Full report of research activities and results (R000223750)

Visuo-spatial abilities in Autism

Background

Despite having impairments in socialisation and communication, individuals with autism have been found to show intact or even superior visuo-spatial abilities. Specifically, good visuo-spatial performance is indicated by rapidly detecting a figure embedded within a larger design (Shah & Frith, 1983) and by solving block design problems swiftly (Shah & Frith, 1993). Frith (1989) proposed that the intact skills found in autism, including superior visuo-spatial skills, could be explained by weak central coherence. The theory of weak central coherence predicts that individuals with autism will process information locally, focusing on detail, rather than globally. Attention to local components of a stimulus would explain good performance on the block design task where one needs to visually segment the design in order to recreate it using individual blocks. Having weak central coherence would also allow one to easily perceive the target stimulus that forms a smaller component within the larger design in the embedded figures task. Furthermore, a second prediction of weak central coherence is that individuals with autism will fail to process incoming information in context. In support of this, Shah and Frith (1983) have argued that superior performance on the embedded figures task may be due to those with autism experiencing 'less capture by meaning', which implies that they are impaired in utilizing prior knowledge for processing input.

Therefore, there are two possible explanations which may account for good performance on the embedded figures task. Those with autism may process information locally, by attending to the component parts, rather than processing the global whole. Alternatively, individuals may not integrate meaning or prior knowledge when processing information. However, a recent study by Ropar and Mitchell (2002) demonstrated that individuals with autism were able to visually integrate local elements within their field of vision, but failed to integrate their prior knowledge to the same extent as controls. Using a shape constancy paradigm Ropar and Mitchell (2002) found that a circular stimulus viewed at a slant was judged more accurately by individuals with autism than controls when ambient perspective cues were eliminated. This shows that knowledge alone was sufficient to cause exaggeration of shape in those without autism but not those with autism. In a second condition when perspective cues were included, those with autism exaggerated circularity in a similar way as controls. Therefore integration of local elements was not a problem for those with autism as the depth cues surrounding the stimulus had influenced their perception. This study suggests that perception in autism is distinctly different, and may be less top-down than in those without autism.

The research we conducted was based on a proposal to carry out a series of experiments to test the theory that individuals with autism rely less on top-down processing. The influence of knowledge on perception was explored on two different levels. Firstly, we examined the encoding or input of information in those with and without autism. In experiment one, individuals were presented with words and pictures sequentially in which half of the items were thematically related (animals or food) and the remaining half were not. We predicted that those with autism, unlike controls, would fail to use the meaningful thematic link to help them recall words. On the other hand we expected that those with autism would be able recall just as many related pictures as those without autism since this may allow them to use a visual strategy.

A second level in which the influence of top-down processing was explored is related to the output of knowledge. Three studies were carried out to investigate whether higher-level knowledge interferes with the ability to perceive a stimulus accurately in those with autism as it does in those with typical development. It was expected that those with autism would be less affected by the meaningful context which causes the illusory distortion of shape in the Sheppard illusion (see figure 2 in method section). This was explored by comparing estimations of shape made on the Sheppard illusion with a condition requiring one to make the same judgements but without the meaningful context. We also predicted that those with autism would show less boundary extension, which results from the activation of conceptual knowledge, when asked to recall a scene from memory. Finally, we anticipated that those with autism would be more accurate than controls at judging shape when asked to view a stimulus through a Da Vinci window.

Objectives

We had 2 general aims:

1.) To carry out basic research into the strengths of the autistic intellect, with a view to detailing the positive qualities that could be nurtured by educational and therapeutic programmes of intervention.

Outcome: We now have a clearer picture of autistic visuo-spatial abilities. Individuals with autism/Asperger's Syndrome do use meaning, contrary to prediction, like matched participants to assist their recall of words. There was also no evidence to suggest that individuals with autism processed information presented pictorially any better than comparison participants. When asked to recall pictures of scenes from memory individuals with Asperger's Syndrome, like typically developing adults, falsely recalled seeing more of the boundary than was presented. Consistent with our predictions, those with autism/Asperger's Syndrome showed less influence by top-down knowledge when asked to estimate shape on the Sheppard illusion which extends our previous findings (Ropar & Mitchell, 2002). Contrary to our predictions, those with autism performed similarly to comparison participants in estimating shape when inspecting a stimulus through a Da Vinci window. However, these findings are likely to be a result of features specific to this method used to investigate perception. Details are reported in the ***Method & Results*** section.

