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ORIGINAL CONTRIBUTION

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Selective difficulty in recognising facial expressions of emotion in boys with ADHD

General performance impairments or specific problems in social cognition?

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Abstract Research on emotion understanding in ADHD shows inconsistent results. This study uses control methods to investigate two questions about recognition and understanding of emotional expressions in 36 five- to eleven-year-old boys with ADHD: [1] Do they find this task more difficult than judging non-emotional information from faces, thus suggesting a specific social-cognitive impairment? [2] Are their judgements about faces impaired by general limitations on task performance, such as impulsive responding? In Part 1, 19 boys with ADHD and 19 age-matched typically developing boys matched facial expressions of emotion to situations, and did a control non-emotional face-processing task. Boys with ADHD performed more poorly than age-matches on both tasks, but found the emotion task harder than the non-emotion task. In Part 2, 17 boys with ADHD and 13 five-to six-year-old typically developing boys performed the same tasks, but with an 'inhibitory scaffolding' procedure to prevent impulsive responding. Boys with ADHD performed as well as the younger controls on the non-emotional task, but still showed impairments in the emotion task. Boys with ADHD may show poorer task performance because of general cognitive factors, but also showed selective problems in matching facial emotions to situations.

Key words ADHD – emotion – social cognition – impulsiveness

Introduction

ADHD is a complex disorder and recent work emphasises the need for care in diagnosis, which will promote a clearer understanding of the nature of difficulties in ADHD [2]. In this paper, we investigate emotion understanding in ADHD with methods designed to assess the specificity of any difficulties. Problems in social relations, although not diagnostic of ADHD, are a very common feature in the condition: as many as 60% of such children are estimated to suffer such difficulty [13, 14]. Children with ADHD also have well-documented cognitive impairments (e.g. poor executive functioning, poor response inhibition) that may affect their performance on a wide range of tasks [8, 15]. In this paper, we consider whether children with ADHD have difficulty in processing social information, in this case recognising and understanding facial expressions of emotion, and whether any difficulties are due to general cognitive deficits or to a more specific impairment in processing information about emotions.

Despite the clinical picture, evidence about the nature and extent of social-cognitive impairment in ADHD is mixed: some studies report very minimal or

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no deficits while others report more substantial problems (e.g. 7, 9). Results may be inconsistent because of the wide range of social-cognitive skills studied, heterogeneity of samples, and limited sample sizes. In this paper, we investigate a more restricted but important social-cognitive skill: recognising and understanding facial expressions of emotion. Understanding what emotions others are experiencing is important in moderating one's social behaviour: for example, is a friend becoming upset at being teased, or are they enjoying it, is an observer excited or frightened by an act of bravado?

Some recent research suggests that children with ADHD may have problems in processing emotion. Downs and Smith [4] reported an unpredicted deficit in emotion understanding among five- to nine-year-old boys with combined ADHD and oppositional defiant disorder (ODD). These boys tended to perform more poorly than non-clinical and autistic boys on emotion tasks that required labelling facial expressions and matching emotion labels to verbally described situations in increasingly complex situations. Singh et al. [16] reported that children with ADHD have deficits in recognising facial expressions of emotion. They tested 50 five- to thirteen-year-old children (32% girls) on photographs of six basic emotional expressions: fear, anger, sadness, disgust, happiness and surprise. Vignettes gave brief definitions, for example, 'If you've done something that someone told you not to do, that person would be displeased with you. They would be angry' ([16], p.133). Children then indicated which photograph showed the emotion described. Average correct identification was 74%, which Singh et al. contrast with an 89% correct response rate found in a separate study of typically developing children.

