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The Development of Emotional Concepts in Autism

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Abstract—Forty-one high-functioning individuals with autism between the ages of 7 and 36 and an age and intelligence matched comparison group were investigated in their ability to recognise emotions in photographs. A colour identification task served as control condition. The autistic group was significantly impaired on the emotions task only. There was no substantial difference between groups in the structures underlying their emotional concepts (pleasantness and arousal). However, there is a trend for the autistic group to rely on other strategies in the recognition of emotions than the comparison group. These strategies may be insufficient in the appreciation of facial expressions.

Introduction

Numerous studies on the comprehension of emotions have shown that people with autism are impaired in recognising and understanding emotional expressions. The comprehension of emotional expressions has mostly been investigated with facial expressions. Procedures such as recognition of facial expressions from photographs or videos, labelling expressions in pictures or tape recordings, picture to picture or picture to sound matching, matching pictures of facial expressions to a situational context, or combinations of these tasks have been employed. These studies varied in many ways, such as age of the autistic subjects (preschool age to adolescence), kind of control group (normally intelligent or mentally retarded children), matching variables (verbal or nonverbal measures, chronological or mental age) and experimental procedures. Because of this methodological heterogeneity it is perhaps not surprising that some authors report contradictory results. Hobson (1991) gave a detailed overview of this research and considered

the various methodological and conceptual problems involved. He concluded that *the body of the evidence is in favour of a disturbed comprehension of emotional expressions in autism, although the results are not always in agreement.* His conclusions have been confirmed and extended by four other studies that investigated the comprehension of emotions in more elaborate ways. The fact that emotional expressions in facial photographs are less salient to children with autism than, for instance, hats (Jennings, 1973; Weeks & Hobson, 1978) and wigs (Bormann-Kischkel, 1990) has been confirmed by behaviour observations in natural situations. Preschoolers with autism were less attentive towards an adult expressing distress, fear or discomfort than mentally retarded and normal children. They appeared to ignore or not to notice the adult but were more engaged with other activities, such as toy play (Sigman, Kasari, Kwon & Yirmiya, 1992). Fein, Lucci, Braverman and Waterhouse (1992) compared the ability of 15 children with pervasive developmental disorders (PDD) to match four different emotions to an appropriate context (e.g. scared—child falling off a ladder). Although they found no difference between the PDD-group and a comparison group of normal children, the children with PDD were slightly but significantly better on a nonsocial control task equated with the emotions task for difficulty. A similar result was reported by Capps, Yirmiya and Sigman (1992). They compared the ability of nonretarded children with autism to understand simple emotions, such as happiness and sadness, with their performance at complex ones, such as pride and embarrassment. Happiness and pride share features of pleasantness but differ in locus of responsibility and controllability. A similar distinction can be drawn for sadness and embarrassment. The performance of children with autism was quantitatively not very different from that of the normal children, but they required more time and prompts to talk about the complex emotions, and they did not differentiate sadness from embarrassment on the basis of locus of controllability. Many of them reported experiences as embarrassing which had external causes and were uncontrollable by themselves.

Emotions and their contribution to empathetic behaviour were studied in high-functioning children with autism by Yirmiya, Sigman, Kasari and Mundy (1992). They presented their participants with videotaped segments of stories with a protagonist experiencing one of five emotions (happiness, anger, pride, sadness and fear). The children had to label each emotion the protagonist experienced, state their own feeling, and to describe why they felt so. Although the autistic children did quite well on all these tasks, their performance was inferior to the normal comparison children. To sum up, children with autism exhibit peculiarities in the way in which they deal with emotional expressions. Although high-functioning individuals appear to understand simple emotions such as happiness, anger, sadness and fear, they are less competent with more complex ones and have more problems relating them to a context.

A characteristic of many if not all studies on the comprehension of emotions is the small magnitude of effects, especially with high-functioning subjects. This has been taken as an argument against a core deficit of the comprehension of emotions in autistic children. A small effect often indicates a large overlap in distributions. Although this does not qualify the task under consideration to be used for diagnostic discriminations, it cannot be interpreted as a nonexistence of differences. A small effect may also indicate an impairment as opposed to complete inability. For instance, autistic children may develop compensatory strategies to overcome their handicap. Hobson, Ouston and Lee (1988) have shown that autistic adolescents use other strategies than mentally retarded adolescents to identify facial expressions. The autistic persons' handicap became obvious only when the task grew more difficult. In two other studies, it was noted that children with autism were more easily confused than control children in sorting pictures of facial expressions by items with perceptual (but not conceptual) similarity (Bormann-Kischkel, 1990; Ozonoff, Pennington & Rogers, 1991). The notion of autism as a "logico-affective state" proposed by Hermelin and O'Connor (1985) provides another explanation along these lines. They suggest that high-functioning autistic children may overcome part of their problems by using cognitive or intellectual routes to process emotions. Because these strategies are sub-optimal, however, they cannot fully compensate for the deficit.

