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Drawing ability in autism:

a window into the imagination

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Abstract

This study investigated imagination via drawing tasks, in 15 children with autism and 15 children with Asperger Syndrome, compared to verbal mental age matched normal children and children with moderate learning difficulty (MLD). Experiment 1 used the Draw an Impossible Man task. Whilst children with autism were impaired relative to the normal group, they were not impaired relative to the children with MLD. In order to probe for an imagination deficit, Experiment 2 employed a more challenging measure of imaginative drawing, a task involving mixing categories to produce drawings of real or unreal entities (e.g., drawing half-fish/half-mouse). This revealed an autism-specific deficit. Experiment 3 confirmed this was not due to difficulties in combining elements per se. Experiment 4 required subjects to transform a picture (e.g., a cloud into a swan) and again found an autism-specific deficit. Children with Asperger Syndrome were only impaired when required to make such transformations spontaneously.

Autism is characterised by a 'triad' of features. A great deal of research has been conducted into two of these: the social and communication difficulties. However, the third symptom in the triad remains somewhat neglected: that of limited imaginative ability and restricted interests [1]. The few experimental investigations into this have mostly been concerned with the deficit in spontaneous pretend play (e.g. [2-5]. These suggest an imaginative deficit, but few studies have addressed imagination directly.

Our earlier study began to do this by assessing the ability of children with autism to imagine *unreal* objects [6] . This study was based on Karmiloff-Smith's [7] paradigm, where normally developing children were asked to draw a house and a man, and then asked to draw a *man that doesn't exist,* and a *house that doesn't exist.* For brevity, we refer to this as the Draw An Impossible Man Task. Karmiloff-Smith found that when drawing things that didn't exist, older normal children (8-10 yrs) introduced changes that included adding elements from other conceptual categories. Even younger normal children (4-6 yrs) deleted elements or changed the size and shape of elements. In contrast, we found that most children with autism had marked difficulties producing drawings of unreal objects. In fact, their drawings of real and unreal objects were remarkably similar [6].

The studies reported here had four aims: First, to test if our earlier results [6] replicate. Secondly, to test if the deficit on the Draw an Impossible Man Task is a developmental phenomenon (for example, a function of mental age). Thirdly, to test how children with autism perform on related tasks requiring imagination. Finally, to test if results differ if the diagnosis is Asperger Syndrome or autism. In Experiment 1, we therefore tested if the Scott and Baron-Cohen [6] findings replicated in a sample of children with autism with a higher verbal mental age, and if they extended to children with Asperger Syndrome (AS). Subsequent experiments (2-4) were planned to investigate production of imaginative drawings by children with autism and AS.

In the experiments reported here, rather than attempting to measure how imaginative a response is, we focus on drawings of *unreal entities* (e.g., a walking candle) and *unreal transformations* (e.g., turning a cloud into a swan). The contents of such drawings are, we think, unambiguously imaginary.

Participants

Four groups of children took part in the study. Their details are summarised in Table 1. The first was a group of 15 children with autism, all of whom met the standard diagnostic criteria [1]. The second was a group of 15 children with Asperger Syndrome (AS). AS was defined as meeting the criteria for autism but with no history of general cognitive or language delay. Children in both of these groups were diagnosed by independent clinicians and were attending special schools in Merseyside or Cambridgeshire. It should be noted that the lack of any cognitive delay at the time of diagnosis is what determined their diagnosis, even though some of these children were now clearly showing a discrepancy between their chronological age (CA) and verbal mental age (VMA). The third group comprised 15 children with moderate learning difficulties (MLD), attending a special school in Peterborough. Finally the fourth group were 15 normally developing children, all attending a primary school in Merseyside.

The autism group and moderate learning difficulty group were matched on VMA, calculated using the Test of Reception of Grammar [8], which is held to give a clearer estimate of language comprehension than does a simple vocabulary test. The AS group was matched with the autism group on chronological age and was included so as to test if the findings from the autism group were unique to that group or not. Inevitably, because AS by definition includes no history of language delay, the group with AS had a higher VMA than the autism group. Since limited imagination is a defining feature of both autism and AS, any similarities and possible differences between these syndromes merit attention. One child with autism was missing from Experiment 2. The adjusted CA of the autism sample in Experiment 2 was x = 12:8 (sd = 3:2) and the adjusted VMA was x = 6:7 (sd = 2:3).

insert Table 1 here

Design and procedure

The children were seen individually in a quiet, plain room in their school, or in a similar room in the section of Developmental Psychiatry in Cambridge. Each of these rooms had a window covered by blinds to minimise copying of visible objects in any of the four experiments reported.