Such deficits in emotion understanding might reflect primary difficulties in social cognition or secondary consequences of more general cognitive dysfunctions, such as inattention and impulsiveness. In other disorders, such as autism, social impairments have been explained in these contrasting ways, as primary social-cognitive difficulties (e.g. lack of a theory of mind; 1) and in terms of general cognitive dysfunction (e.g. lack of central coherence; 6). Distinguishing these types of explanation is a particularly crucial issue in relation to ADHD, where general cognitive dysfunctions are defining symptoms of the disorder. It is therefore important in ADHD research to include control tasks that require similar levels of attention and motivation but do not involve emotional content, and to assess the influence of cognitive constraints on overall performance in experimental tasks.

In this paper, we compare judgements of emotion from facial expressions with a control task requiring non-emotion judgements of faces (Part 1), to assess whether boys with ADHD had any specific impairment in judging emotions. We also compare performance on these two tasks with a 'scaffolded' version of the tasks designed to discourage impulsive responding (Part 2), as such responding could selectively impair the performance of boys with ADHD. The clinical group were randomly assigned to Part 1 or Part 2. Because we used a different control group for each part, we report the study in separate sections for the two parts of the study.

Participants

Clinical group

36 boys with ADHD were recruited from the first 59 children seen at a specialist ADHD clinic in a primarily rural region of south–east England. The children referred to the clinic had already been diagnosed with ADHD but the clinic provided a full review of diagnosis using DSM-IV criteria, a full history and interview with parent and child by a child psychiatrist and full assessment from an educational psychologist specialising in ADHD. Diagnosis was not confirmed for any case where there were other factors that would explain the presenting behaviour. The 36 boys were those of the 59 whose diagnosis was confirmed and whose parents agreed to take part in the research study. Parents who refused cited as a primary reason the difficulty in travelling to the testing laboratory. All but one boy in Part 1 were taking rapid-acting preparations of methylphenidate for their condition, but none had taken medication on the day of testing, which was always at a weekend, when most did not normally take any medication. All boys in this group scored average or above for their age on the block design and vocabulary subtests of the Wechsler Intelligence Scale for Children (WISC: [18]), protecting against the possibility of failure as a result of general learning difficulties. There were no significant differences in either subtest between children participating in Part 1 and Part 2, both $Fs < 1$.

Typically developing groups

Two groups of boys were recruited, for Part 1 and Part 2 of the study, from two semi-rural schools in the same geographical area as the clinic. All had been identified by their teachers as having no learning disabilities or attentional problems and no registered special needs. Specific details for each group are given in the appropriate section below.

Part 1: Comparison of emotion and non-emotion judgements of faces

In seeking appropriate control tasks to assess understanding of emotion expression in ADHD, it is

instructive to look at the literature on autism, where understanding facial expressions of emotion has been a focus of research for many years (e.g. 3, 12). Hobson, Ouston and Lee [12] argued that children with autism have difficulty specifically in perceiving facial expressions of emotion, while other accounts, such as central coherence theory [6], would posit that poor emotion recognition results from a more general perceptual tendency to process any complex stimulus in a fragmentary rather than an integrated way. This debate shows the importance of using control tasks to test whether difficulties in emotion recognition are the result of general perceptual or cognitive limitations rather than specific difficulties with emotions.

Such control tasks have not been widely used in studies of emotion understanding in ADHD, but they are common in research with autistic children (e.g. see [11] for a discussion of methods). In choosing a control task, we required a task that involved making non-emotional judgements of faces parallel to the emotion task. Our emotion task, described in full below, required some inferential skill (e.g. inferring that someone finding a mouldy yogurt in their lunchbox would be disgusted). Our control non-emotional task therefore also needed to involve some inference. We developed a control task that required children to make an inference about a physical property of a face, based on the ideas of Davies et al. [3]: for example, one can infer that someone with a sticking plaster on their face may have been scratched.