Another reason for a failure to find differences between groups may be the small number of emotions studied (mostly only three or four). Extending the number of emotional expressions would improve the basis of comparisons. A series of interesting studies by Russell (1983) and Bullock and Russell (1984, 1985) provides a method to deal with these problems. They studied emotion recognition in normal preschool children and adults by using nine pictures of emotional expression and 15 different emotion terms, some of which were synonyms, e.g. angry–mad. (Because this was an American study, angry and mad were considered as synonyms.) They found that normal preschool children were inferior to older children and adults in their comprehension of emotion terms. However, a multidimensional scaling procedure (MDS) revealed that the structure underlying the responses was identical for all age groups. Young children organised emotional concepts by the underlying two dimensions "pleasure vs displeasure" and "high vs low arousal" just as adults did. This was also true for German children and adults (Bormann-Kischkel, Hildebrand-Pascher & Stegbauer, 1990). The advantages of this approach are twofold: it has been tested with several groups of normal children and adults, thus providing a wide base for comparisons. Furthermore, the multidimensional scaling procedure allows for an investigation of structures underlying the children's responses and may provide information on the strategies used.

In order to rule out the influence of unspecific factors, such as attention problems, we devised a control experiment which was identical in task demands and response format to the first one but different in content. The children were presented with small colour plates of medium satiation values, which they had to match to different colour names. The results of a pilot study with normal 5-year-old children and adults (Kulzer, unpublished diploma's thesis) indicate that this material shows some parallels to the emotion task: the children made more errors than the adults, but their responses were not randomly dispersed across the spectrum. Colours adjacent to each other according to the colour circle were more easily confused than colours further apart. The structure underlying all subjects' responses was the same, namely, a colour circle with the dimensions "red–green" and "blue–yellow".

Because we assume that there is a specific deficit in understanding emotional expressions in autism, we expect autistic children to be impaired in the comprehension of emotion terms, but not in the comprehension of colour terms. Further, if persons with autism use strategies in the comprehension of emotions which differ from those of persons without autism, the multidimensional scaling procedures should provide different solutions for the emotion terms only, but not for the colour terms.

Method

Subjects

The autistic group consisted of 41 individuals with autism who conformed to Rutter's (1978) criteria in showing characteristic features in their social, language and communicative behaviour. All exhibited (more or less marked) stereotypies and/or special interests. All subjects had been diagnosed prior to their participation in this study by a child psychiatrist or by an experienced clinical psychologist not affiliated with this study. For an additional control, 21 cases were checked according to DSM-III-R criteria. All these subjects fulfilled the criteria for early infantile autism. No differences were noticed between those subjects with DSM-III-R diagnoses and those without. Three children were inpatients of a child psychiatry department in Munich, 15 children and adults were contacted through the German national parents' association in Munich. Many of them were patients at the child psychiatry institution. Twenty-one participants were tested at a counselling centre for autistic children and adolescents in Vienna. A nonverbal test of intelligence (Raven's Coloured Progressive Matrices or Standard Progressive Matrices 1987), a vocabulary test (subtest 6: "Synonyme finden" [Synonyms] from "Adaptives Intelligenz Diagnostikum" AID (Kubinger & Wurst, 1991), a screening for colour blindness (Dvorine, 1963), and the two experimental tasks were administered to each subject. The age of the subjects varied from 7;0 to 35;4 years. All subjects were able to follow verbal instructions and, with one exception, were verbal.

The control group consisted of 41 children and adolescents. They were individually matched by age and Raven's raw scores but not by their performance on the vocabulary test. Because of the heterogeneous IQ and age in the autistic group, the control group comprises a mixed sample. Criteria for selecting participants for the comparison group were their correspondence in age as well as IQ score to one member of the group with autism, and a history of developmental speech and language disorder or multiple developmental delay. Care was taken that individuals with autistic features were excluded, either by prior diagnosis or by clinical impression. Both authors, who carried out the testing (C. B.-K. and B. B.), have had substantial experience in working with autistic children, so that it is unlikely to have included a nondiagnosed person with autism. Because of the very high IQ scores of three autistic participants, the criterion of a developmental disorder had to be given up in these cases, since no corresponding subjects could be found. Instead, three normal participants, matching in age and IQ, were selected.

Of the comparison group, 15 children had a diagnosis of developmental speech and language disorder or of multiple developmental delay (including language, reading and motor development). Three children were severely dyslexic, eight were learning disabled (no further specification), and 12 mentally retarded (two with Down's syndrome, 10 without further diagnosis). In addition, two normal children and one normal adult from the technical staff of the University of Regensburg participated as comparison subjects. They were recruited from the same child psychiatry unit as the autistic children ($N = 8$), from a special school for children with speech and language disorders ($N = 5$), from two schools for learning disabled pupils ($N = 12$), two schools for mentally retarded children ($N = 12$), and from normal schools ($N = 3$). Informed consent was obtained from all parents and from the adult participants themselves. Age, IQ and vocabulary scores are presented in Table 1. It should be noted that one participant from the comparison group had to be dropped in the Colour Task (see below), because he turned out to be colour-blind on the screening for colour-blindness.

Table 1. Means and standard deviations (SD) of age, IQ- and vocabulary-scores for the autistic and control group

	Autistic Group (N = 41)	Control Group (N = 41)
Age*	173.4	161.4
SD	82.6	65.2
Raven†	86.8	85.9
SD	24.7	23.8
AID-Synonyms‡	40.1	46.9
SD	18.7	22.1

*Months, †IQ-scores, ‡T-scores.

