Being Aware of Own Performance

How Accurately Do Children With Autism Spectrum Disorder Judge Own Memory Performance?

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Title page

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Being aware of own performance: How accurately do children with autism spectrum disorder judge own memory performance?

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Scientific Abstract
Self-awareness was investigated by assessing accuracy of judging own memory performance in a group of children with autism spectrum disorder (ASD), compared to a group of typically developing children (TD). Effects of stimulus type (social vs. non-social), and availability of feedback information as the task progressed, were examined.

Results overall showed comparable levels and patterns of accuracy in the ASD and TD groups. A trend level effect (p.061, d=.60) was found with ASD participants being more accurate in judging own memory for non-social than social stimuli and the opposite pattern for TD participants. These findings suggest awareness of own memory can be good in children with ASD. It is discussed how this finding may be interpreted and it is suggested that further investigation into the relation between content, frequency and quality of self-awareness and the context of self-awareness is needed.

Keywords: Autism spectrum disorder; Self-awareness; Meta-memory; theory of mind
Lay abstract

Though the concept of theory of mind, or ‘mentalising’, originally referred to the ability to represent the mental states of self as well as others, most research has focused on the ability to mentalise about other peoples’ minds. Studies of self-awareness are relatively scarce. This study investigates self-awareness by assessing accuracy of judging own memory performance in a group of children with autism spectrum disorder (ASD), compared to a group of typically developing children (TD). Effects of stimulus type (social vs. non-social), and availability of feedback information as the task progressed, were examined. The children were asked to remember a picture sequence of either faces (social stimuli) or buildings (non-social stimuli). The children were asked to judge their expected memory performance during the task and to judge the accuracy of the pictures recalled. The judgments of performance and accuracy were at a comparable levels and patterns for the ASD and TD groups. A difference of large effect was found with ASD participants being more accurate in judging own memory for non-social than social stimuli and the opposite pattern for TD participants. These findings suggest awareness of own memory can be good in children with ASD. It is discussed how this finding may be interpreted and it is suggested that further investigation into the relation between content, frequency and quality of self-awareness and the context of self-awareness is needed.
Do people with autism spectrum disorders (ASD) know their own minds? This provocative question follows from a well-established cognitive account of these neurodevelopmental disorders, the idea that people with ASD have impaired ‘theory of mind’. Though the concept of theory of mind, or ‘mentalising’, originally referred to the ability to represent the mental states of self as well as others, most research has focused on the ability to mentalise about other peoples’ minds. However, Frith and Happé (Frith & Happé, 1999; Happé, 2003) presented the hypothesis that difficulty representing mental states may also apply to one’s own mind in ASD. Frith (2003) has further suggested that a notion of “the lacking self” may indeed unify the existing social and nonsocial theories of ASD, explaining the mixed manifestations of both deficits and assets. This suggestion makes self-awareness in autism spectrum disorder an important focus for research. In addition, ‘insight’ is a critical phenomenon for understanding aspects of learning and development and thereby planning effective interventions. This has been described for other clinical groups such as those with intellectual impairment (Farrant et al., 1999b) or traumatic brain injuries (Kristensen, 2004).

Despite the potential importance of self-awareness, relatively little research exists related to understanding self-awareness in ASD. Recently the interest has increased both empirically and theoretically. Empirical studies investigating self-awareness have recently been reviewed by Williams (2010), including studies focusing on recognising own (false) beliefs, intentions, knowledge, thought processes, body and agency. Williams (2010) proposes the theoretical argument that autism involves a specific deficit of the ‘psychological self’, or theory of own mind, in contrast to an apparently typical awareness of the ‘physical self’. Difficulties in self-awareness in
ASD would support the theoretical suggestion that awareness of own mind depends on the same underlying functional system/process as awareness of others’ minds, a position argued for in depth by Carruthers (2009).