Experiment 1: Draw An Impossible Man

Method

This experiment tested if the results from Scott and Baron-Cohen [6] could be replicated. The experimenter gave the child a pencil and paper and asked the child, *"Can you draw me a picture of a man?"* (A woman was equally acceptable if the child asked). The child was praised and the picture placed to one side. The experimenter then said, *"Now I want you to draw a man with two heads* ". In all stages of testing every picture produced was praised and the child was asked if the picture could be kept. Scoring followed their criteria. Scott and Baron-Cohen's control stimuli were not employed, since there was no need to check the subjects could understand the words "real" and "impossible", as these were not included in the instructions (see above).

Results

All children across groups were able to draw a picture of a man, and passed the Control Questions. Results from all of the Experiments are shown in Table 1. When the children where asked to draw an impossible man, the children with autism were significantly worse than the normally developing children, but did not differ from the children with MLD (Autism x Normal, $\chi^2 = 6$, $p<0.02$). No other group comparisons reached significance (all $p>0.05$). Examples of their drawings are shown in Figure 1. Inter-rater reliability for coding drawings of men as real or impossible (using Scott and Baron-Cohen's criteria) was high

(98%).

insert Figure 1 here

Discussion

This experiment set out to retest our earlier findings [6] that children with autism have difficulties in producing drawings of unreal entities. Results did not confirm these findings. Although the group with autism were significantly impaired relative to the normal group, they did not differ significantly from the MLD group. This difference between the Scott and Baron-Cohen study and the present one may be due to the children with autism in this study having a higher VMA (mean VMA = 6:9, relative to 4:11 in the Scott and Baron-Cohen [6] study). The lack of a group difference between the autism and MLD groups may also have been due to the small sample sizes. A further possibility is that no autism-specific deficit was seen here because of the simple instructions used ("Draw a man with two heads", instead of "Draw an impossible man", or "Draw a man that is not real", etc.,).

However, we would be wary of yet concluding that because 66.7% of the children with autism passed this test, that in autism there is no deficit in drawing imaginatively. This is because the test used in Experiment 1 may have been too low-level to reveal any autism-specific deficit - that is, inappropriate to this sample's developmental level. The same argument applies to the simplified tests used by Leevers and Harris [9]. In Experiment 2, we therefore used a more challenging test.

Experiment 2: Real vs Unreal category mixing

The aim of this second experiment was to test if children with autism and Asperger's Syndrome could produce drawings involving fusing representations of real objects to depict an unreal product. It is possible that combining representation of real entities (e.g. animals, boats, houses, etc.) into 'unreal' new forms, may be more challenging for them than the task in Experiment 1, and therefore might reveal an autism-specific deficit.

Method

'Real' category mixing

The experimenter gave the child a pencil and paper and asked the child to draw a house. When this was completed the experimenter asked the child to draw a boat. The experimenter then said, "Now I want you to draw a special kind of boat that people live in. It's a bit like a boat and a bit like a house. It's called a house-boat." This procedure was repeated using 'sofa' and 'bed', combining to make a 'sofa-bed'. We recognise that some children might never have seen a house-boat or a sofa-bed, but these are in principle 'real' entities, in contrast to the next type.

'Unreal' category mixing

The experimenter asked the child to draw a fish. Once this was completed, the child was asked to draw a mouse. No child had any difficulty with this pre-test. The experimenter then said “Now I want you to draw a strange animal that you might find in a story book - an animal that is half-fish and half-mouse”. The intention of the story book reference was to indicate to the child that a non-real response was acceptable, whilst avoiding terms such as ‘pretend’, so as not to disadvantage the children with autism, who may not understand such terms [10].This procedure was repeated using the topics of a pig and a tree. Half the sample received the ‘real’ combinations first, and half received the ‘unreal’ combinations first. We use the term ‘unreal’ for these, simply because these entities are in principle impossible.