Material

Emotion Task. The same nine pictures as in Bullock and Russell (1984) were used. These photos depict nine different female models posing different emotions, six of which (happy, angry, sad, afraid, disgusted, surprised) are from the Ekman and Friesen (1975) set. The remaining three (excited, calm, sleepy) pictures have been added by the authors*. We followed Bullock and Russell's (1984) procedure except for using German emotion terms. The pictures were 8.5×12 cm in size mounted on cardboards of 12×17.5 cm and laminated for protection. Exemplars of all photos have been published in Bullock and Russell (1984).

Colour Task. For the control experiment, subjects were presented with 10 colour plates. These were small chips with a diameter of 1.0 cm, which were selected from the "Roth 28 Hue Test" (Roth, no year given). This test consists of 28 nonlucent colour plates with equi-distant hue values distributed across the colour circle. We selected 10 out of these 28 plates with five principal hues (= red, yellow, green, blue, purple) and their five intermediate combinations (orange, bluish green, etc.). These 10 hues divide the colour circle into 10 equal regions. Brightness and saturation of the plates are medium (-/5/5 according to the Munsell notation). The 10 plates are equidistant in their hues (nine intermediate steps) with one exception (six intermediate steps between chips 10 and 16). The Roth chiffres of the plates are 1, 10, 16, 25, 34, 43, 52, 61, 70 and 79. The plates were labelled as red, orange, yellow, olive or yellow–green, green, blue–green, turquoise, blue, violet, and pink or red–blue respectively, by 30 adults not involved further in this study. It should be noted that although the hues were the most typical ones for the respective colour regions, not all plates were prototypes of the colour terms. This was so, because lightness (= value, V) and saturation (= chroma, C) were at medium levels. For a prototypical red, yellow, blue, etc. more satiated hues would have been required. Our decision to use colours of medium satiation was based on two considerations: The Munsell colour solid is not symmetrical with regard to satiation but varies depending on the hue and lightness of a colour. Using the most satiated colours would thus have implied a difference in satiation across hues. Further, we anticipated that it might be hard to elicit second or third choices from highly satiated colours. Confusions among hues and overextensions of colour terms are more likely to occur with nonprototypical category members (Heider, 1971; Rosch, 1975). Although the Munsell system is a pragmatically devised colour scheme, its logic of construction with some limitations corresponds to a psychological system of colour perception (Indow, 1988).

Procedure

All tasks were administered in one or two sessions, always in the same order. The first session included the Colour Task, the Emotion Task, the screening for colour blindness and a test of auditory

emotion recognition, which will not be dealt with further in this paper. In the second session, the IQ and vocabulary tests were presented. Total testing time varied between 1.5 and 2.5 hours. No attempt was made to counterbalance the experimental conditions, because this would have required a within-group matching by age and intelligence, which would have imposed too many restrictions on the selection of participants.

For the Emotion Task, all pictures were arranged in front of a child, mostly in a 3 × 3 arrangement. The experimenter asked the child to hand her a picture of a woman who was, e.g. happy. Without replacing this picture the child was asked to select another one, and finally a third one ("And who else is happy?"). After a child had made three choices, all pictures were put back, the cards were rearranged, and the next emotion term was presented accordingly. Sixteen different emotion terms were used so that a maximum score of 16 could be obtained. Together with their translations, they can be found in Appendix A (for further details, see Bormann-Kischkel et al., 1990). If children refused to make a second or third choice they were not forced to do so. However, this happened in less than 5% of all stimuli. The Colour Task was presented accordingly. Here, the maximum score was 17.

Results

First choices

For some emotions and colours, synonyms were used, because in our previous studies both terms had been produced with almost equal frequencies. The maximum number of correct first choices was therefore 16 for the emotion terms and 15 for the colour names. Although all participants were presented with 17 colour terms, the terms *oliv* [olive] and *ocker* [ochre] were dropped from the analysis because it became apparent during testing that these colour words were unknown to many children. Owing to an experimenter error, some of the children got prompts from one experimenter, while others (tested by another experimenter) did not. Although the results reported subsequently did not differ, when both terms are included, we decided to omit these colour names from the analysis of the correct first choices.

On the Emotion Task the autistic group was correct on the average on 6.9 emotion terms, the comparison group on 8.4 terms. On the Colour Task, the average correct scores were 10.5 for the autistic group and 10.4 for the comparison group (see Figs. 1 and 2). An analysis of covariance with vocabulary as a covariate revealed no overall difference between groups ($F_{78,1} = .88$, $p = .350$), a significant effect of task ($F_{79,1} = 6.80$, $p = .011$), and a significant group by task interaction ($F_{79,1} = 6.80$, $p = .011$). The influence of the covariate (vocabulary) is highly significant with a ß-weight of .46 ($t = 4.60$, $p < .001$). A posteriori comparisons for each task (ANOVAS with vocabulary as covariate) show that both groups differ significantly on the Emotion Task ($F_{79,1} = 7.03$, $p = .010$), but not on the Colour Task ($F_{78,1} = .94$, $p = .336$).

