Psychological Medicine, 1999, **29**, 1405–1410. Printed in the United Kingdom

Can children with autistic spectrum disorders perceive affect in music? An experimental investigation

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ABSTRACT

Background. Children with autistic spectrum disorders typically show impairments in processing affective information within social and interpersonal domains. It has yet to be established whether such difficulties persist in the area of music; a domain which is characteristically rich in emotional content.

Methods. Fourteen children with autism and Asperger syndrome and their age and intelligence matched controls were tested for their ability to identify the affective connotations of melodies in the major or minor musical mode. They were required to match musical fragments with schematic representations of happy and sad faces.

Results. The groups did not differ in their ability to ascribe the musical examples to the two affective categories.

Conclusions. In contrast to their performance within social and interpersonal domains, children with autistic disorders showed no deficits in processing affect in musical stimuli.

INTRODUCTION

In a recent series of studies we investigated musical cognition in a group of musically naive children with autism (Heaton *et al*. 1998, 1999*a*). Overall, the findings from these studies suggest that for these individuals the perception of musical stimuli is intact and in some instances enhanced. For example, we have found enhanced pitch memory, interval discrimination and chord disembedding (Heaton *et al*. 1999*b*). However, music involves other aspects as well as perceptual/cognitive ones and in the experiment to be reported here a first attempt will be made to examine emotional responses to music.

Umemoto (1990) suggests that the psychological structure of music can be divided into four interacting musical dimensions that correspond to different levels of perception and cognition. In the first dimension there is identification and discrimination of tones, in the second the perception of melody, rhythm and harmony occurs, in the third there is comprehension of compositional structure by analysis and in the fourth the emotional cognition or empathic understanding of the meaning, character or script of a composition occurs. The notion that full appreciation of musical meaning necessarily involves an emotional or empathic reaction on the part of the listener is widely held, indeed Aiello (1994) suggests that we listen to music in order to partake of the emotional and aesthetic experience that it offers, and it is at this level that music becomes meaningful.

It is of relevance here to consider some musical mechanisms by which emotion is conveyed to listeners. It has been suggested (Kivy, 1980; Davies, 1994) that the 'natural expressiveness' in a musical composition arises as a result of surface resemblances between musical elements (e.g. melody, rhythm, metre, tempo) and human actions (movement, gait, carriage). Thus, *legato*

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music is perceived as peaceful and gentle while compositions with *staccato* articulation are considered to be lively and energetic (Wedin, 1972). Other aspects of musical compositions that are rooted in stylistic conventions, for example patterns of tension and resolution and deviations from musical expectancies (Meyer, 1956) might be similarly expressive but only for the more musically sophisticated listener.

In Western music, musical mode is highly suggestive of emotion, with the major mode having a positive connotation and the minor mode having a negative one. It has been suggested that this effect may depend upon acoustic spectral differences in the major and minor triads (Helmholtz, 1877) although some researchers believe that these associations are culturally acquired rather than having a physiological basis (Davies, 1994; Kivy, 1980). However, that these connotations are found among the musical unsophisticated was demonstrated long ago (Heinlein, 1928) and has more recently been observed in infants as young as 3 years of age (Kastner & Crowder, 1980).

Questions concerning the understanding of affective meaning are of particular relevance when considering the case of children with autism. The earliest descriptions of these children highlighted a lack of responsiveness to those around them (Kanner, 1943) and more recently Hobson (1989, 1990, 1993) has suggested that affective and interpersonal deficits are the core impairments in autism. A range of studies have shown that people with autism experience difficulties in recognizing emotional expressions on faces (Scott, 1985; Hobson, 1986*a*, *b*; Hobson *et al.* 1989; MacDonald *et al.* 1989; Bormann-Kischkel *et al.* 1995; Tantam *et al.* 1989; Ozonoff *et al.* 1990) and between faces and voices (e.g. Hobson *et al.* 1989; Loveland *et al.* 1994). The question to be addressed here is whether the deficits in emotional processing observed among those with autism will be manifested within the musical domain.