Scoring

Combination drawings were scored as passing if on both trials in a given condition they met the criterion of representing a unified entity with elements of the two primary representations, e.g., the ‘fish’ - ‘mouse’ combination had to be drawn as one ‘animal’ with mouse and fish features. Children were scored as failing if they drew two separate real entities. All pictures were rated by 2 independent raters blind to the diagnoses of the individuals and to the aims of this study. Inter-rater reliability was 98.3%.

Results

All children across groups were able to draw the individual entities in both the real and unreal conditions.

Real category mixing: In this condition, where participants were asked to draw real combinations, the children with autism were not significantly worse than either the control group (Autism x MLD, $\chi^2 = 3.57$, $p > 0.05$; Autism x Normal, $\chi^2 = 3.57$, $p > 0.05$) or the children with AS (Autism x AS, $\chi^2 = 3.57 > 0.05$. Thus, no other group comparisons reached significance at the $p > 0.05$ level.

'Unreal' category mixing: In this condition, where participants were asked to draw 'unreal' combinations, the children with autism were significantly worse than both the control groups: Autism x MLD, $\chi^2 = 16.3$ $p<0.001$; Autism x Normal, $\chi^2 = 16.3$ $p<0.0001$. More of the children with AS produced impossible combination drawings than did children in the autism group (Autism x AS, $\chi^2 = 10.08$ $p<0.005$). No other group comparisons reached significance (all $p>0.05$).

Discussion

Experiment 1 found a deficit in children with autism drawing unreal entities only in relation to normally developing, but not MLD, controls. Experiment 2 however found that the children with autism were significantly impaired only when asked to draw unreal combinations. The tendency of this group was to draw two separate real entities. (Examples of their drawings are shown in Figure 2). Whilst we cannot conclude what caused this group difference, one possibility is that in autism there may be a problem representing unreal entities. To check that the deficit in Experiment 2 was not simply due to an inability to fuse two primary representations, we administered the Finke, Pinker and Farah [11] task of imagining what is created when 2 shapes are joined together (e.g., what is created when one joins a J with a D on its side? Answer: an umbrella). This is described in Experiment 3, next.

insert Figure 2 here

Experiment 3: Imagining Combinations

A simplified version of the Finke, Pinker and Farah [11] task was developed. This simplified version reduced short term visual memory demands, as piloting revealed that the original task was too difficult for children of this ability range. The modified test therefore used mainly familiar shapes rather than letters, involved no rotation, and the shapes were presented on a board in front of the child. However, the necessity of manipulating two representations in mind, to create a novel representation, remained.

Method

Participants were presented with a black plastic board and plastic shapes (semi-circle, circle, 2 triangles, square and a letter ‘j’). The experimenter asked the child to name all the shapes before proceeding. The experimenter then placed one shape (e.g., a square) on the board and asked the child to name it. Then he placed a second shape (e.g., a triangle) approximately 15 cm away from the first shape, and level with it on the board. Again the child was asked to name it. The experimenter then said, *"If I were to put the triangle on top of the square, what would it look like? What could it be?"* (Correct response: house). The child's answer was noted. The child was then asked if they would like to move the shapes into position. This was done in order to check that the child had understood the instructions. If the correct response had been given, or if an equally plausible one was given (e.g. a rocket), then the experimenter said, *"Yes, well done, it is a house (or an 'x')"*. If not, the child was given this opportunity to guess again, with the shapes in position. Any responses were noted. This procedure was repeated for the first five combinations shown in Figure 3.

The order of presentation of the first four combinations was randomised. The final trial was a recombination of the semi-circle and triangle, but with the shapes inverted (forming either an 'ice cream' or a 'boat'). The final trial was designed to test for any 'fixedness' of newly formed combinations, since in this way the participant could form two different novel representations from two primary representations (depending on whether they are inverted or not), or give the same response on both trials. Inability to inhibit should lead to the child making the inflexibility error (i.e. failing to generate both the ice-cream and the boat as response options). Two children from the MLD, autism and AS groups, and one child from the normal group failed to give a response to either the 5th or the 6th combinations, so their tendency to make an inflexibility error could not be assessed and they were removed from that part of the analysis.