**Meta-memory**

The study of meta-memory has been suggested as one way to approach the study of self-awareness (Farrant et al., 1999b). Metamemory is the knowledge and regulation of memory processes, and constitutes one aspect of metacognition. Metamemory is viewed as involving two aspects; a declarative aspect and a procedural aspect (Lockl & Schneider, 2002; Schneider et al., 2000). The declarative aspect refers to factual knowledge about one’s own memory and memory systems (Schneider et al., 2000), including knowledge of the effect on memory of variables related to tasks, persons and strategies (Farrant et al., 1999b). The procedural aspect of metamemory refers to the ability to use memory skills flexibly and adaptively in relation to the contextual demands, by monitoring memory status and regulating memory activities (Lockl & Schneider, 2002). These processes rely on the ability to access both own prior experience of memory tasks, and own intentions and memory in the current situation. Different paradigms have been used to assess developmental trends in monitoring skills looking at children’s judgments of memory performance: e.g. predicting own performance in advance of the learning process, referred to as “ease of learning (EOL)”; predicting own performance during or after a memory task, referred to as “judgement of learning (JOL)”; and judgement of ability to recognize items that are not currently recalled, referred to as “feeling of knowing (Karably & Zabrucky, 2009; Lockl & Schneider, 2002; Schneider et al., 2000). Another paradigm focuses on judgments of the quality of memory performance, looking at children’s confidence in their own memory (Roebers & Howie, 2003).
Meta-memory in autism

Some of the above approaches to meta-memory have been used in studies with children with ASD. Researchers have focused on the declarative aspects of meta-memory, investigating for example, the knowledge of the brain’s function compared to the heart’s (Baron-Cohen, 1989), the knowledge of retrieval strategies and the effect of task length and age on memory performance (Farrant et al., 1999b), and the distinction between mental states such as knowing and guessing (Fisher, 2002; Kazak et al., 1997) or knowing and remembering (Bowler et al., 2000). Others have focused on the procedural aspects, focusing e.g. on the actual use of memory strategies in relation to different tasks (Bebko & Ricciuti, 2000), recall readiness (Farrant et al., 1999a), and aspects of memory monitoring (Bowler et al., 2004; Farrant et al., 1998; Hala et al., 2005). So far no studies have looked at the judgements of performance or the certainty of these judgements in children with ASD.

The findings to date are generally mixed and suggest both competencies and difficulties with meta-memory in the autism group. In an attempt to interpret these mixed results it has been suggested that meta-memory abilities interact with the task structure such as support and cues in encoding or recall setting (Bowler et al., 2004; Farrant et al., 1998; Hala et al., 2005). Bowler and colleagues (Bowler et al., 2004; Bowler, 2007) have formulated the task support hypothesis (TSH) suggesting that memory in ASD relies on external scaffolding to a greater extent than memory in TD. The stimuli to be recalled can also affect memory performance in ASD and typically developing groups differently. For example, intact or superior performance on topographical stimuli and impaired performance on faces has been reported in ASD (Blair et al., 2002; Webb, 2008). So far no studies have investigated this difference in relation to aspects of meta-memory.
This study focused on meta-memory, and more specifically on the monitoring and evaluation of memory performance as a procedural aspect of meta-cognition, as a possible way of operationalizing and assessing an aspect of self-awareness.

The purpose of the study was to investigate: a) the accuracy of judging one’s own memory performance using judgements of total performance and certainty judgements for each stimulus, b) how accuracy is affected by stimulus type (social versus non-social), and c) how accuracy is affected by varying amounts of available information during task progression. These questions were investigated for children with ASD and a comparison group of typically developing children (TD) matched on VMA. These specific questions and the general focus on judging own performance have not been addressed in previous studies.