Method

Participants

Nineteen boys from the clinical group described above, with an average age of 8 years 11 months (range 5 years 10 months–11 years 9 months). On average, this group scored below the fifth percentile on the attentiveness dimension of the ACTeRS parent ratings [17] covering independence in remaining on-task, persistence and following instructions, and all were below the 20th percentile. They were also on average above the 90th percentile on ACTeRS-rated hyperactivity (rating fidgeting, irritability, impulsiveness and restlessness), with all individual scores above the 80th percentile. Five of the boys had an additional diagnosis of Oppositional Defiant Disorder (ODD). The 19 typically developing boys, recruited as described above, had a mean age of 8 years 11 months (range 7 years 2 months–11 years 0 month).

Table 1 Description of pictures used for each situation

Emotion situations:
Happy: Thomas has just found his lost puppy
Sad: Thomas has just lost his favourite video
Angry: Thomas has just found his little brother tearing his book
Surprised: Thomas has just found an apple on an orange tree
Frightened: Thomas has just seen a big spider jumping out
Disgusted: Thomas has just found a mouldy yogurt in his lunchbox
Non-emotional situations:
Hot (Sunglasses): Thomas has just been out in the sunshine
Cold (Woolly hat): Thomas is just going out in the snow
Wet (Wet hair): Thomas has just come in from the rain
Ill (Thermometer in mouth): Thomas is not feeling well
Scratch (Sticking plaster on face): Thomas has just scratched his face
Safe (Safety helmet): Thomas is just going near some falling rocks

Materials

Children saw one set of six photographs for the emotion task, and a further set of six photographs for the non-emotional task. The content of the photographs and the associated situations are given in Table 1. The photographs were colour 4-inch × 6-inch prints posed by an 11-year-old boy who had been given both the emotion label and the situation for the emotion tasks, and a range of props, as shown in Table 1, for the non-emotion tasks. Facial expressions for the non-emotion tasks were posed as neutral. All the photographs were judged correctly by a sample of 5 adults.

Design and procedure

Clinic children were tested individually in a university laboratory. The task was part of a battery of tests of social and cognitive function and was presented in a random order. Children were given breaks at set points and as otherwise required, although all completed the current task within a single session. The control children were tested individually in a single session at their school on the same task, which was randomly ordered in a battery of tasks. All testing was performed by one of three female experimenters.

The non-emotional and emotion matching tasks were presented in random order. Within each task, the presentation order of the six situations was randomised. For each task, the six photographs were arranged in a 3×2 array, in random order. The experimenter explained, "Here are six pictures of Thomas. I'm going to tell you some things that happened to Thomas, and I want you to choose the right picture for each thing that happened. The first thing that happened is that ...". Then the experimenter read out a situation and the child's task was to point to the face that best fitted the situation. Children were given a score of one for each face correctly matched, with a

Table 2 Means and SD (in parentheses) for non-emotional and emotional situation-matching tasks in ADHD and control groups: Study 1 (max. score = 6)

	Non-emotional	Emotional
ADHD (n = 19)	3.16 (2.52)	1.79 (2.30)
Control (n = 19)	5.95 (0.23)	5.31 (1.00)

Table 3 Percentage of children in each group choosing correctly for each situation for (a) emotional and (b) non-emotional matching tasks: Study 1

(a)	Happiness	Sadness	Disgust	Surprise	Anger	Fear
ADHD (n = 19)	31.6	42.1	31.6	21.0	26.3	26.3
Control (n = 19)	94.7	78.9	94.7	78.9	94.7	89.5
(b)	Hot	Cold	Wet	Ill	Scratched	Safe
ADHD	94.7	42.1	42.1	42.1	52.6	42.1
Control	100	100	100	100	94.	100

total score of six for the emotion set and six for the non-emotion set.