Additional outcome: Although it was not specified as an explicit aim, the research has also contributed to our understanding of perception in typically developing individuals. The results from all studies provide evidence that top-down processing plays an important role in perception. This will be highlighted in the section on the Sheppard task where the findings are especially informative in relation to drawing processes.

2.) Apart from informing theory, we aimed to generate information relevant to a project currently funded by the Shirley foundation that is concerned with building virtual environments for helping individuals with autism to learn social skills.

Outcome: In collaboration with colleagues from engineering and computer science at Nottingham, along with the National Autistic Society (Wilson, Benford, Mitchell, Cobb, Hopkins), we were awarded 400k by the Shirley Foundation (April, 2000 - March, 2003) to investigate virtual environments for social skills training in individuals with Asperger's Syndrome. The design of the virtual environments is informed by what we are discovering about visuo-spatial abilities in autism from this ESRC-funded project. Additionally, we (Mitchell, Cheng & Ropar) have been awarded a grant of £20,000 from the Bailey Thomas Trust Fund to investigate implications of the heightened visuo-spatial abilities in autism for developing expertise in draughtsmanship. This demonstrates how the basic findings of the current project can be informative for the development of educational programmes which seek to build on the strengths of the autistic intellect.

We formulated some specific objectives as a way of satisfying the broad aims stated above:

1. To examine whether individuals with autism are more effective in processing visual than verbal input.
2. To examine whether individuals with autism are less likely to be influenced by conceptual knowledge in their depictions.

Methods & Results

This is organised into 2 sections, each addressing an objective stated above. The order in which the studies are discussed reflects the order in which they were developed and carried out.

<u>Objective 1: Input of information</u>

Experiment 1: Recall of words and pictures

The aim of Experiment 1 was to investigate whether individuals with autism and Asperger's Syndrome utilise prior knowledge when asked to recall words and pictures in a cued and non-cued condition. Studies have shown somewhat mixed evidence in the ability to use a thematic link to recall words in autism using a non-cued paradigm (Tager-Flusberg, 1991). Therefore, intially we wanted to know if those with autism/Asperger's Syndrome could apprehend the thematic link when presented with our list of words which were carefully matched between related and unrelated conditions. The plan was firstly to present the non-cued version of the task to participants, and then to proceed with the cued version if we found those with autism/Asperger's Syndrome failed to use their prior knowledge to assist with word recall.

The stimuli in this experiment consisted of four lists with each containing 20 items. Two of the lists were made up of words, and the other two consisted of pictures taken from Snodgrass and Vanderwart (1980). In each list of 20 items, 10 were related (e.g. food items or animals) while the remaining 10 were unrelated. Particular care was taken to match the related and unrelated items so that the findings could not be explained by differences in stimuli difficulty. In order to ensure that the related items did not differ in any way to the unrelated items in each list, they were individually matched on picture familiarity, picture complexity (Snodgrass & Vanderwart, 1980), and for word frequency (Kučera-Francis). Additionally, the mean word length across lists was also controlled for. The mean ratings for related and un-related items in each of the two lists can be seen below in Table 1. No significant differences were found between related target items and their un-related matches on any of these factors.

Table 1: Mean ratings for related and unrelated items in each of the two lists.

Ratings	**Animal List**		**Food List**	
	Related Items	**Unrelated Items**	**Related Items**	**Unrelated Items**
Picture Familiarity	2.54	2.60	3.5	3.61
Complexity Rating	3.71	3.13	2.22	2.26
K-F Frequency	13.8	13.9	14.3	14.2
Word Length	5.2	5.5	5.2	5.9

Seventeen individuals with autism and 17 with Asperger's Syndrome participated in this study. Two control groups were also tested which were matched with the Autism and Asperger's groups on chronological age, verbal IQ, and performance IQ. See table 2 for details.