Multiple regressions

Given the large ranges of age and IQ in our samples, it is conceivable that these variables, in addition to vocabulary, exerted an influence upon the tasks studied. Moreover, we were interested in the relative contribution of these factors to each group. We therefore, calculated multiple regressions for each task and group
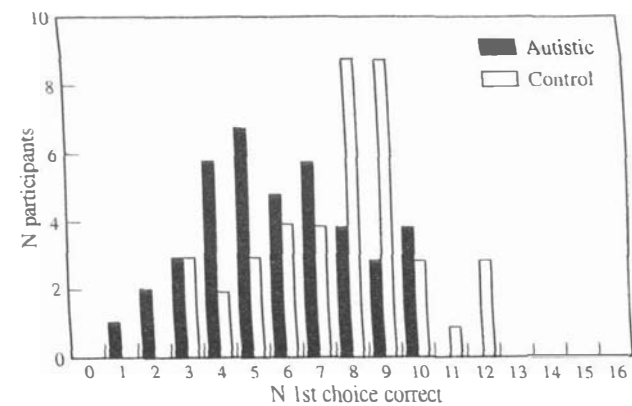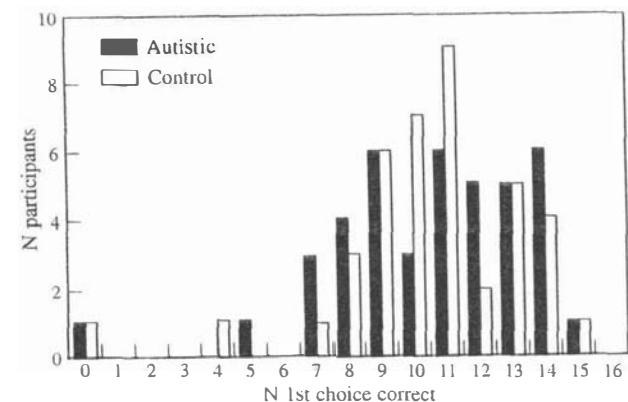
Fig. 1. Distribution of scores on the Emotion Task.

Fig. 2. Distribution of scores on the Colour Task.

separatively. On the Emotion Task, different variables influence each group. The score of the autistic group is significantly influenced by the vocabulary score only (ß = .43; $t = 2.96$, $p = .005$), while the comparison group is influenced by their IQ scores only (ß = .45; $t = 3.12$, $p = .003$). No other variables are of significant influence. On the Colour Task, the vocabulary score exerts the greatest influence upon the amount of correct first choices in both groups (Autistic group: ß = .60; $t = 4.72$, $p < .001$; comparison group: ß = .42; $t = 2.98$, $p = .0051$). Age contributes to the correct colour choices of the comparison group only (ß = .34; $t = 2.42$, $p = .021$). The contribution of all remaining variables to the regression equation again is nonsignificant.

Single colour and emotion terms

With one exception, the correct first choices for each emotion term were above chance for both groups (binomial distribution with a priori probability $p = 1/9$).

The exception was the term *entsetzt* [terrified], which both groups did not associate with the standard picture D. Instead, there was a shift in focus to picture C [surprised]. The control group was significantly superior to the autistic group on the terms *zornig* [angry] ($\chi^2 = 11.4$, $p < .01$) and *erstaunt* [astonished] ($\chi^2 = 3.96$, $p < .05$). There was a trend for the comparison group to be better on *überrascht* [surprised] ($\chi^2 = 2.71$, $p < .10$), *erschreckt* [scared] ($\chi^2 = 3.47$, $p < .10$), and *wütend* [angry] ($\chi^2 = 3.17$, $p < .10$).

Both groups were above chance on their first choices on all colour terms (binomial distribution with a priori probability of $p = 1/10$). Despite the lack of an overall difference between groups, the autistic subjects were superior to their comparison group on the colour name *gelbgrün* [yellow–green] ($\chi^2 = 4.73$, $p_{t/f-1} < .05$).

Structure of emotions

The autistic participants made more errors than the control participants. The next question was whether the structure underlying the responses is different for the autistic subjects as compared to the control subjects. We therefore computed a multidimensional scaling analysis (MDS). In this analysis, similarities between stimuli (pictures or chips in our case) are converted into geometrical distances. Stimuli similar to each other will also be spatially close to each other in a geometrical representation. Varying the number of dimensions of the space will lead to different solutions. The configuration representing the data best according to a goodness-of-fit criterion is selected for interpretation. The dimensions describing the space in which the data are depicted represent the underlying structure of the subjects' choices and have to be interpreted psychologically. The co-occurrence of the frequency of two pictures among the three choices to a given emotion term can be regarded as an indirect measure of similarity. From these frequencies a matrix of similarity was computed by determining how often particular pairs of photographs were included among a s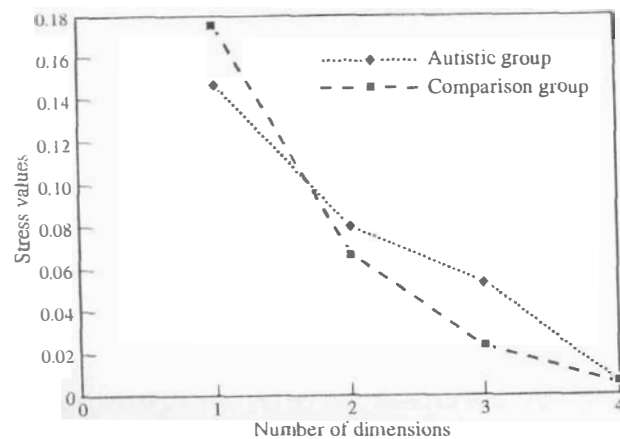ubject's three choices. This matrix was then subjected to a nonmetric MDS (SPSS-X, 1991). The "stress value", which is a measure for the amount of variance left unexplained by a given solution, serves as a goodness-of-fit criterion. Because a model with too many dimensions is difficult to interpret, one usually prefers the n-dimensional solution which shows the sharpest decrease in stress from $n-1$ to n dimensions. This is the two-dimensional solution for both groups (Fig. 3).