Results

The mean scores for each group on the non-emotion and emotion tasks are shown in Table 2. A repeated-measures ANOVA with group (clinical or typical) between subjects and task type (non-emotion and emotion) within subjects showed a main effect of group, with the ADHD group performing more poorly overall, F (1, 36) = 35.28, $P < 0.001$. There was also a main effect of task, F (1, 36) = 19.31, $P < 0.001$, with the non-emotion task being easier than the emotion task. Although the difference between non-emotion and emotion tasks was greater for the clinical than for the control group, the interaction between task and group was not significant, F (1, 36) = 2.62, $P > 0.10$. The power of this comparison is probably affected by the close-to-ceiling performance of the control group. Variability for the clinical group was greater than for the controls, and this variability is not explained by the wider age range of the boys with ADHD: there were no significant correlations between performance and age within the two groups or across both combined.

Scores for the individual items are shown in Table 3. Any differences should be interpreted with caution, since there was only one item for each emotion. Guessing the correct item given six choices yields a 17% chance of correct responding on each trial. The overall level of guessing can only be approximated: children could point to the same face more than once, although they only rarely did so. Levels of performance in ADHD were generally similar over the different emotions (30–40% correct) except for surprise, which was markedly poorer (21% correct). Performance in ADHD across the non-emotion items was also fairly similar, with correct responding between 40–50%, except for the 'hot' item, answered correctly by nearly all children.

There were no significant performance differences in the ADHD group between those diagnosed with ODD and those not, consistent with other findings showing no distinction in executive functioning between ADHD with and without ODD [7].

Discussion

Overall, boys with ADHD performed more poorly than the control group in matching faces to situations. Also, performance on the emotion-matching task was lower than on the non-emotion task. In the absence of a control task, the results might have suggested an emotion recognition deficit in boys with ADHD. However, these findings alone do not provide clear evidence that children with ADHD have difficulty specifically in matching facial expressions of emotions to situations. The use of a control task showed that they also performed poorly when making judgements about non-emotional characteristics of faces. This result highlights the importance of including control tasks.

The experimenters noted informally that for the ADHD group, children tended to respond quickly and apparently impulsively, without carefully scanning the whole set of photographs. This group therefore seemed disadvantaged by the inability to inhibit responding. This is consistent with the proposal of Oosterlaan and Sergeant [15] that children with ADHD have difficulties in self-regulation of responses, and in regulating response inhibition [8], that would affect their task performance generally. We investigate this possibility in Part 2 by assessing the influence on task performance of a procedure to help children inhibit impulsive responding.

Part 2: Influence on face judgements of inhibiting impulsive responding

The questions raised for Part 2 were twofold. Firstly, we wanted to check whether the ADHD group may be disadvantaged overall by impulsive responding and poor self-regulation of responses. We altered the task to provide a form of scaffolding to discourage impulsive responding, in an attempt to overcome these limitations and to provide a purer measure of children's ability to match emotional expressions to

situations. Secondly, we assessed whether poor performance on emotion tasks in Part 1 could be a result of not recognising the emotions displayed in the photographs.

Typically developing children in Part 1 showed performance on both face-matching tasks that was close to ceiling. One possibility is that the boys with ADHD performed below age-appropriate levels because the task was generally attention demanding. In the second part of the study, we therefore included a control group of younger typically developing children, in an attempt to equate the overall level of performance in the two groups.

Method

Participants

17 boys with ADHD from the clinical group of 36 described above. None had taken part in Part 1 and none had co-morbid ODD. Average age was 8 years 2 months (range 5 years 8 months–10 years 6 months). The group was on average below the 10th percentile on ACTeRS attention and hyperactivity, and each child fell below the 20th percentile for hyperactivity. All except two children fell below the 20th percentile for attention, but there were two outliers who were predominantly hyperactive rather than inattentive. A control group of 13 boys, recruited as described earlier, had a mean age of 5 years 5 months (range 5 years 0 month–6 years), significantly younger than the clinical group, F (1, 29) = 36.44, $p < .0001$. Materials were the same as those used in Part 1.