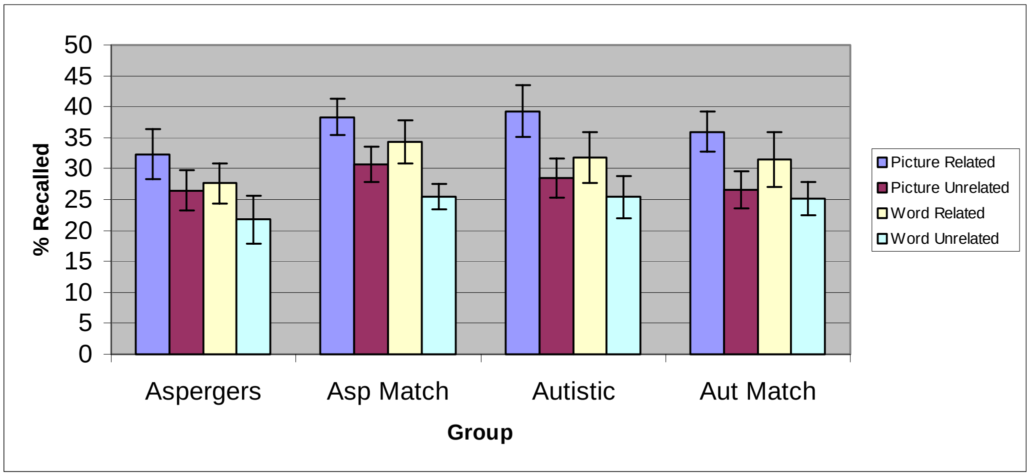
Table 2. Participant details

		Autistic	Autistic Match	Aspergers	Asperger Match
N		17	17	17	17
Age (yrs;mos)	Mean	13;1	12;9	13;2	13;0
	SD	1;2	1;1	1;6	1;7
	Range	11;0-14;7	11;2-14;7	10;2-15;10	10;3-15;8
VIQ	Mean	83.76	84.82	96.71	96.35
	SD	12.58	14.05	16.97	17.28
	Range	55-108	63-105	67-123	63-126
PIQ	Mean	87.59	90.35	95.12	105.35
	SD	14.9	21.46	17.61	19.28
	Range	63-115	62-127	66-133	62.128
FIQ	Mean	84.18	86.41	95.59	100.94
	SD	10.63	17.83	17.22	18.87
	Range	68-105	60-109	69-124	60-130

Each participant was presented with a word list and a picture list, however the thematic link was always different between conditions creating 4 possible conditions. For example, an individual who was presented with a list of words having an animal theme was then presented with pictures containing a food theme. After viewing each list the participants were asked to recall as many items as they could. The number of related and unrelated items were recorded for both the word and picture lists. Figure 1 displays the percentage of related and unrelated items recalled for pictures and words.

Results showed that individuals with autism, like their control group, recalled more related than unrelated items ($F_{(1,32)}=12.074$, $p<0.005$). Those with Asperger's Syndrome also recalled more related than unrelated words like their comparison group ($F_{(1,32)}=5.905$, $p<0.05$). These findings were contrary to our predictions and previous findings which suggests those with autism spectrum disorder fail to utilise meaning to assist with recall. Further analyses showed that those with Asperger's Syndrome and their matched controls recalled significantly more pictures than words ($F_{(1,32)}=12.588$, $p<0.005$). Thus, a failure to find any group differences in recall of words versus pictures suggests those with autism and Asperger's Syndrome do not have a special advantage for processing pictorial information in comparison to control groups.

Figure 1. Mean percentage of related and unrelated items recalled for pictures and words.



Contrary to our predictions we found that both individuals with autism and those with Asperger's Syndrome did use prior knowledge to assist with word and picture recall. This is inconsistent with Tager-Flusberg's (1991) finding that individuals with autism fail to use their prior knowledge to assist them in recalling words. Although our findings were unexpected, they are very important especially in light of more recent findings in this area. Tager-Flusberg's study has been argued as providing crucial evidence for the "theory of weak central coherence" in autism. Our findings however confirm more recent evidence that individuals with autism do use meaning to assist word recall (Lopez & Leekam, 2002). Lopez argues that Tager-Flusberg's findings may be specific to the categories used (animals & food) or due to not matching the related and unrelated lists appropriately. Our study used the same categories as Tager-Flusberg' s (1991) which means the first explanation can be ruled out. Our study, as well as Lopez's, matched the related and unrelated items carefully on a variety of factors unlike Tager- Flusberg's study. This suggests that individuals with autism spectrum disorders may not have as much difficulty using meaning to assist recall as initially thought.

Objective 2: Output of knowledge

This section is divided into 3 studies which explore the output of knowledge.

Experiment 2: Sheppard task

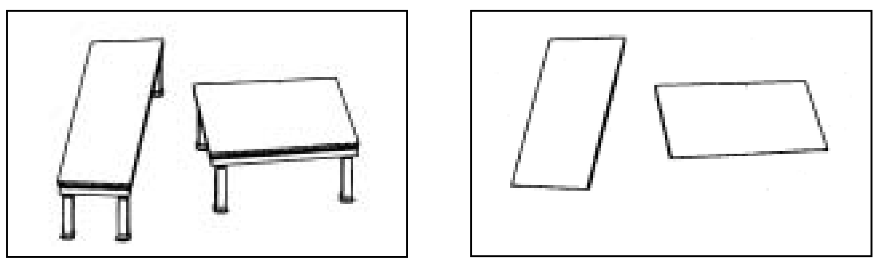
The aim of the Sheppard task was to explore whether individuals with autism and Asperger's Syndrome are less influenced by their prior knowledge when estimating shape. Two different versions of the task were developed and are discussed in this section: a computer version and a drawing version.