METHOD

Participants

Twelve children with autism and two children with Asperger syndrome participated in the experiment. The children were aged between 7 years 9 months and 15 years (mean: 10 years 9 months). Their scores on the Raven's Progressive Matrices Test (Raven *et al.* 1988) ranged between 87 and 147 (mean: 108) and their scores on the Peabody Picture Vocabulary Test (Dunn, 1965) ranged between 56 and 126 (mean: 92·71). Two of the children with autism had verbal IQ scores of 56 and the individual scores for the rest of the sample fell approximately within the normal range. The subjects in the two non-autistic control groups were matched to the children with autism on an individual basis for chronological age, gender and either performance on the Peabody Picture Vocabulary Test (Group 2) or the Raven's Matrices (Group 3). Two of the participants in the verbal IQ matched control group attend a school for children with moderate learning difficulties and the remaining children attend mainstream schools. The subject's psychometric and age data are shown in Table 1.

Materials

Visual stimuli

Two schematic faces, one with a happy and the other with a sad expression were used in the experiment and are shown in Fig. 1. The children were also supplied with a 'HAPPY' and a 'SAD' label, to be paired with the appropriate picture.

Auditory stimuli

As previously suggested many musical aspects, including rhythm, tempo and dynamics, contribute to the mood of a composition. As this study is specifically concerned with musical mode these features were controlled as far as was possible. Thus, twenty-four newly composed, four bar melodies were used in the experiment. Each one was similarly structured, having a simple tonic, dominant, tonic progression (1–V–1). Four versions of each melody were generated and were as follows: (1) harmonized major mode (with 1–V–1 chords); (2) harmonized minor mode (with 1–V–1 chords); (3) major tune; and (4) minor tune. An example of one set of stimuli is shown in Fig. 2.

The 96 versions were played on an electronic keyboard (piano setting) and subjected to a 'logic' procedure, which ensures equality of note length and tone quality. They were randomized across keys, and presented at the same moderate speed, with none encompassing more that one octave or varying with regard to

https://doi.org/10.1017/S0033291799001221 Published online by Cambridge University Press

Table 1. *Psychometric and age data for experimental subjects*

Group	Mean age	Peabody Picture Vocabulary Score		Raven's Matrices Score	
		Mean	(S.D.)	Mean	(S.D.)
1 Children with autism	10 years 9 months	92·71	(21·08)	108	(2·15)
2 Verbal IQ matched controls	10 years 9 months	92·85	(16·50)		
2 Non-verbal IQ matched controls	10 years 6 months			108·28	(2·13)

* *t* tests revealed no significant differences between the autistic and control groups on the matching variables.

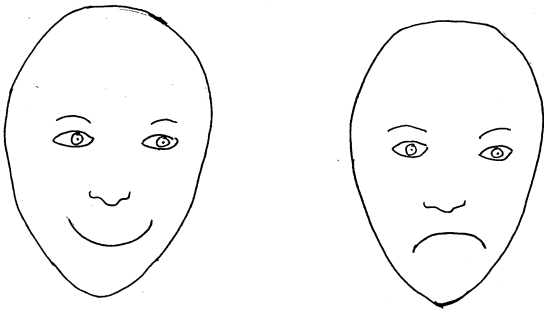
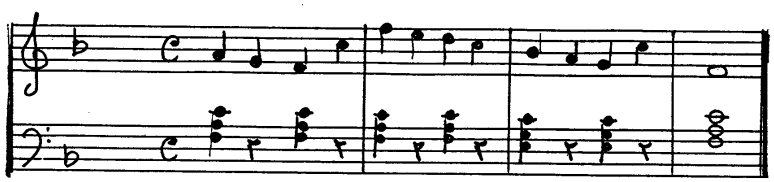


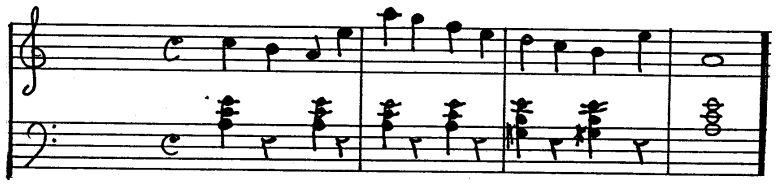
FIG. 1. Schematic representations of happy and sad faces.