Method

Participants

24 students with ASD (age 10.1-15.7 years, mean13.4, SD 1.5) and 21 typically developing students (TD) (age6.4-14.5 years, mean10.1, SD2.5) were included. Participants in the ASD group all attended specialist autism schools, which required a diagnosis of autism, Asperger’s syndrome, atypical autism or PDD-NOS for entry into the school. Furthermore, a formal diagnoses, by a trained psychiatrist or pediatrician, of autistic disorder, Asperger’s disorder, atypical autism or pervasive developmental disorder not otherwise specified (PDD-NOS) according to established criteria (DSM-IV-TR, APA, 2000; ICD-10, WHO, 1992) were needed for inclusion.

The TD group was recruited from a mainstream school. The ASD group was heterogeneous in relation to IQ level (ASD: FSIQ, range 53-145; TD: FSIQ, range 72-127). As cognitive level could influence memory performance and meta-memory the TD group was matched based on verbal mental age (VMA). Baseline verbal and non-verbal abilities were assessed by a short form of the
Wechsler Intelligence Scale for Children—Third Edition UK (WISC-III: Wechsler, 1991). Verbal ability was assessed by performance on the Vocabulary and Information subtests. Non-verbal ability was assessed by the Block Design and Picture Completion subtests of the WISC-III. The verbal and performance IQ estimates gained from this short form have high reported reliability (Sattler, 1992). The use of short forms of Wechsler intelligence scales with individuals with ASD has been found to be reliable (Minshew et al., 2005). Verbal mental age was calculated based on the verbal subscales. The ASD group had a higher mean VMA in years (M=11.8, SD=3.6, range 6.4-16.8) than the TD group (M= 10.9, SD=1.9, range: 7.3-14.3) but this difference was not significant (t(36)=-1.1, p=.280, d=-.32). All participants were male.

Materials and procedure

The meta-memory task was an adaptation of a task design used by Bebko and Ricciuti (2000) focusing on memory for the sequence of visual stimuli and different visual stimulus types as used by, for example, Blair et al. (2002).

The task consisted of a training phase and 4 repetitions of a memory task including meta-memory questions. The tasks were administered by hand. The participants were introduced to the task as a series of memory games where they would be asked to remember some pictures and asked to say how they thought they would perform on the task and how certain they were of each remembered picture. The set-up and the materials were developed with autism specific difficulties in mind focusing on increasing the clarity of the task using a high degree of organization and visual support. The training phase allowed the participants to familiarize themselves with the procedure of the task. The general structure of the memory task and the meta-memory questions are illustrated in figure 1.

The participants were presented with series of 6 black and white stimulus pictures, either 6 faces or 6 buildings. Buildings were presented in the 1st and the 4th trial and faces in the 2nd and 3rd trial. The stimulus pictures were presented one at a time for 3 seconds each. After each picture in the sequence of 6 had been exposed and then re-covered, participants spent 30 seconds on a distracter task, sorting coloured pictures of either animals or food into simple categories: “Things I like vs. Things I do not like” in the 1st and the 2nd task and “Things that are good for me vs. Things that are not good for me” in the 3rd and 4th task. Participants comprehension, concentration and engagement with the task were monitored; no participants had to be excluded due to failure in these respects. During the recall phase, participants were instructed: “Ok when I tell you to start you can find the 6 pictures I showed you and put them in the same order”. The 6 original stimuli and 6 distracter pictures were shown. All pictures were fixed with paperclips on a board. Another board with 6 paperclips was placed just below the folders hiding the original stimuli highlighting where the chosen pictures should be placed and the correspondence with the task stimuli. Feedback was provided revealing the originally presented pictures, showing the entire sequence for approximately 5 seconds. No verbal feedback was provided.

Meta-memory was assessed by asking the participants two types of meta-memory questions: performance judgements related to the number of items remembered correctly, and certainty judgements regarding the confidence with which each item was selected as remembered.