Computer version

Participants are asked to alter one shape to make it appear visually identical to another using a computer programme. There are two conditions in the experiment. One condition is based on the Sheppard stimuli which includes two shapes that look like table. Although the tabletops appear to be different, they are actually identical in size and shape (See figure 2-a.) The difference in appearance of the table tops is a result of one's knowledge about object properties. In the control condition the meaningful context surrounding the same shapes is removed therefore they appear to be more similar (see figure 2-b). Although the shapes in the control condition do not appear as different as those in the table condition, they do appear to differ slightly. This difference is due to an illusion effect which results from the orientation of the figures in relation to our perceptual field. Since this involves perceptual processing at a basic level we would expect those with autistic spectrum disorder to succumb to the illusory effect just like their comparison groups.

Figure 2: Stimuli used in Sheppard task.

a.) Table condition   b) Control condition



A computer programme written in java script was developed to present these stimuli on a laptop computer. Participants were presented with 3 trials of each condition. For each trial the figure on the left remained static while the shape of the right hand figure could be altered using the arrow keys of the computer keyboard. The up and down arrow keys could adjust the width, and the right and left arrow keys altered the length.

Seventeen individuals with autism and 17 individuals with Asperger's Syndrome participated in this study. Each of these groups were matched with a comparison group on chronological age, verbal IQ and performance IQ (see table 3 for details).

Table 3: Participant details

		Autistic	**Autistic Match**	**Asperger's**	**Asperger Match**
N		17	17	17	17
Age (yrs;mos)	Mean	13;1	13;2	13;5	13;4
	SD	1;0	0;11	1;6	1;6
	Range	11;9-14;7	11;8-14;7	10;2-15;10	10;2-15;8
VIQ	Mean	79.29	82.12	95.94	88.12
	SD	14.06	16.11	17.27	13.91
	Range	55-108	55-110	67-123	66-111
PIQ	Mean	85.94	83.00	98.82	99.35
	SD	16.24	19.14	16.66	19.28

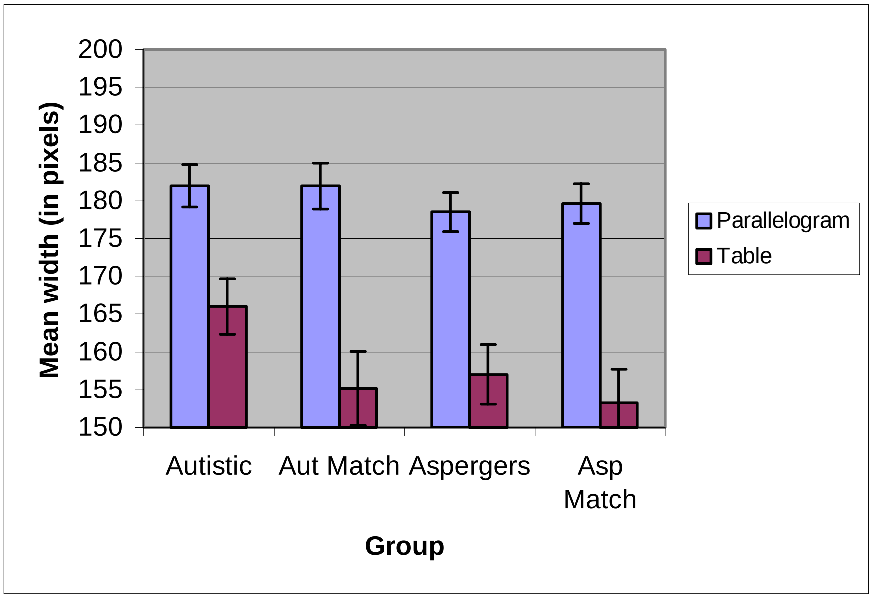
	Range	63-115	62-107	66-133	63-129
FIQ	Mean	80.82	81.24	97.29	92.79
	SD	13.41	18.02	17.23	16.41
	Range	56-105	56-109	69-124	62-116

On each trial participants were instructed to make the shape on the right exactly the same size as the shape on the left, however, the shape on the left is standing up and they were to make the shape on the right so that it is lying down. In order to make sure that each participant understood the task, they were presented with two practice examples.