Fig. 3. Stress values of the multidimensional scaling solutions for the emotional expressions.
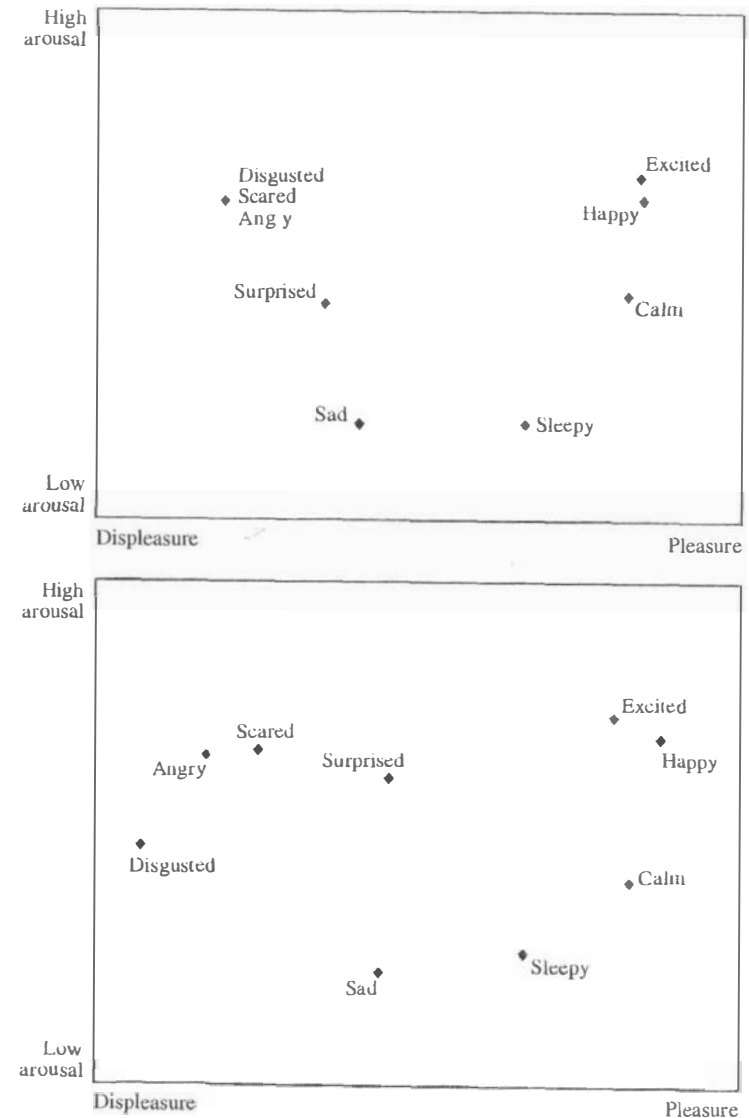

Fig. 4. Multidimensional scaling representation of emotional expressions. Above: Autistic group; below: Comparison group.

Although the MDS representations for the individuals with autism and the comparison participants form elliptic rather than circular configurations, the two dimensions describing this representation are the same ones as those found in all previous studies: "pleasure vs displeasure" (horizontal axis) and "high vs low arousal" (vertical axis; Fig. 4).

However, there is a gap in the autistic persons' representation in the upper half, which is due to the "wrong" position of the surprised picture. Because similar results have been found with younger normal children (Bormann-Kischkel *et al.*, 1990), we split the autistic and the comparison group into a younger and an older one (median < 15 years) and performed separate MDS analyses. While the MDS-solution for the younger comparison group, too, shows a gap in the upper part of the configuration, the data of the older comparison group form a closed, elliptic configuration, with the surprised picture receiving high scores on the arousal dimension. No such shift occurs for the autistic group, however. Apparently, there was a developmental shift leading to a different evaluation of the surprised face by older children and adults. This shift, however, did not occur in the autistic group.