Design and procedure

Children with ADHD were tested individually in a university laboratory by a female experimenter and control children were tested individually at school by the same experimenter. The tasks were embedded in random order within a battery of tests, as in Part 1, with the emotion and non-emotion set adjacent in a random order, the photographs laid out in a random 3×2 array, and the questions within each set randomly ordered. The inhibitory scaffolding was achieved by the experimenter saying: 'Now, don't point to any of the pictures until you've looked at each one carefully. Which picture do you think is the one where Thomas has just ....? This one (pointing to the first), this one (pointing to the second)...', through all six pictures in the set, until each picture had been brought to his attention. If necessary, the experimenter prevented the child from choosing before all six pictures had been indicated, by moving his hand away from the pictures. At the end of the emotion task, if the child had failed on any of the items, the experimenter gave him the six emotion labels and, using the scaffolding procedure again, asked him to label each of the six emotional expressions.

Table 4 Means and standard deviations (in parentheses) for non-emotional and emotional situation-matching tasks in ADHD and control groups: Study 2 (max score = 6)

	Non-emotional	Emotional
ADHD (n = 17)	5.65 (0.86)	2.53 (2.50)
Control (n = 13)	5.07 (2.06)	4.31 (1.31)

Results

The mean correct situation-matching responses for each group on the two tasks are shown in Table 4. We performed an ANOVA with task (non-emotion or emotion) within subjects and client group between subjects. Unlike in Part 1, which used an age-matched control group, there was no overall difference between performance in the clinical and the younger control group, F (1, 28) = 1.31, n.s. Performance on the emotion matching task was significantly poorer than that on the non-emotion task, F (1, 28) = 22.57, $P < 0.001$. Of most interest was the significant interaction between group and task, F (1, 28) = 8.24, $P < 0.01$. The ADHD group was no worse than the control group on the non-emotion task, but poorer than the control group on the emotion task. This was confirmed by the significant difference between the emotion and non-emotion task for the ADHD group, t (16) = 5.62, $P < 0.001$, and the lack of difference for the control group, t (12) = 1.3, n.s. The clinical group thus showed a greater lag on the emotion task relative to the non-emotion one than did the control children. Although the boys with ADHD scored higher on this task than the ADHD group in Study 1, who received no scaffolding, they were well below the level of performance shown by the control group of 5–6-year-olds.

As the ADHD boys in the two parts of the study were recruited together and randomly allocated to condition, we can directly compare performance in the two subgroups. The clinical group in Part 2 was slightly but non-significantly younger than that in Part 1, F (34) = 1.76. An ANOVA on scores for boys with ADHD only, with task (emotional or non-emotional) within subjects and condition (inhibitory

Table 5 Mean percentage of children responding correctly for each emotion on (a) situation-matching and (b) labelling tasks: Study 2

	Happiness	Sadness	Disgust	Surprise	Anger	Fear
Situation Matching						
ADHD (n = 17)	58.8	41.1	52.9	29.4	29.4	41.2
Control (n = 13)	92.3	61.5	92.3	46.1	53.8	84.6
Labelling						
ADHD	100	76.2	85.7	85.7	95.2	66.6
Control	100	100	100	100	100	100

scaffolding absent – Part 1, or present – Part 2) between subjects, showed that, as expected, children did better in the scaffolded condition than the unscaffolded one, F (1, 34) = 6.29, $P < 0.05$, and that the non-emotional task was easier than the emotion task, F (1, 34) = 44.43, $P < 0.001$. There was also a significant interaction between task and condition, F (1, 34) = 6.75, $P < 0.01$: in boys with ADHD, the improvement made by scaffolding was significantly greater for the non-emotion task than for the emotion task.

Performance on individual non-emotion items, shown in Table 5, was uniformly high. For emotion items, the order of difficulty of each emotion was quite similar for the two groups, although control children scored higher than the clinical group for each emotion.

One possible reason for failure on the emotion situation-matching task is that children had a more basic difficulty in fitting labels to facial expressions of emotion. However, the present results do not provide strong support for this: those children with ADHD who failed any situation-matching task were still able to label the emotional expressions correctly in 85% of cases. Average labelling scores for each emotion are shown in the lower half of Table 5.