For each trial, the final size of the right hand figure was recorded in number of pixels for the height (x) and width (y) dimensions separately. For the purposes of the analyses, the mean estimations of length and width over the three trials for both the table and the parallelogram were calculated.

Analyses revealed no differences between groups in judgements made on the length of the stimuli, however groups did perform significantly differently when estimating width. The mean width scores for each group on both the parallelogram (no context) and the table (context) condition can be seen below in Figure 3. The actual target width is 200 pixels. Although all groups were more accurate in estimating width on the parallelogram condition, there was a significant group by condition interaction ($F_{(1,32)}=5.367$, $p<0.05$). This interaction was due to those with autism being more accurate than their matched comparison group on the table condition. All groups performed similarly on the parallelogram condition in that they all underestimated width in relation to the target width of 200.

Figure 3. Means width scores across groups for the parallelogram and table conditions on computer task.



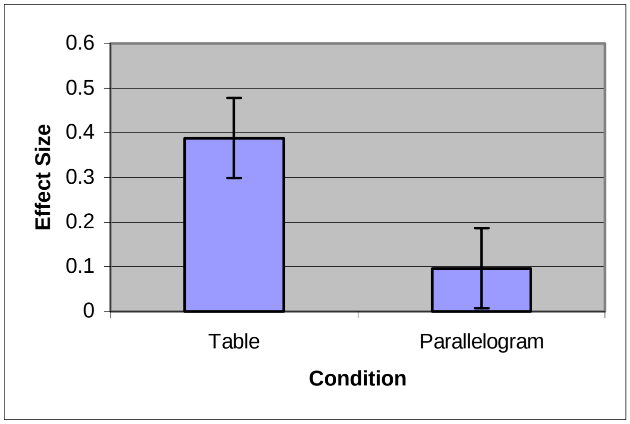
The finding that those with autism and Asperger's Syndrome were affected by the illusory effect on the parallelogram condition, like controls, suggests that their basic perceptual processing is intact. This confirms our previous research which shows individuals with autism and Asperger's Syndrome show typical perception of visual illusions (Ropar & Mitchell 1999; 2000). The results also showed that individuals with autism are less affected by their conceptual knowledge when estimating shape on the table condition. These findings confirm earlier research (Ropar & Mitchell, 2002) which suggests that perception in autism may be less top-down.

Drawing version

We wanted to see if we were able to replicate the findings from the computer version of the Sheppard task using a paradigm which required one to draw the stimuli. In this task participants were asked to draw both figures in the table condition and the parallelogram condition. Initially data was gathered from 30 typically developing adults with a mean age of 26 years old.

The ratio of length to width was calculated for each drawn figure on both conditions. Thus the size of the effect could be calculated for each condition by subtracting the ratio of the right figure from the ratio of the left figure. An independent samples t-test comparing the effect size for the table condition with the effect size for the parallelogram condition showed that there was a significant difference between the conditions ($t_{(28)}$=2.260, $p<0.05$). The illusion effect was therefore stronger in the table (context) condition than the parallelogram (no context) condition. These findings replicate what was found in the control groups in the computer version of the Sheppard task.

Figure 4. The mean effect size for the parallelogram and table conditions on drawing task.



Although we were unable to test individuals with autism and Asperger's Syndrome within the time period of the grant; we are planning to follow up testing these groups. If individuals with autism are less affected by their prior knowledge as in the computer version, then we might expect them to be more accurate in their reproduction of the stimuli in the drawing condition.

Experiment 3: Boundary extension

The aim of Experiment 3 was to investigate boundary extension in those with and without Asperger's Syndrome. The phenomenon of boundary extension occurs when an individual, after being shown a photo of a scene (e.g. town), falsely recalls seeing more of the surrounding boundary of the image than was actually there. It is argued that the effect results from the activation of our prior knowledge in relation to items within the scene. Therefore, if individuals with Asperger's Syndrome are less likely to utilise their prior knowledge, as found in previous research (Ropar & Mitchell, 2002; Experiment 2- Sheppard task), then we would expect them to extend boundaries less than comparison participants.

A computer programme written in java script was developed to present 16 photographs to participants and to allow them to manipulate the size of the image using the arrow buttons on the keyboard. The photographs varied according to two factors, content (object or person) and presentation (cropped or uncropped). The rational for including these factors is based both on boundary extension and autism literature.

Figure 5. Examples of stimuli (initial presentation and boundary extension).