Because the stress values of the MDS indicated no substantial difference between the two- and the three-dimensional solutions for the autistic group, we also looked at the three-dimensional solution. The third dimension could not be interpreted in terms of emotional concepts, but was a reflection of morphological features. At one end of the axis, there were all the pictures with an open mouth and exposed teeth, whereas expressions with lips closed lay at the other end. Even expressions which are contradictory in their hedonic value but similar with regard to exposed teeth, such as happy and angry, were situated close together on this axis. We therefore suggest that this dimension reflects the influence of perceptual similarity on the subjects' choices of emotional expressions. No such dimension was substantiated for the comparison group, however. To our knowledge, there is no way of testing the difference in the reduction of stress between both groups. We can therefore report this finding as an interesting trend only.
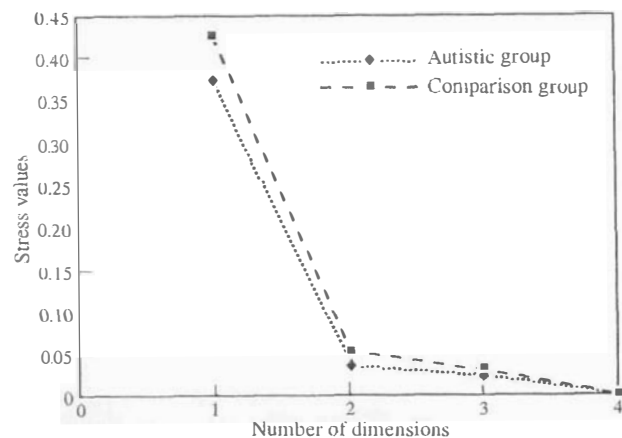
Structure of colours

The same results as in the pilot study were obtained for both groups. There is a very clear indication for a two-dimensional solution from the stress values of both groups (Fig. 5).

The configuration obtained by the MDS are nearly perfect circles with the dimensions "red vs green" and "blue vs yellow" for both groups (Figs. 5 and 6).

Because of the distinct stress reduction from the one- to the two-dimensional solution, no three-dimensional solution was interpreted.
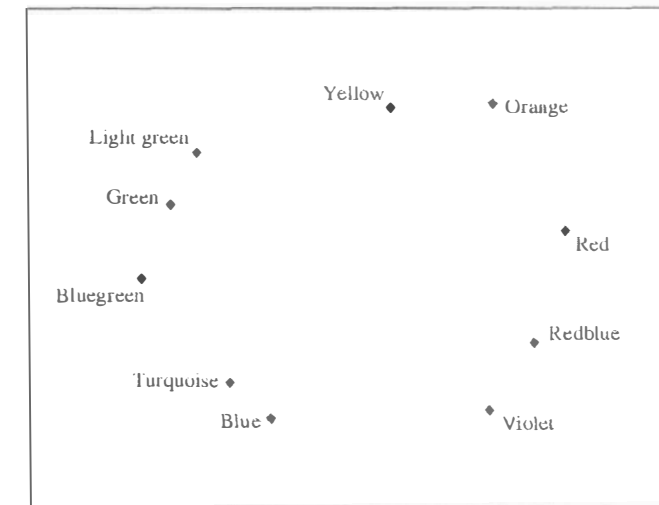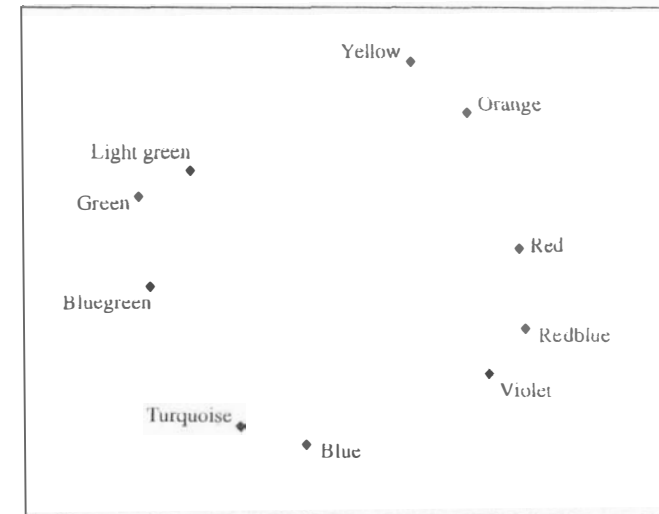

Fig. 6. Multidimensional scaling representation of colours. Above: Autistic group; below: Comparison group.

Fig. 5. Stress values of the multidimensional scaling solutions for the colours.

Discussion

Before turning to the task under study we consider it necessary to discuss the appropriateness of our comparison group and of the control task. The rationale behind our selection of participants for the comparison group was to control for factors that in addition to the diagnosis of autism might influence the task behaviour. We considered age, cognitive endowment and a history of developmental disturbances as the most critical ones. Because of the variation of age and IQ in our autistic sample it was impossible to confine the control group to members of one diagnostic group. Admittedly, our procedure has the disadvantage of obscuring within-group variation. The same argument holds true for the autistic group, however, because the occurrence of autism is considered to be determined by multiple factors. As long as there is no agreement on nosologically founded subgroups in autism we see no other way to deal with this problem.

It may also be questioned, whether the recognition of colours constitutes an appropriate control condition for the recognition of emotional expressions. This is true, for instance, with regard to the lack of a visuo-spatial factor. Other arguments against the use of colours might include their low level of abstraction and the intense amount of training that subjects receive on colour matching but not on emotions matching. The latter objection can be dealt with quite easily: colour matching games and tasks are common with all young children, both normal and handicapped, and do not constitute a training programme exclusive for autistic children. Therefore, one would not expect a specific advantage for this group on colour matching.