insert Figure 3 here

Results

The maximum score was 6. One-way analysis of variance (ANOVA) was used to compare groups on numbers of correct responses. No significant differences were found ($F(3,56) = 2.25$, $p > 0.05$) overall. However, when participants were asked to recombine the previously combined shapes, triangle and semi-circle the autism group were significantly less flexible than both control groups. More of the autism group made the inflexibility error (giving the same response on both trials involving a semi-circle and a triangle), compared to the normally developing children and the children with MLD (Autism x Normal $\chi^2 = 8.82$ $p<0.01$; Autism x MLD $\chi^2 = 4.5$ $p<0.05$). 30.8% of the AS group also made the inflexibility error, but no other group differences reached significance (all $p>0.05$).

Discussion

It is clear from the results of Experiment 3 that the children with autism could join two primary representations just as well as did the controls. Thus, the impairment in Experiment 2 cannot simply be one of 'bolting'. This eliminates one hypothesis outlined earlier (that children with autism cannot fuse representations) but this leaves two other candidates: an executive dysfunction vs. a decoupling deficit. The executive dysfunction theory [12, 13] would suggest that children with autism are unable to produce unreal drawings because they cannot inhibit producing drawings of real things. In contrast, Leslie's [14] contention would presumably be that whilst children with autism can produce primary (real) representations that accurately represent the real world, they have difficulty processing decoupled representations. Decoupled in this sense implies decoupled from reality, such that these representations can be changed and manipulated in 'unreal' ways. The fact that the children with autism tended to make an error of inflexibility in Experiment 3 suggests that the executive dysfunction hypothesis may well be correct. However, the executive dysfunction hypothesis would predict difficulties irrespective of whether the task involved joining primary representations to form real or unreal things. This does not therefore easily explain the results of Experiment 2. In contrast, the decoupling hypothesis would predict difficulties only when combinations of primary representations produce unreal entities, since these are decoupled representations - they no longer have normal truth relations [14]. In the final Experiment below, we tested the decoupling theory further.

Experiment 4: Transforming a Picture

In this final experiment, participants were merely asked to make additions to pictures, taken from a set of 260 standardised pictures [15]. Once again, the type of transformations asked for were either real or unreal, and as will be seen, there were two levels of unreal transformation.

Method

The experimenter presented 4 pictures in each of 4 conditions, in the following order:

Condition 1: Real transformations. In this condition participants were shown 4 pictures, one at a time, and the experimenter asked the child to name the picture. For each picture the experimenter then asked the child to "*draw on the picture and make it into an x. Make it look like an x"*. These transformations were real in that the transformation could occur (e.g., turning a "bowl" into a "saucepan"). By 'real' here is meant that in the physical world, this transformation could be achieved. All work was praised and no time restrictions were imposed.

Condition 2: Unreal transformations. In this condition exactly the same procedure was used except that the transformations were in reality not possible (e.g., turning a "cloud" into a "swan"). 'Unreal' here implies that in the physical world this transformation could not be achieved. (Of course, in a drawing, any transformation can be achieved. Hence this definition.)

Condition 3: Unreal anthropomorphic transformations. The same procedure was used, with the transformations again being impossible but this time it was also anthropomorphic (e.g., turning a "light bulb" into a "crying light bulb").

Condition 4: Spontaneous transformations. The procedure was repeated except that the child was asked to invent their own transformation. The experimenter said, "*Now, this time I want you to choose what you are going to make the picture into. Try and make a picture of something completely different, something that we haven't done before."* This condition was included because it allowed the content of spontaneous transformations to be examined. As a measure of how imaginative their spontaneous transformation was, the number of transformations from (inanimate) artefacts to animate entities (people and animals) was recorded for each group. Producing an animate entity from an inanimate artefact is clearly only possible in the imagination. The number of transformations that changed category was noted. An example of a category change would be turning a "comb" into a "train". Turning a "comb" into a "brush" would not count as a category change. A fixed order of conditions was used, to go from levels assumed to be easier through to more difficult so as not to deter children from completing a many conditions as possible.