Initial presentation   Showing boundary extension


There were two phases to the experiment, a presentation phase and a judgement phase. In the presentation phase participants were shown all 16 photographs one at a time in a random order. Each photograph was displayed at a certain magnification (112.5% or 81.25%). In the judgement phase participants were again shown each of the photos individually, however they were displayed at a different magnification level from how they appeared in the presentation phase. Participants were instructed to use the plus and minus buttons on the keyboard to zoom the scene in and out until it appeared to look the same as when they initially saw the stimuli. The program recorded the final size for all 16 images adjusted by the participants and also recorded the time taken to adjust each image.

Seventeen individuals with Asperger's Syndrome and their matched controls participated in this study as well as 20 typically developing adults (see table 4 for details).

Table 4: Participant Details

		Asperger's	**Asperger Match**	**Adults**
N		17	17	20
Age (yrs;mos)	Mean	14;0	13;6	26:1
	SD	2;0	1;7	8:8
	Range	9;7-16;5	10;11-15;8	18:11-53:7
VIQ	Mean	101.89	97.56	
	SD	13.64	11.91	
	Range	73-123	73-115	
PIQ	Mean	99.39	105.56	
	SD	16.14	13.82	
	Range	66-133	75-124	
FIQ	Mean	100.83	101.61	
	SD	14.52	12.73	
	Range	70-124	72-119	

The results of the Asperger matched control group have not yet been coded and analysed, therefore the analyses is restricted to those with Asperger's Syndrome and typically developing individuals. The mean boundary extension for all 16 photos (see table 5) and the mean time (see table 6) taken to carry out the entire task was calculated and analysed.

The results revealed no differences between groups in terms of boundary extension, but there were differences between groups in the mean time taken to perform the task. In all conditions except "cropped objects" individuals with autism made their judgements more quickly than typically developing adults. This may suggest that individuals with Asperger's Syndrome are more efficient when processing visual information from memory than typical adults. Further analyses need to be carried out comparing those with Asperger's Syndrome with their matched control group to see if there are boundary extension differences between these groups.

Table 5. Mean boundary extension.

Group	**Cropped**		**Uncropped**	
	Objects	**People**	**Objects**	**People**
Asperger	12.41	14.84	8.85	13.48
Adult Controls	5.16	16.09	14.69	9.06

Table 6. Mean time (msecs) to perform the task.

Group	**Cropped**		**Uncropped**	
	Objects	**People**	**Objects**	**People**
Asperger	10611.94	9715.69	8601.39	8727.36
Adult Controls	13080.00	13069.75	11286.63	11369.50

Experiment 4: Da Vinci window task

The aim of Experiment 4 was to investigate the influence of prior knowledge on perception of shape in individuals with and without Asperger's Syndrome. The paradigm was based on a procedure carried out by Reith and Dominin (1997) which requires participants to make judgements about the shape of a stimulus while viewing it through a Da Vinci window.

A Da Vinci window is an apparatus (see figure 6) which is meant to reduce the salience of the 3 dimensional depth cues when viewing an object in order to make it easier to reproduce it more accurately. The Da Vinci window consists of a wooden frame holding a transparent Plexiglas pane. However, apart from depth cues, one's prior knowledge about an object's properties also may cause us to perceive the object inaccurately (e.g. shape constancy). If individuals with Asperger's Syndrome are less affected by their prior knowledge as has been previously found, then we would expect them to be more accurate in judging shape on this task. Participants were seated at one end of a table in order to view a stimulus (i.e. box tilted at a 70^{o} angle) through a Da Vinci window (see figure 7).