Performance judgement questions were asked of the participants 3 times during the recall task. Each time the participants were asked “How many pictures do you think you will be able to place in the same order?”/”How many pictures do you think you have placed in the same order?”. A visual scale with the number 0 to 6 was provided for supporting performance judgements if needed. The timing
of the questions in relation to the memory task is illustrated in figure 1. The first time (before the stimuli had been presented) links to the “ease of learning (EOL)” concept, and the second (after the distracter task but before recall) and the third time (after recall) both link to the “judgement of learning (JOL)” concept (Karably & Zabrucky, 2009). To obtain more accurate judgements participants needed to monitor the available information. The information available for making performance judgments varies during the task being more general and declarative in the beginning of the task and more grounded in the actual memory process later in the task. Good monitoring ability was expected to lead to the later judgements being more accurate than the first.

For the certainty judgements the participants were asked to judge how sure they were of each of the pictures they had selected during recall. They were asked if they were totally sure, pretty sure or unsure. This question is similar to the paradigm used by Roebers and Howie (2003). These questions were asked after recall of the full sequence, pointing to each picture at a time. Definitions of being totally sure, pretty sure or unsure, with visual symbols, were provided to aid participants during the certainty judgements.

A brief training phase preceded the testing, during which only three black and white pictures of different objects were used as stimuli for recall. Otherwise the same procedure as described in the memory task was used. The purpose was to familiarize the participants with the memory task and especially with the meta-memory questions asked during the task. The performance judgement scale and the definitions of the certainty judgements were also introduced during the training phase. Participants’ comprehension and engagement with the task were monitored, and administration was curtailed if either was deemed inadequate. No participants were excluded due to poor participation.
Statistical analysis

Three types of variables were computed: 1) variables reflecting ordered recall performance (ORP), 2) variables reflecting performance judgement accuracy (PJA), and 3) variables reflecting confidence judgement accuracy (CJA). For each of the three types of variables two stimulus-specific scores were computed using the mean of the two stimulus-specific trials. Ordered recall performance (ORP) captured the number of pictures recalled in the correct order. Performance judgement accuracy (PJA) captured the degree of accuracy of each performance judgement based on the absolute difference between ORP and the judgement of the number of stimuli remembered. Using the absolute difference the score did not discriminate between over- and under- predictions. Thus, if a participant judged that he would remember 3 pictures in the correct order but actually remembered 5 pictures in the correct order, the PJA score would be the numerical difference (recall minus judgement), in this case 2. The scores ranged from 0-6 with a lower score representing more accurate performance judgements irrespective of actual memory performance. Participants were also classified according to relative performance on the social (faces) versus non-social (buildings) stimuli. Participants with lower PJA-face score than PJA-building score were classified as more accurate on faces, and vice versa. Two participants from the ASD group and one participant from the TD group were equally accurate on the two stimulus types and were excluded from the analysis using this classification. The variables reflecting confidence judgement accuracy (CJA), used the certainty judgement (sure, pretty sure or unsure) compared to the quality of recall for that stimulus (correctly recalled stimulus in correct position, correctly recalled stimulus but in wrong position, or incorrect/distractor). 3 levels of confidence accuracy were established: judgment in accordance with quality of recall (e.g. ‘sure’ for correct stimulus in correct position or ‘unsure’ for distractor stimulus) giving a score 0, judgement somewhat in accordance with quality of recall (e.g. ‘pretty sure’ for correct stimulus in wrong position) giving a score of 1, and no accordance between
judgement and quality of recall (eg. ‘sure’ for distractor stimulus) giving a score of 2. For each trial the CJA score was formed by summing the confidence accuracy scores for each picture. The score ranged from 0 to 12 with a lower score representing more accurate certainty judgements.

All variables except PJA-face were normally distributed. Spearman’s correlations were used to assess associations between PJA-face and other measures while Pearson’s correlations were used to assess associations between measures. If relevant, based on correlation analysis, scores were corrected by regression analysis allowing a corrected analysis of any potential group differences. Repeated measures analysis (ANOVA) was used to investigate patterns of PJA and CJA scores and group and stimuli variation of these patterns across trials and across phases within the trial. Chi-square analysis was used to compare the distribution of participants divided by relative performance on the two stimulus types. Cohen’s d was calculated and Cohen’s conventions (1988) used to estimate effect sizes.