The argument that colours are of a lower conceptual level than emotions cannot be refuted. Because we did not use fully satiated colours, this task was not trivial for the subjects. But matching an ochre chip to the term "yellow" can still be considered as a primarily perceptual, not a conceptual task. This would indeed be a serious problem, if it led to a ceiling effect. However, this was not so, as we shall point out.

In devising the experiment, we were aware of these problems but decided to keep colours as a control experiment, because there also are parallels between emotions and colours. In both tasks, a correspondence between verbal concepts and visual stimuli from a particular domain has to be formed by the subject. Similar developmental courses have been suggested for colours and for emotions: At the beginning of life, the colour space is thought to be divided into only a few areas, with gradually increasing differentiation (e.g. Berlin & Kay, 1969). In very much the same way, the development of emotional concepts has been hypothesized. Very young children are thought to discriminate emotions according to pleasantness and arousal only. Later on, they will develop more differentiated, adult-like categories labelled "happiness", "anger", "sadness", etc. (Bullock & Russell, 1986). The data from our pilot studies support these developmental similarities. Finally, we did not find any other material paralleling the emotion task in terms of providing prototypical class members for a given concept, and of being structured in a two-dimensional, circular configuration. We therefore think that despite some differences, colours qualify as an appropriate control condition.

We found a clear deficit in the recognition of emotions in our sample of high-functioning persons with autism. This impairment was specific to emotion concepts and did not extend to colour concepts. Because of the multiple control conditions in studying an age as well as IQ matched comparison group and in partialling out the effects of verbal development we think that it is unlikely to attribute the results to a cognitive–intellectual deficit or a difference in verbal–conceptual ability. No differences either between high-functioning children with autism and normal children in their general cognitive-semantic abilities were found by Tager-Flusberg (1985a,b).

The Emotion Task and the Colour Task differed in difficulty, with the Emotion Task being more difficult for both groups. This would be a severe problem, if it resulted in a ceiling effect on the Colour Task. Although the distribution of scores on the Colour Task (Fig. 2) does not support this, it has to be admitted that a control task of comparable difficulty would have been better.

The autistic participants' results are above chance on all but one emotion term (*entsetzt* [terrified]), which, however, was also poorly understood by the comparison group. This means that high-functioning persons with autism do not suffer from a complete inability to understand emotions but that they are less efficient as compared to a group of non-autistic persons of similar age and intellectual development. As in many other studies, the overall size of the effect in the recognition of emotions is small. As we pointed out in our Introduction, this may indicate impairment as opposed to complete inability. On the other hand, it can also mean that the autistic group included some individuals who were unable and others who were well able to perform the task. As can be seen from Fig. 1, the distribution of scores of the autistic group is very similar to that of the comparison group, but with a lower mean. This validates our interpretation of an impairment in the recognition of facial expression in individuals with autism.

Another difference between groups in the recognition of facial expression was revealed by the multiple regression analysis. Individuals with autism were influenced only by their verbal abilities on the Emotion Task, while the comparison group was strongly influenced by their IQ. Perhaps, this pattern indicates that the comparison group used more reasoning strategies such as deduction or exclusion strategies in matching the pictures to emotion terms, while the individuals with autism resorted more to word–picture associations.

Looking at the performance at single emotion terms, the participants with autism exhibit specific deficits on the concepts *erstaunt* [astonished], *zornig* [angry], and less pronounced for *überrascht* [surprised], *erschreckt* [scared] and *wütend* [angry]. With the exception of *zornig* and *wütend,* these emotion terms can be interpreted as more complex ones with regard to cognitive involvement. These are all concepts expressing a mismatch between an individual's expectation and an environmental event, which is externally controlled. For instance, in order to be surprised one needs to have a notion that an event is unusual in a given situation, and it cannot be internally controlled. This provides an interesting link to the results from Capps *et al.* (1992). They, too, found the impairment to be greater in complex emotions with an external locus of control (such as embarrassment). These emotions require knowledge of situations and social scripts, in which autistic people are also impaired

(Fein *et al.* 1992). Emotion terms such as surprise, astonishment, etc. are therefore not only expressions of an inner feeling state but they also require knowledge about an event. This notion of the "aboutness" of an emotion is reminiscent of the ability to form second-order representations, which are thought to be prerequisites for a "theory of mind". One could argue that emotional expressions which are not mere signs of an inner experience but relate to an event outside of an individual might be precursors of a "theory of mind" in an emotional mode (see also Bormann-Kischkel, Amorosa & von Benda, 1993).

These explanations do not apply to the impaired comprehension of *zornig* [angry] and *wütend* [angry] by the autistic subjects. It could be that they have not yet acquired the correct meanings of these words. However, there is no indication that these terms are less frequent or more unusual in German than many of the other emotion terms. Maybe, the visual features of the photo were not properly recognized by many individuals with autism. Although picture E was correctly recognized in our pilot study, it is somewhat atypical, as the model shows an open-mouthed angry face, making it thus a very intense expression. Perhaps anger of this intensity has never been observed in reality by many people with autism and thus was not properly recognized by them. Given their general lack of interest in other people's behaviour in movies, etc. they are unlikely to have learnt it incidentally, which may have been the case with the comparison subjects.