Figure 6. Da Vinci window apparatus

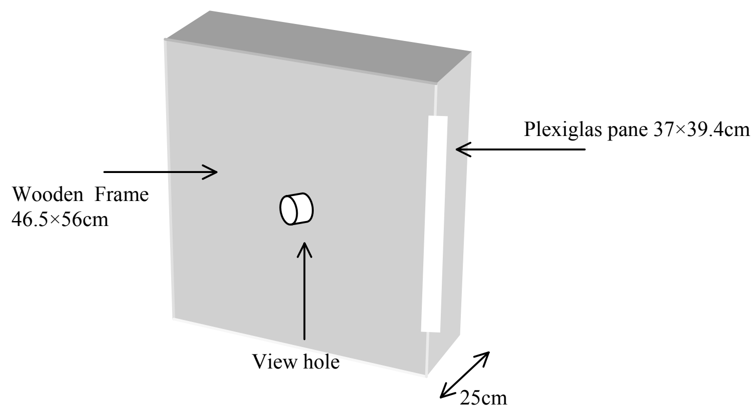
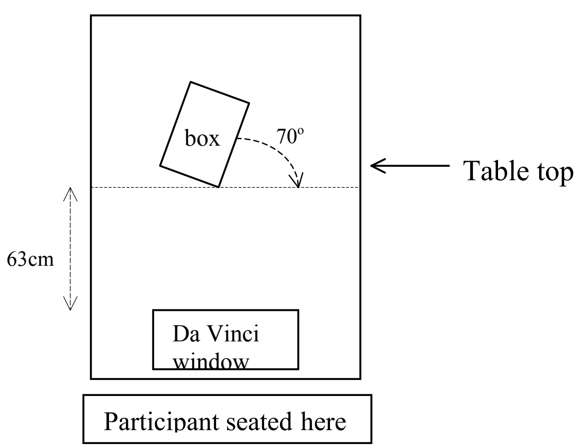
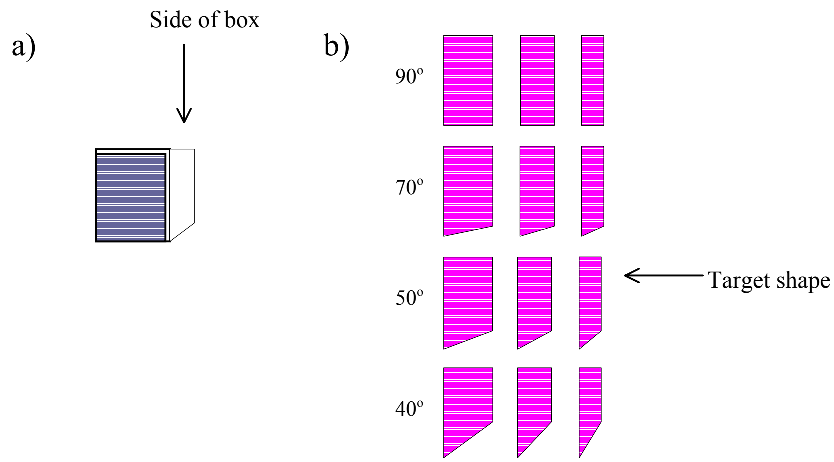


Figure 7. Arial view of experimental setup.



When participants looked though the viewing hole of the Da Vinci window the box stimulus appeared as it does in Figure 8a. Participants were then asked to select the shape which best matched the side of the box (projected shape of stimulus) from a number of coloured transparent forms (see figure 8b).

Figure 8. (a) Stimuli as viewed through Da Vinci window with arrow indicating side of box. (b)The coloured transparent forms presented to participants including the target shape.



The shape was then placed on the transparent Plexiglas window where the participants could check to see if it matched the projected shape of the side of the box. Participants were allowed to continue with this process until they found the shape they believed was the correct match. The number of attempts made before settling on the correct target shape was recorded as well as the time taken to successfully complete the task.

Participants included 16 individuals with Asperger's Syndrome who were matched with 16 controls (see table 7 for details). If those with Asperger's Syndrome are less influenced by their prior knowledge about stimuli, they should be able to identify the target shape in fewer trials and within a shorter period of time than control participants.

Table 7: Participant Details

	Asperger's	**Asperger Match**

N		16	16
Age (yrs;mos)	Mean	14;1	13;7
	SD	1;8	1;6
	Range	10;10-16;2	10;11-15;7
VIQ	Mean	100.75	97.63
	SD	13.70	12.65
	Range	73-123	73-115
PIQ	Mean	99.00	104.31
	SD	17.15	13.86
	Range	66-133	75-121
FIQ	Mean	100.00	101.10
	SD	15.16	13.32
	Range	70-124	72-119

Table 8. Results from Da Vinci task.

	Aspergers	**Asperger Match**
Number of participants correct on final trial	13/16	12/16
Mean time to complete task (SD)	116.64 (57.63)	118.00 (60.42)
Mean number of trials taken to reach target (SD)	3.94 (1.98)	4.38 (2.06)

Analyses revealed no significant differences between those with and without Asperger's Syndrome in the number of individuals who succeeded, in time taken to complete the task, or in the number of trials to reach the target shape.

These findings are inconsistent with our predictions and with our previous findings which suggest perceptual processing in individuals with Autistic Spectrum Disorder is less influenced by prior knowledge (Ropar & Mitchell, 2002; Sheppard task- ESRC grant).