dynamic range (loud to soft) or pitch height. They were then recorded onto four DAT tapes, each of which included six melodies for each condition (condition 1, harmonized major; condition 2, harmonized minor; condition 3, major tune; condition 4, minor tune). No tune was ever repeated on the tape. Thus, if a tune appeared in the accompanied major condition on tape 1, it would be in the accompanied minor condition, the major tune condition and the minor tune condition on tapes 2, 3 and 4 respectively. Which of the four tapes was heard by any particular child was counterbalanced across groups.

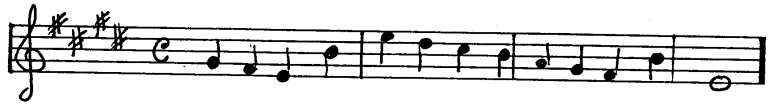
(1) Harmonized mode



(2) Harmonized minor mode



(3) Major mode tune



(4) Minor mode tune

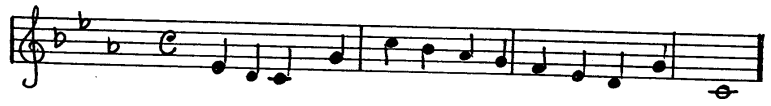


FIG. 2. Examples of musical stimuli used in the experiment.

https://doi.org/10.1017/S0033291799001221 Published online by Cambridge University Press

Procedure

Testing for all but one subject, who was seen at home, was carried out at school. The children were tested individually and all attempts were made to avoid disrupting peripheral noise. They were first presented with the two schematic face pictures for identification and were asked 'what does this face look like?'. All but one autistic child immediately labelled the faces as 'happy' or 'sad' as did the controls. The children were then shown the verbal labels and asked to put them with the faces. Some of the children who participated in the experiment had low verbal IQ scores and as no information was available about their reading level, the experimenter read out the words for these children. However, as these children had very readily identified the schematic faces they were included in the experiment. After identification of the visual stimuli, the children were told that they were going to listen to some tunes, and that they should indicate, either by pointing or saying, whether these were happy or sad. They were then presented with one of the four DAT tapes. All responses were recorded by the experimenter.

RESULTS

The means and standard deviations for correctly matching schematic faces with musical mode are shown in Table 2. In this experiment a total score of 12 could be achieved by chance, and therefore a one sample t test comparing this to each of the individual obtained total scores was carried out on the data. The results showed that scores were significantly above chance (children with autism $t = 5{\cdot}44$, df, 13, $P < 0{\cdot}001$; group 2, $t = 4{\cdot}15$, df, 13, $P < 0{\cdot}001$; group 3, $t = 8{\cdot}35$, df, 13, $P < 0{\cdot}001$). Only one child with autism and one control child (with moderate learning difficulties) scored below 12. Although the task was quite a difficult one, the overall pattern of responses and the standard deviations obtained across the three groups suggest that floor effects were probably not obscuring possible differences in homogeneity of variance. Indeed Levene's test for homogeneity of variance was carried out on the data and was not significant ($F = 3{\cdot}18$, 2,39, NS). A three-way analysis of variance was then performed. The two within group factors were stimulus type (harmonized/unharmonized) and mode (major/minor) and the between group factor was diagnosis (autistic/controls). The analysis revealed a significant main effect of stimulus type ($F = 8{\cdot}34$, df, 1,39, $P = 0{\cdot}006$) with overall scores being significantly higher for harmonized versions. There was no significant main effect for either mode (major/minor) ($F = 3{\cdot}09$, df, 1,39, NS) or diagnosis (autistic/controls ($F = 1{\cdot}38$, df, 2,39, NS), neither were there any significant interactions between variables.

