findings also highlight the robustness of the personal episodic memory difficulties in ASD as a deficit has been observed across a variety of tasks. However, although no group differences were observed on the episodic components of the autobiographical memory interview or on the two personal semantic memory tasks (the fluency and interview tasks), a distinctive pattern of remembering was observed in the ASD group, relative to controls. Whilst there was a significant effect of time period on memory performance in the control group, with recall peaking at the secondary school and five years post-school periods, this effect was not evident in the ASD group; instead the number of memories recalled did not significantly differ as a function of time.

Previous research has revealed three robust temporal characteristics of autobiographical memory (cf. Conway and Pleydell-Pearce 2000): (a) Childhood amnesia; people tend to recall few memories from the first few years of their life, (b) the reminiscence bump; the increase in the frequency of the number of life events recalled from the adolescence and early adult life time periods, and (c) the recency effect; more events are remembered from recent time periods. The potential absence of this characteristic pattern of autobiographical memory recall in ASD, specifically the reminiscence bump, has several important implications. Firstly, the secondary school and five years post school time periods encompass adolescence, a time at

which self-identity becomes more defined (Erikson 1980). Autobiographical memory serves an important function in the construction of our personal identity (Wilson and Ross 2003); indeed, autobiographical memories are instrumental in forming and shaping our current goals, beliefs and self-views, possibly reflecting a reciprocal relationship between autobiographical memory and the self (cf. Conway and Pleydell-Pearce 2000). The autobiographical memory difficulties in ASD may therefore be related to the development of self-identity in this group. As research has shown individuals with ASD to have difficulties in terms of self-monitoring (Russell 1999), in processing self-referential information (Toichi et al. 2002) and in developing self-concepts (Lee and Hobson 1998), this explanation appears plausible.

Importantly, generation identity (Mannheim 1952) is also pertinent at this time period, which involves personal identification with a particular social group. Individuals with ASD typically display atypical levels of social interaction with peers (Bauminger et al. 2003) and experience difficulties with friendship (Baron-Cohen and Wheelwright 2003), potentially impacting on the ability to effectively relate to a social group. This lack of social identification in ASD may also affect the development of a coherent life story, particularly considering the important social narrative function of autobiographical memory (Nelson 1993). Further research is therefore necessary to explore the presence and/or absence of these characteristic patterns of autobiographical memory in ASD more systematically to ascertain how this impacts on the development of self and social identity in ASD. This, in turn, may be related to the social difficulties experienced in ASD.

However, it is important to note that there was wide variation in the abilities of the ASD group on some of the autobiographical memory tasks, particularly on the specificity measure of the episodic memory narrative task (Han et al. 1998). On this task, all but four of the control group scored at ceiling levels, whilst performance in the ASD group was extremely varied (only four participants in the ASD group scored at ceiling level; the remainder of the group scored between four and six on this measure, out of seven). Considering this variation in performance, it is of interest to identify which factors may underlie performance on these tasks. Two possible candidates are general intelligence or general memory ability, however no correlations between autobiographical memory and IQ were observed in the present study and general memory ability has been shown to be unrelated to autobiographical memory in previous research assessing autobiographical memory in ASD (Goddard et al. 2007). Therefore, further research is needed to ascertain whether any social or cognitive measures may be predictive of autobiographical memory performance in ASD. Executive function abilities, for

example, have been implicated in theoretical models of autobiographical memory (cf. Conway and Pleydell-Pearce 2000) and impaired central executive capacity has also been associated with difficulties in autobiographical memory retrieval (Dalgleish et al. 2007). Considering that ASD is associated with impairments in executive function (cf. Hill 2004), this may be one explanation for the autobiographical memory difficulties found in ASD. Likewise, theory of mind abilities have been linked to personal episodic memory (Perner and Ruffman 1995) and may further contribute to the difficulties faced in ASD. It would also be of interest to examine autobiographical memory in relation to levels of symptom severity and whether this may account for this variation.

Interestingly, variation in the performance of the ASD group was also observed on the episodic and semantic autobiographical memory interview (Bekerian et al. 2001) at the secondary school and five-years post-school time periods. Specifically, whilst the control group tended to score very highly at these time periods, performance in the control group was more varied (performance ranged from floor to ceiling levels). One factor potentially underlying this variance regards the development of the self-concept in ASD. As previously mentioned, theoretical accounts of autobiographical memory (e.g. Conway and Pleydell-Pearce 2000) stress the importance of the self in autobiographical memory. Specifically, they have emphasised the importance of current goals and self-concepts in retrieving autobiographical memories. It is plausible that those individuals with ASD that have a well-developed conception of the self are more able to successfully retrieve autobiographical memories, whilst those who have a poorer self-concept are less able to retrieve related memories. This would be particularly relevant at the secondary school and five-years post-school periods, which are a critical time for self-development and self-identity. Investigation of the relationship between the self and autobiographical memory in ASD would therefore be an interesting avenue for future research.

Overall, this research has suggested a distinctive pattern of recall in the ASD group, but this study does have certain limitations. Firstly, due to time and financial limitations it was not possible to confirm diagnostic status in the ASD group using standardised diagnostic instruments. Although all participants in the ASD group did have a formal diagnosis of ASD from a Clinical Psychologist or Psychiatrist, future studies should seek to confirm these findings using more stringent diagnostic criteria. Secondly, no attempt was made to confirm the accuracy of reported memories. Although some previous studies have attempted to assess the veridicality of autobiographical memory in ASD using a staged-event paradigm (e.g. Bruck et al. 2007; McCrory et al. 2007), these studies have assessed personal event

memory in children, who are more suggestible to this type of methodology than adults. In addition, this method is only able to assess memories for relatively recent time periods, whereas the present study aimed to provide an assessment of memory across the lifespan. Future research into the accuracy of memory in ASD is, however, a fruitful area of research and has important implications regarding eye-witness testimony. A third issue regards how no group differences were observed regarding the qualitative aspects of autobiographical memory narratives (e.g. references to emotions, self/other and sensory elements within the narratives), despite the ASD group generating fewer specific autobiographical memories. This may be attributable to the high level of support at retrieval on this task, for example some of the questions biased retrieval of emotional events or self/other memories, potentially obscuring any group differences in these categories. Examination of memory narratives without this high level of support may therefore shed some light on any group differences here.

In summary, the study has demonstrated a personal episodic memory deficit in adults with ASD, using a variety of methodologies. It has also found evidence of a deficit dissociation between personal episodic and personal semantic memory in this group. Moreover, the study has also found evidence of a distinctive pattern of remembering in ASD; whilst the secondary school and five years post-school time periods had a facilitative effect on recall in the control group, this effect was absent in the ASD group. Considering the importance of the adolescence and early adult life time periods in the formation of both self and social identity, this has important implications regarding the social difficulties experienced in ASD. Future research is therefore necessary to explore these memory difficulties in greater depth and to identify the mechanisms underlying the episodic autobiographical memory difficulties in ASD. This may, ultimately, lead to advances in our understanding of both the autobiographical memory difficulties and the social deficits in ASD.

Appendix

Episodic memory narrative task questions.

1. Can you tell me about all the things that you did before you went to bed last night? Tell me everything that you did after you ate dinner until right before you went to bed.
2. Now, can you tell me everything you did when you woke up this morning?
3. Now, can you tell me just one thing you did recently that was enjoyable?
4. What did you do for your last birthday?
5. Now, can you tell me about a time, when you were younger, when your parents punished you for something?
6. Can you tell me the first thing that you can remember in your life, your very first memory? How old were you when you think this event occurred?
7. What's the very first (i.e. earliest) birthday that you can remember? What did you do for that birthday?

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