There are at least 3 possible reasons which may explain the failure to find a difference between groups on the Da Vinci window task. Firstly, it may be that those with Asperger's Syndrome are influenced by their prior knowledge when estimating shape. However, in light of our previous findings suggesting otherwise, we believe that the results may be due to characteristics specific to the Da Vinci window paradigm. It could be that the task is not as sensitive as the other tasks (e.g. Sheppard & Ellipse tasks) which measure responses in very small increments (e.g. # of pixels). Alternatively, it is possible that depth cues were not completely eliminated in the task. Although binocular depth cues were eliminated from the task some monocular cues still remained. Since previous research (Ropar & Mitchell, 2002) has shown those with Asperger's Syndrome are equally affected by depth and perspective cues this may explain why they were not more accurate in judging shape on the Da Vinci task. Our plan is to continue to explore this area by devising various conditions that will allow us to discover which of these alternatives is correct.

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Activities & Outputs

Manuscripts in preparation

The influence of knowledge on perception of the Sheppard illusion in individuals with Autism Spectrum Disorder
– To be submitted by May, 2003

The influence of knowledge on drawing the Sheppard illusion in adults
-To be submitted by June, 2003

Do individuals with autism use meaning to assist recall of words and pictures?
-To be submitted by August, 2003

Are individuals with autism less susceptible to boundary extension?
- To be submitted by November, 2003

Perception through a Da Vinci window: The influence of prior knowledge and perspective cues in Asperger's Syndrome.
- To be submitted January, 2004

In the proposal, we stated our aim to publish in high impact international journals. The first paper we plan on submitting to the Journal of Child Psychology and Psychiatry and the second to the Journal of Experimental Psychology which are both journals which are held in high esteem. We believe that the rigorous methods used and the interesting results found in these studies will make them ideally suited to these journals.

<u>Conference and seminar presentations</u>
Invited to present research at Scottish Autism Research Group Seminar Series (SARG). March 2003- Glasgow, Scotland. "The influence of conceptual knowledge on perceptual processing in autism".

International meeting for autism research (IMFAR) - 2002 Orlando, Florida - poster presentation. "The role of prior knowledge in autistic perception."

British Psychological Society-Developmental Section 2002 Sussex - paper presentation "The influence of depth cues and prior knowledge in judgments of shape in autism".

Invited to present at workshop on autism at St John's College, Cambridge 26th-28th March, 2002 . Convened by Dr. Kate Plaisted and Dr. Dermot Bowler. Funded by the Wellcome trust. "Perceptual processing in autism".

<u>Invited talks</u>
Experimental Psychology, University of Oxford, January 2003
Psychology Department, University of Durham, February 2003
Cruckton School, Shrewsbury, April 2003

Impacts
It is rather soon to assess the impact of the work so far as it is has not yet been submitted for publication, however the research has been presented at number of conferences,

seminars, and Universities. On all of these occasions the work has received positive feedback and has instigated a lot of interest. The project has also received attention from the University as Ropar and Mitchell were interviewed about the research for an article which was published in the University Newsletter. This has resulted in a number of parents of autistic children and adults with Asperger's Syndrome contacting us to take part or learn more about the research.

The work also has an applicable impact in relation to research funded by the Shirley Foundation (Wilson, Benford, Mitchell, Cobb & Hopkins), in which we are investigating social skills training in individuals with Asperger's Syndrome, using virtual environments. Knowledge gained from the ESRC-funded project allowed us to make various assumptions which in turn informed the design of virtual environments. For example, the ESRC research suggests that individuals with autism/Asperger's Syndrome would have no difficulty with low level perceptual processes, such as those involving visual illusions (Experiment 2) or with perceiving depth and perspective cues (Experiment 4). This suggests that they would not have problems perceiving and understanding the virtual computer-based environments created by the Shirley Foundation project.

Future Research Priorities

The main priority is to follow up the questions that have arisen from this research project. Funding has been awarded to Mitchell, Ropar, and Cheng by the Bailey Thomas Trust fund to explore atypical perception and drawing expertise in autism, Asperger's Syndrome and Autistic savants. Our findings from this research might show less influence by conceptual knowledge across the autistic spectrum in varying degrees. They may also suggest that individuals with ASD are likely to excel in disciplines that require objective depiction, such as draughtsmanship.

A second priority is to explore how atypical perception may impact upon motor functioning. Ropar has been awarded funding as part of a New Lecturer's grant to collaborate with Professor Steve Jackson looking at perceptual motor skills in autism. Our findings from this research may reveal that motor difficulties found in Asperger's Syndrome and autism may be a result of atypical perceptual processing.

A third priority is to tackle the problem from a slightly different angle in an eye-tracking study. We can deduce different patterns of attentional focus from rival theories of visuo-spatial performance in autism, and this could be measured by tracking eye movements. Nottingham is a centre of excellence for eye-tracking research, arising from Professor Geoffrey Underwood's lab. Future plans include collaborating with Underwood to explore perceptual processing in autism.