Scoring

Each child's drawings in each of the four conditions (4 drawings per condition) were scored as passing or failing and assigned a score of 1 or 0 respectively, yielding a possible maximum score of 4 per condition. Drawings were scored as failing if the requested transformation was not made. In Condition 4, simply changing a balloon into a stripey balloon would be counted as a fail as no category change has been made. All pictures were rated by 2 independent raters blind to the diagnoses of individuals and to the aims of this study. Inter-rater reliability was 100%. A criterion for passing on each condition of 2 or more was adopted.

Results

Significant group differences occurred only in the Unreal and the Spontaneous conditions.

Significantly fewer children with autism produced two or more of these unreal transformations, compared to children in all other groups (Autism x children with other groups, $\chi^2 = 6.2$. $p < 0.02$). Fewer children with autism also passed the Spontaneous Transformation condition (Autism x other groups, $\chi^2 = 4.61$. $p < 0.05$). The types of transformations made by each group in the Spontaneous condition are reported next.

Spontaneous Transformation condition

Analysis of the number of transformations involving a category change of any kind in the Spontaneous condition revealed a significant group effect: ANOVA ($F(3, 56) = 13.27$, $p < .0001$). Subsequent Tukey analysis revealed that the autism group differed significantly from the other groups at the .01 level. Since the AS group were not matched with other groups on VMA, an analysis of covariance was performed for number of transformations involving a category change of any kind x group, with VMA as the covariate. The main effect of group remained significant ($F(4,55) = 15.22$, $p < .001$).

When the type of category changes made were examined, significantly fewer children with autism (26.67%) produced any artefact to animate transformations at all, whereas 86.67% of the children with MLD, and 86.67% of the normally developing children did (Autism x MLD $\chi^2 = 18$ $p < 0.01$; Autism x Normal $\chi^2 = 18$ $p < 0.01$). Also, significantly fewer children with AS (20%) produced artefact to animate transformations relative to the control groups (AS x MLD $\chi^2 = 22.24$ $p < 0.01$; AS x Normal $\chi^2 = 22.24$ $p < 0.01$). Despite being told that any transformation would be permissible, far fewer transformations produced by the children with autism and AS involved this impossible category shift, i.e., artefact to animate. The children with autism in particular made far fewer transformations that changed category type at all. The tendency in both the clinical groups was to produce transformations that either failed to change the object at all, or that produced highly associated objects.

In the Spontaneous Transformation condition, when participants were asked to transform pictures into *'something completely different",* significantly more of the transformations produced by the children with autism (41.3%) were judged to be highly associated within-category transformations (e.g. transforming a 'kettle' into a 'teapot'). In comparison, only 8.47% of the transformations made by children with MLD and 10% of those made by normally developing children were highly associated transformations (Autism x MLD $\chi^2 = 28.85$ $p < 0.001$; Autism x Normal $\chi^2 = 25.69$ $p < 0.00$ 1). The AS group also produced a high proportion of highly associated transformations, 23.64% of their drawings being of this type, and this was significantly more than both control groups (AS x MLD $\chi^2 = 8.55$ $p < 0.005$; AS x Normal = 6.66 $p < 0.01$.) The difference between the autism and AS groups also reached significance (Autism x AS $\chi^2 = 7.11$ $p < 0.01$). Examples are shown in Figure 4.

insert Figure 4 here

Discussion

To recap, Experiment 2 suggests that difficulties in children with autism occur when they are asked to make transformations and combinations from two primary representations to form an *unreal* entity. Experiment 3 showed this was not due to the process of combining elements 'in mind' per se. Experiment 4 suggests that even when instructed what to turn the picture into, children with autism again only demonstrated problems with the unreal transformations. A group effect in the Spontaneous condition was also found: both the autism and AS groups produced far fewer unreal transformations and tended rather to produce highly associated within-category transformations. These results are predicted by the decoupling theory but are difficult for the executive dysfunction theory to explain.

It is interesting to note that whereas the vast majority of developmentally normal children and children with MLD made transformations of the artefact to animate type, very few of the children with autism or AS made any transformations of this kind. Keil found that children of all ages were willing to conceive of artefact to artefact transformations (e.g., bowl and saucepan) as possible. In contrast, artefacts to animate transformations (e.g., table to dog) were judged as impossible by the vast majority of 5 - 9 year old children [16]. We suspect that the reason the kindergarten children in the present study felt able to make these transformations, which they clearly knew to be impossible, was that they treated it as a game involving the imagination.