Results

Ordered recall performance

Table 1 shows the performance on ordered recall for both stimulus types in the ASD and comparison groups. Since ORP-scores proved to be significantly correlated with VMA (r=.65 for TD and r=.48 ASD for ORP total; p<.05), regression analysis was used to adjust ORP-scores for VMA.
Analysis of the adjusted recall scores showed no significant group difference in ORP and no effect of stimulus type or interaction of stimulus type and group.

Performance Judgement Accuracy

Table 2 shows the group means (and standard deviations) for PJA for the two stimulus types in the ASD and TD groups across the three time points. PJA did not correlate with CA or VMA, so no adjustments were made.

Repeated measures ANOVA showed a significant difference (F(1.75)=10.4, p=.000) with a small effect size (partial eta squared=.20) between the three times of judgements within trials (see figure 2) for both groups. LSD comparison revealed all means to be significantly different from each other with the third PJA being the most accurate and the second PJA being the least accurate. Group effect, stimulus type effect and interactions were non significant.

Chi-square analysis showed a trend with a large effect size (p=.061, Fisher’s exact test – one-sided, d=0.60) for more individuals in the ASD group to be better on buildings than faces (14/24 participants buildings>faces), and the opposite pattern in the TD group (13/21 participants buildings<faces)
Confidence judgement accuracy

Table 3 shows the mean (sd) confidence judgement accuracy scores by group and stimulus type. CJA did not correlate with CA or VMA, so no adjustments were made.

Repeated measures ANOVA illustrated in figure 3 (stimulus type by trial) showed a significant difference across the four trials ($F(3)=4.30$, $p=.006$, partial eta square=.09). LSD comparison showed CJA in trial 1 to be significantly less accurate than CJA in the other trials. There was no significant main effect of group, main effect of stimulus type or group by stimulus type interaction.

Discussion

Our main finding, using a task characterised by a high degree of structure and actively enquiring about the participants’ estimates of performance, was that memory monitoring abilities of participants with ASD and TD did not differ. This is seen in comparable accuracy levels both on the more general judgements of overall performance (PJA) and on the more specific certainty estimates of each of the selected stimuli types (CJA). It is also reflected in comparable patterns of accuracy, when looking at accuracy across task repetition and within task judging performance based on different types of information. For both groups VMA correlated with ordered recall but not with PJA or CJA.

Findings concerning the participants’ ordered recall showed no significant effect of stimulus type as previously reported findings (Blair et al., 2002; Webb, 2008). However a trend of large effect size
was found for ASD participants to be better at judging their memory performance for building stimuli than face stimuli and the opposite pattern in the TD group. Combined with other studies investigating the effect of different stimulus types (Blair et al., 2002; Cipolotti et al., 1999; Loth et al., 2010) this suggests that the difference found between ‘social’ and ‘non-social’ stimuli may also be relevant in relation to meta-cognition.

The pattern of PJA during the task showed that the PJA was most accurate when given last in the task and based on both experience with the task material and the actual recall of the pictures. The least accurate judgement was the judgment immediately after having seen the specific task material but before doing the actual recall. Instinctively one could assume that it would be easier to give an accurate judgement when the specific material to remember is known compared to the judgement provided in the beginning with only the task definition of having to recall and place 6 pictures of buildings/houses in the same order. However, Schneider and colleagues (2000) describes that for JOL a judgement after studying the task material is far from perfect, while a delay between stimuli presentation and JOL is found to provide more accurate judgements. Schneider and colleagues (2000) interprets this as the participant being “tricked” by the short-term memory leading the participant to believe they will be able to recall more than they actually do. In this study the results of multiple performance judgements show that also the general experience of ones own memory performance based on the general task characteristics is more accurate than the judgement immediately after exposure to the specific task material.