Discussion

In Part 2, the scaffolding procedure was clearly effective in improving performance for boys with ADHD, since they performed markedly better than their counterparts in Part 1. However, the effect of the scaffolding was group- and task-specific: it helped the clinical group more in the non-emotion task than in the emotion task. This suggests that while inhibitory scaffolding may help children with ADHD overcome their general impulsiveness, and make non-emotional inferences at a level comparable to typically developing children of a similar age, they still found it harder to match emotion-eliciting situations to facial expressions. This pattern of results is consistent with the idea that children with ADHD are hampered in processing emotional information not just by general cognitive limitations, but also by impairment in understanding links between expressed emotions and situations. This is also consistent with recent research in adults with ADHD showing deficits in emotion understanding relative to non-social perceptual and cognitive processing [5].

Absolute levels of performance for the ADHD group on the emotion tasks were low, although not at chance levels. They were substantially lower than in the study by Singh et al. [16], probably because of differences between the studies in task requirements. Singh et al. required their subjects only to match faces to an emotion label. We did not give children a label, but asked them to match the facial expression to a situation, a task that is probably more similar to an everyday situation. This interpretation of the task differences is supported by the fact that boys with ADHD in Part 2 did as well as reported in [16] on labelling emotions. It seems unlikely that the children in our study did so poorly on judging emotions from situations because of a general difficulty in drawing inferences, since they performed more adequately on the non-emotional inference task. Perhaps the children had learned simple expression-label matches but had more difficulty in recognising the significance of emotions in specific contexts. This pattern is similar, although less severe, than the pattern of problems shown in autism [10].

The present results also suggest there is a discrepancy between the ability to attach labels to facial expressions of emotion and that of matching an emotional expression to an appropriate situation. This has implications for assessing emotion understanding in special populations. A superficial analysis based on labelling could suggest that a child understands emotion, but this labelling may reflect rote association of an expression with a label, without a good understanding of how emotions relate to situations. Several studies of emotion understanding, which showed minimal differences between controls and children with ADHD have used measures that primarily involve labelling, rather than matching emotions to situations (e.g. [16]). It is important to assess whether the ability to label an emotion is supported by an ability to match to situations. Impairment in matching emotions to situations might help explain why children with ADHD may recognise an expression, say, of distress in a peer, but do not connect this expression to the concurrent situation.

Clearly, this small study has several limitations which urge caution in interpretation of the results: the sample size is small, and we only used one example of each facial expression, so further work with a variety

of tasks and larger sample sizes is needed. Also, the group of children with ADHD would have had some heterogeneity: although we checked for learning disability, ODD and co-morbid disorders that would have explained ADHD-like symptoms, the clinical group will have varied in aspects that may have affected their performance, such as levels of emotionality and of hyperactivity. However, the results do show the value of control tasks in testing hypotheses about the source of difficulties in emotion processing for this group.

The present results suggest that boys with ADHD have both a general difficulty in attending to the tasks used, and a selective difficulty in processing information about facially expressed emotions. General cognitive impairment (e.g. in inhibitory control) might be posited to account for the difficulties children have in addressing themselves to the tasks used. However, the results suggest that matching emotions to situations poses extra difficulties, since performance on emotion matching specifically was not much improved by providing inhibitory scaffolding. This has implications for explaining the peer problems experienced by many children with ADHD. Some problems with peers might be expected because of the behavioural difficulties experienced by children with ADHD, but the current results suggest that problems in assessing the link of emotions and situations might also contribute. This question could be clarified by further work into behaviour and emotion understanding in children with ADHD with and without clear social impairments. Whatever the primary cause, it is likely that any social-cognitive deficits would become part of a vicious spiral in which children with ADHD are less likely to experience constructive social interaction in which to develop further insights into others' emotions.

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