DISCUSSION

Unusually, the results from this experiment failed to distinguish between children with autism and matched controls in identifying the affective connotations of major and minor musical mode. The overall level of performance on the experimental task was not very high (69·12%) although it was significantly above chance. However, performance levels for accompanied versions of melodies were higher (73·16%) than for unaccompanied versions (65·25%) and this was statistically significant. Musical accompaniment increases the level of harmonic information about melodies and it seems probable that this is why the affective connotations are more readily identified in accompanied versions of melodies.

Table 2. *Means* (*and standard deviations*) *for subjects' correct matching of schematic faces to tunes across four experimental conditions*

Group	Total score		Harmonized major mode		Harmonized minor mode		Major tune		Minor tune	
	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)	Mean	(S.D.)
1 Children with autism	15·71	(2·55)	4·14	(0·86)	4·36	(1·34)	3·57	(1·87)	3·64	(1·28)
2 Verbal IQ matched controls	16·42	(3·99)	4·5	(1·16)	4·5	(1·45)	3·07	(2·13)	4·36	(1·64)
3 Non-verbal IQ matched controls	17·64	(2·53)	4·57	(0·94)	4·28	(1·59)	4·07	(1·27)	4·71	(1·14)

* Maximum total score = 24 (six stimuli for each of the four experimental conditions).

https://doi.org/10.1017/S0033291799001221 Published online by Cambridge University Press

That the children with autism could recognize emotional expression in music at this simple level might not be so surprising when one considers that they do not appear to be impaired at emotion recognition at all levels of complexity. For example Capps, *et al*. (1992) found that cognitively unimpaired autistic children were able to understand simple emotions and Baron-Cohen *et al*. (1993) found that this was also true for autistic children with cognitive impairment. In the Capps *et al*. study it was also found that autistic subjects could understand some complex emotions, although here they needed significantly more prompting and time than their matched controls. The complex emotions used in their study were pride and embarrassment, and the authors suggested that particular difficulties with these reflect mentalizing deficits consistent with theory of mind accounts of autism. That they might not experience particular difficulties with recognition of happy and sad faces may be, as Frith *et al*. (1994) suggest, because they might recognize the outward signs of happiness and sadness without understanding the underlying thoughts and feelings of those experiencing such emotions. In the present study, it was major and minor music that had to be assigned to visually presented expressions of happiness and sadness and this required the categorization of the musical stimuli into two types, which could then be assigned according to culturally prescribed rules. Thus, even at the cautious level of interpretation, the autistic children in the study, like their normal controls, were able to assign the different melodies they heard to two different affective categories.

One question to be asked here is how these findings relate to the unusual pattern of emotional responsiveness and behaviour within the interpersonal domain in those who are autistic. Two different explanations for these observed abnormalities posit different kinds of deficits, both of which may be inapplicable to descriptions of the experience of music or art in general. How would a deficit in interpersonal relatedness (Hobson, 1993) influence an individual's reaction to a piece of music or a picture? It is of course quite true that an artist strives to communicate his own view of the world in his productions. However, the piece of art then takes on an existence of its own and the direct and interpersonal aspects become more or less inconsequential. When one considers mentalizing deficit explanations for emotion abnormalities in autism (Happé, 1994) one comes up against a similar difficulty. Do we need meta-representations of a composer or artist's intentions in order to appreciate the affective aspects of the composition. As Aiello (1994) suggests, people listen to music primarily for the aesthetic and emotional experience that it provides. If we take the examples of Wagner's *Overture to Tristan and Isolde* and paintings by Monet of his garden, it becomes clear that the experiences they give rise to are primarily affective, in terms of themselves and their aesthetic power. We do not need any knowledge about the states of mind or the emotional intentions of either Wagner or Monet for this.

Thus, even on a simpler level then, there is no reason why a person with autism should not be able to appreciate emotional connotations embedded within the musical and artistic languages relative to their level of intelligence and age. Certainly, the findings from the present study support this conclusion.

This research was supported by the Nuffield Foundation (grant reference: DIR/05). We would like to thank the pupils, teachers and Headmistress of Spring Hallows School, Ealing for their kind cooperation in this study.

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