Limitations of this study included relatively small participant groups that were heterogenous for intellectual ability and age. Larger groups might have allowed the group difference in relative PJA for faces versus buildings to reach significance. Another limitation was a relative small number of task repetitions. Ideally, more tasks with each stimulus type would be included to rule out possible
variations in specific picture sequences that might have different difficulty. Future studies might benefit from recruiting a more homogeneous ASD group and should include an additional control group with moderate learning difficulties/intellectual disability to establish the specificity of any memory/met-awareness differences in ASD.

In line with other studies investigating aspects relevant to self-awareness, as reviewed by Williams (2010), it is evident that some abilities of self-awareness are not affected in the ASD group. The findings of intact awareness of own memory performance go against the expected deficits in ASD in awareness of the ‘psychological self’. The task support hypothesis presented by Bowler et al. (2004) may aid in interpreting the findings. The awareness of own memory performance can be seen as supported by the present task, which directs the participants’ attention towards the ‘psychological self’. Following this line of thought, one hypothesis is that self-awareness in ASD may be more context dependent than in typical development. The interaction between the individual and the context may influence both when and how often self-reflection is activated and the quality of that reflection.

Vygotsky’s concept of extracortical organization of higher mental functions as developed by Luria (1973) could be a relevant theoretical framework for this hypothesis and therefore for understanding self-awareness in ASD. The extracortical organization of higher mental functions refers to the universal principle that “… higher forms of conscious activity are always based on certain external mechanisms.” (Luria, 1973, p.31) One very concrete example is the use of alarms to remind us of important things to do such as putting out the trash at the right time. This hypothesis could also explain the efficacy of physical organisation and visual structure in supporting persons with ASD and could assist in designing effective interventions for this group. The unique interaction between the person’s mental functions and the external structures available supports the development of a
different way of functioning. At this point changing the external structures changes the way of functioning.

Vygotsky uses this framework in his well known concept: zone of proximal learning which specifies that there is a span between what the person is able to do alone and what the same person is able to do when scaffolded by another person – such as the toddler that is able to do a puzzle when their mother sits next to them and e.g. point to the next piece or instruct the child to turn the puzzle piece a tiny bit. This scaffolding will in time help the child learn to do the same activity alone. In typical development self-awareness of both physical and psychological aspects become internally organised and in time will be efficiently prompted by endogenously stimuli, such as directing attention both on how other persons react when entering a new setting and on prior experience, such as experience with a similar setting and knowledge of the person, in order to guide ones actions and reactions in that setting.

Following this line of argumentation self-awareness in ASD can for some individuals be seen as extended in this “stage” where the activation, direction and frequency of self-awareness is dependent on external mechanisms. These external mechanisms can be other persons asking about their perspective or feelings or it may be other cues in the environment such as written reminders “how are you feeling” or “what do you think of the movie” or less obvious cues specific to the individual that activates personal memories that may or may not be relevant to the situation. So when entering a new setting, prior experiences relevant to that setting may not be activated unless other persons or external cues explicitly direct the persons attention towards this specific information.

In the present study, self-reflection (regarding memory) was initiated by the experimenter cueing participants to give a judgement, thereby requesting some introspection – this was done very overtly and repeatedly within the task. However, in this study the same mechanisms may also be supporting
the judgements of the TD group. To understand metacognition and self-awareness in ASD further, it will be necessary to investigate the mechanisms underlying metacognition. This investigation should focus on how variations in external cues may or may not differently affect the accuracy of metamemory for persons with ASD and other groups. One way to minimize external cues could be to include a task design with implicit or self-initiated judgements.

Using the concept of extra cortical organisation we argue that it is the development and current organisation of self-awareness that is different in ASD leading to differences in attention to internal states. The difference suggested by Williams between physical and psychological aspects of self-awareness may be one relevant dimension of organisation. In ASD self-awareness may be directed at and organised around other aspects of life than what is normally expected. This may certainly provide the person with certain unique insights. At the same time the person may need support in order to direct the skills of self-awareness towards information relevant to navigate more effectively in relation to other persons and in the community. Information that would thereby give a higher degree of control and direction in one’s own life.