General Discussion

The experiments reported here pursue the theme that there is a specific impairment in children with autism in the ability to process non-veridical representations [6] . Experiment 1 found that whilst children with autism showed a deficit in performance compared to developmentally normal controls in their ability to draw a man with two heads, they were not significantly worse than MLD controls. This difference in results from Scott and Baron-Cohen [6] may reflect the difference in both the CA and MA of subjects.

When tested using a more challenging task, Experiment 2 showed that children with autism alone differed in their performance in combining two representations to form an unreal versus a real representation. Experiment 3 found that this deficit in performance was not likely to be due to a 'bolting' impairment (combining 2 elements), since children with autism were as able as controls to combine shapes to produce an object. Finally, Experiment 4 found that even when visual working memory load was reduced, by giving children a picture to make additions to, the children with autism were still impaired relative to controls in their ability to make impossible (unreal) transformations under instruction. It was also found in this experiment that both the children with autism and Asperger Syndrome (AS) produced far fewer imaginative, unreal transformations spontaneously and that both these groups tended to generate within a highly associated category set.

The children with AS performed at or near ceiling on each experiment, except in the Spontaneous condition in Experiment 4, where deficits common to both children with autism and AS became apparent, despite the differences in VMA. It should be noted that the impairment in the AS group was only evident when they were required to use their imagination spontaneously. Further research must address why this is the case. These results are consistent with the decoupling theory, though this does not rule out dysexecutive factors.

The present studies have some methodological weaknesses which could be overcome in future research. First, the MLD and normal groups achieve near 100% performance on most tasks, and it would be desirable to avoid such ceiling effects in the future. This was a result of designing the test to ensure that children with autism had every chance to pass. Whilst this does not affect the autism and AS deficits found in this paper, it means that differences between the MLD and normal groups could not be detected, if they exist. It also means that the ‘real’ and ‘unreal’ drawing tasks may have differed in difficulty even for the controls, but that this may have been masked. Secondly, whilst the present studies contain contrasting conditions, on some of these no autistic impairment was seen. It would therefore be useful to include additional control tasks, to test how broad the autistic deficits are. However, the current experiments validate the clinical diagnostic criterion that in autism and AS there is a specific deficit in the use of the imagination. We encourage new studies in this important area to disentangle what may be causing these.

Table 1: Results of all Experiments

	Autism	**Asperger Syndrome**	**MLD**	**Normal**
n	15	15	15	15
Mean CA (sd)	12:9 (3:1)	12:9 (2:6)	12:4 (2:4)	5:2 (2:7)
Mean VMA (sd)	6:9 (2:2)	9:10 (2:5)	6:9 (1:8)	-
No. (&%) passing Expt 1	10 (66.7%)	14 (93.3%)	13 (86.7%)	15 (100%)
No. (&%) passing Expt 2: Real condition Unreal condition	 11 (78.6%) 4 (28.6%)	 15 (100%) 13 (86.7%)	 15 (100%) 15 (100%)	 15 (100%) 15 (100%)
Mean no. of correct responses (& sd's) in Expt 3 (Range 0-6)	3.8 (1.6)	4.5 (0.8)	4.8 (1.3)	4.8 (1.0)
No. (&%) of subjects making flexibility error (Expt 3)	7/13† (53.8%)	4/13† (30.8%)	1/13† (7.7%)	1/14† (7.1%)
No. (&%) of children passing each condition (Expt 4): Condition 1 Condition 2 Condition 3 Condition 4	 14 (93.3%) 10 (66.7%) 9 (66.7%) 11 (73.3%)	 15 (100%) 15 (100%) 15 (100%) 15 (100%)	 15 (100%) 15 (100%) 15 (100%) 15 (100%)	 15 (100%) 15 (100%) 15 (100%) 15 (100%)
Mean no. of category changes made in Condition 4 (Expt 4) (sd)	1.13 (1.7)	2.7 (1.5)	3.5 (0.6)	3.5 (0.5)

†N.B. Only those participants who gave a response for the inverted figure, in Experiment 3, were included in the calculation of the flexibility error.

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