With regard to the performance of single colour terms, no differences between groups emerged except for *gelbgrün* [yellow–green]. This colour term was more often associated with the standard chip by the autistic subjects than by the comparison subjects. We have no explanation for it and consider it a chance result.

Despite the differences in amount of correct responding, the groups were quite similar in the structures underlying their responses to the emotion terms. Just as all other groups studied, people with autism structured emotion concepts by degree of pleasure or displeasure and by amount of arousal. Although these two dimensions provide the best fit for the data, it can be seen that, for the autistic group, no closed pattern emerged, as was the case for the comparison group. For the autistic group, however, there is a gap in the upper half of the configuration. This is mainly due to the "wrong" position of the "surprised" picture, which has low scores on arousal and is close to the "sad" and "sleepy" pictures. This was due to a misinterpretation of the surprised face as being tired. Twelve subjects with autism selected picture C (= surprised) in response to the term *müde* [tired]. Four of them even made it their first choice. Some autistic persons explained their choice by commenting that the woman in picture C was yawning. In contrast, only six subjects of the comparison group selected picture C as a response to *müde* [tired], and only two selected it in the first place. The autistic subjects were obviously focusing on the lower part of the face. A tendency of autistic children to rely more on the mouth region has already been observed by Langdell (1978). Paramey (personal communication, 1993) and Bormann-Kischkel *et al.* (1990) found very similar results for the surprised face with normal preschool children. We therefore think that these results reflect a developmental shift in the strategies used for processing facial expressions. This shift is substantiated by the MDS-solutions of the different age groups, but only for the comparison group.

Two explanations can be put forward to explain these results. Either, autistic children employ scanning strategies, which focus for one reason or another on the mouth region of a face. This may be of advantage in processing inverted faces (e.g. Langdell, 1978), but leads to errors in emotion recognition. The autistic subjects' deficit would then be attributed to a disturbed visual scanning behaviour. Abnormal gaze behaviour has indeed been repeatedly reported for autistic children (e.g. Hutt & Ounsted, 1970; Hermelin & O'Connor, 1970).

On the other hand, attending only to the mouth region of a face could also be viewed as a "piece-meal", perceptually oriented strategy of processing as opposed to a holistic, conceptual one. Such a strategy could also be responsible for the influence of irrelevant features on emotion recognition, such as hats (Jennings, 1973; Weeks & Hobson, 1987), wigs (Bormann-Kischkel, 1990) or otherwise perceptual similarity (Ozonoff *et al.*, 1991). This interpretation is in line with the results of the three-dimensional MDS-analysis. The third dimension reflects a single morphological feature of the face, which, too, suggests the influence of nonholistic, nonemotional perceptual strategies in the processing of facial expressions.

For normal kindergarten children, we related this influence of perceptual features to very early processes in the recognition of facial expressions (Bormann-Kischkel *et al.*, 1990). Very young infants discriminate between different expressions of a face only on the basis of perceptual features, not of emotional meaning (for reviews: Oster, 1981; Nelson, 1987). However, from 7 months onwards, they begin to exhibit a conceptual understanding of emotional expressions (e.g. Bühler & Hetzer, 1928; Caron, Caron & Myers, 1985). From our data, we cannot conclude whether the autistic subjects' behaviour in our experiment is a "left-over" from infantile processing strategies, which perhaps is interfering with a more advanced conceptual strategy, or whether it reflects a deviant mode of processing. But given the importance of emotional expressions from early on in life in so many areas as parent–child interaction, attachment behaviour, or communicative development, a deficit in the recognition of emotional expression should not be too readily refuted as an explanation for the disturbed social and cognitive development in autism, even though it may not appear to be of crucial importance at a later age.

Another implication of our results is that processes involved in the recognition of facial expressions should be studied further. Not only conceptual, but also visuo-spatial or perceptual factors seem to play a role. It would, for instance, be interesting to study the relative contribution of conceptual and perceptual features in autism. This could be done by varying the perceptual features of a face by including, for instance, pictures with nonsense facial patterns.

It should be kept in mind that our results are limited to a subgroup of high-functioning autistic children and adolescents. Even our simple experimental procedure was too demanding for very young and for low-functioning autistic children. However, questions arising from these results can also be tested with them. Discrimination learning paradigms and testing for generalisation along the dimensions of pleasantness and arousal or of perceptual similarity could provide appropriate procedures.

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Appendix

Emotion terms			Colour terms		
fröhlich	—	glad	rot	—	red
glücklich	—	happy	orange	—	orange
sich über eine			braun	—	brown
Überraschung			gelb	—	yellow
freuen	—	excited	gelbgrün	—	yellow–green
erstaunt	—	astonished	hellgrün	—	light green
erschreckt	—	scared	grün	—	green
entsetzt	—	terrified	blaugrün	—	blue–green
wütend	—	angry	türkis	—	turquoise
zornig	—	angry	hellblau	—	light blue
sich grausen	—	disgusted	blau	—	blue
sich ekeln	—	disgusted	violett	—	violet
traurig	—	sad	lila	—	violet
müde	—	tired	rotblau	—	red–blue
gelangweilt	—	bored	rosa	—	pink
zufrieden	—	content			
friedlich	—	peaceful			