From a clinical point of view this means, depending on the specific cognitive abilities of the individual, reflection on inner states is possible but in some cases may need to be scaffolded by external mechanisms. It will be essential to get an understanding of what external mechanisms are necessary to enable the individual’s self-awareness in different situations and how these mechanisms can be provided and developed to support self-awareness more efficiently for people’s everyday functioning (e.g. the change from self-awareness of one’s own emotional state being based on explicit cuing by another person asking “how are you feeling?”, to being based on a visual reminder such as a small heart on the phone cover).

Clinical experience and empirical evidence do suggest that we are still struggling to understand self-awareness in ASD. In contrast to the challenges relating to self-awareness often experienced by
persons with ASD and their families and professionals empirical studies tend to find a more mixed picture of abilities and difficulties. There are interesting theoretical suggestions such as the extracotical organisation of self-awareness or the distinction between physical and psychological aspects of self-awareness (Williams, 2010) but we need more studies in order to tease out the underlying pattern of these findings and qualify the theoretical understanding. We do need to further investigate the content, frequency and quality of self-awareness and in doing so we need to be very aware of the interaction between individuals characteristics and the context of self-awareness. We also need to find research methodologies that are able to incorporate the complexities found in real life situations.

References


Table 1: Ordered recall performance for TD- and ASD-group by stimuli type

<table>
<thead>
<tr>
<th>Stimuli Type</th>
<th>TD-group (n=21)</th>
<th>ASD-group (n=24)</th>
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</thead>
<tbody>
<tr>
<td>Building total (max=6)</td>
<td>Mean (sd)</td>
<td>Mean (sd)</td>
</tr>
<tr>
<td></td>
<td>3.5 (1.4)</td>
<td>3.4 (1.8)</td>
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<tr>
<td>Face total (max=6)</td>
<td>3.6 (1.3)</td>
<td>3.6 (1.4)</td>
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</table>

Table 2: Performance judgement accuracy (PJA) for time 1, 2 and 3 by group and stimulus type:

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<thead>
<tr>
<th></th>
<th>TD-group (n=21)</th>
<th>ASD-group (n=24)</th>
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<tbody>
<tr>
<td></td>
<td>PJA1</td>
<td>PJA2</td>
</tr>
<tr>
<td>Building total (max=6) mean (sd)</td>
<td>1.7 (1.2)</td>
<td>2.1 (1.4)</td>
</tr>
<tr>
<td>Face total (max=6) mean (sd)</td>
<td>1.6 (0.9)</td>
<td>1.7 (1.0)</td>
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</table>

Table 3: Confidence judgement accuracy for TD- and ASD-group by stimulus type and trial

<table>
<thead>
<tr>
<th></th>
<th>TD-group (n=21)</th>
<th>ASD-group (n=24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (sd)</td>
<td>Mean (sd)</td>
</tr>
<tr>
<td>Building (trial 1)</td>
<td>4.0 (1.8)</td>
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<tr>
<td>Building (trial 4)</td>
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<tr>
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<td>Face (trial 3)</td>
<td>3.4 (1.5)</td>
<td>2.9 (1.9)</td>
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<tr>
<td>Face total</td>
<td>3.1 (1.2)</td>
<td>2.8 (1.4)</td>
</tr>
</tbody>
</table>

Figure Captions

*Figure 1:*
Structure of memory task and metamemory questions

*Figure 2:*
Performance judgement accuracy within trials

*Figure 3:*
Confidence judgement accuracy across trials
Figure 1 “top”

Figure 1: Structure of memory task and metamemory questions

Certainty judgement:

Performance judgement:

1 2 3

Presentation of stimuli → Distracter task → Ordered recall → Feedback


Figure 2 "top"

![Figure 2: Performance judgement accuracy within trials](image)
Figure 3 "top"

![Figure 3: Confidence judgement accuracy across trials](image)