THE DEVELOPMENT AND EVALUATION OF A COMPUTER-BASED PROGRAM TO TEST AND TO TEACH THE RECOGNITION OF FACIAL AFFECT

ABSTRACT
Autism is a chronic pervasive neurodevelopmental disorder characterized by the early onset of social and communicative impairments as well as restricted, ritualized, stereotypic behavior. The endophenotype of autism includes neuropsychological deficits, for instance a lack of “Theory of Mind” and problems recognizing facial affect. In this study, we report the development and evaluation of a computer-based program to teach and test the ability to identify basic facially expressed emotions. 10 adolescent or adult subjects with high-functioning autism or Asperger-syndrome were included in the investigation. A priori the facial affect recognition test had shown good psychometric properties in a normative sample (internal consistency: r_{tt}=.91-.95; retest reliability: r_{ii}=.89-.92). In a pre-post design, one half of the sample was randomly assigned to receive computer treatment while the other half of the sample served as control group. The training was conducted for five weeks, consisting of two hours training a week. The trained individuals improved significantly on the affect recognition task, but not on any other measure. Results support the usefulness of the program to teach the detection of facial affect. However, the improvement found is limited to a circumscribed area of social-communicative function and generalization is not ensured.

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Autism is a severe and persisting developmental disorder characterized by a triad of impairments which includes a lack of social interaction, poor communicative skills and restricted stereotyped behaviors and interests. Furthermore, ICD-10 and DSM-IV require the onset of an abnormal development before the age of 36 months. The prevalence of the syndrome is estimated between 5 up to 20/10,000 (1,2), with boys probably being three times more often affected than girls. The aetiology of the disorder is still unknown, but genetic fundamentals are likely in the those cases where no other severe disease is found (3,4).

In the last years, neuropsychological concepts are getting ever more important for the understanding of autism (5,6). Currently, the three most fruitful theories are the lack of Theory of Mind (ToM)-approach, executive dysfunction and the notion of Weak Central Coherence. The ToM was first established in animal studies (7). Later is was picked-up by infant developmental psychology (8) and finally brought into the psychological research on autism (9). The ToM construct covers mental capacities enabling to understand, explain and predict psychological states of others and self. There is now a substantial body of literature showing that problems in ToM form a quite consistent part of the autistic syndrome (10). Even though the recognition of facial affect is also linked to another prominent psychological theory of autistic disorders (11), in contemporary research it has become a popular method of studying more complex ToM capacities. For instance, Baron-Cohen et al. (12,13) demonstrated that subjects with high functioning autism or Asperger-syndrome have difficulties judging emotions and mental states in the faces of others. Moreover, a fMRI-study by Schultz et al. (14) indicates a cortical correlate of face processing problems in autism spectrum disorders involving a reduced activation of the fusiform gyrus.

Today, no cure for autism is available. However, if the syndrome is detected early in life, functional verbal and cognitive skills are present and adequate intervention is carried out, sometimes remarkable quantitative improvements of the symptomatology can be achieved (15). Among other things, a comprehensive treatment of autism contains specific efforts in the area of social-communicative capabilities. For this purpose several techniques partly based on the ToM paradigm have been developed (e.g. 16). Computers are getting increasingly popular to facilitate therapy in autism. In the last two decades several
studies were published which confirm the potential benefits of computer-usage for clinical purposes (17-20).

In this paper we present the development and preliminary evaluation of a computer-based program to test and to train the recognition of facial affect in subjects with higher functioning autism. The objective of this program is to diagnose and support the development of social-communicative skills through the assessment and training of elementary emotion perception and interpretation. Such abilities are perhaps precursors of ToM-deficits (21).

PROGRAM-DEVELOPMENT
To create a computer-aided program to test and to train the capacity to judge facially expressed emotions on different levels, we first collected about 1000 photographs of female and male adult faces expressing a large spectrum of affect from people of different cultures. These included the pictures of facial affect by Ekman & Friesen (22), a series of pictures from colleagues from the district hospital in Regensburg and photographs taken ourselves in cooperation with actors from the Residenztheater in Munich. Like done before by other authors (e.g. 12,13), to engender two different levels of emotion recognition, we also narrowed each of the photos only showing the eyes. In a second step, all these pictures were digitalised and a computer-program was generated to norm them. The internationally known and applied cross-cultural concept of seven basic emotions (happiness, sadness, anger, disgust, fear, surprise, neutral) by Paul Ekman and colleagues (23) was chosen as the reference for rating the pictures of faces and eyes. Finally, using a standardized instruction, the photos of faces and eyes were judged by a mixed non-representative
A normative sample of 35 individuals, mostly students, nurses and non-clinical, non-academic staff of our department. This sample consisted of 23 female and 12 male subjects ranging from 17 to 47 years of age with a mean of 26.8 (SD=6.3). Their average non-verbal IQ on the Standard Progressive Matrices by Raven was 111.6 (SD=8.5). Thereafter, a selection of 50 photographs of faces and 40 of eyes was drawn, on which the sample had reached an agreement of 90% or more on one or two of the seven basic emotional states. These judgments were then viewed as “expected” or “correct” judgments. Using these 50 and 40 visual stimuli respectively and the corresponding normative data, two computer-based tests were designed (figure 1a,b) to tap the ability to recognize basic affect by facial play.

In addition to the test, a selection of 500 photographs was applied to install an adaptive training, complemented by visual and acoustic feedback for each of the faces presented. The mixed ability levels intended to foster the particular talents of each person. The feedback
was achieved by having “smilies” next to the right answer as well as a
convenient sound (figure 2a). If the answer was wrong then a feed-
back sign would be shown (Figure 2b). If the subject pressed it, the
right answer would appear with an explanation (figure 2c). After this
the person could press the “comic-strip” button in order to activate
an example for the corresponding emotion (figure 2d). These com-
ics were taken from “Teaching children with autism how to mind-
read” (16).

MATERIALS AND METHODS
The face-test and the eyes-test were investigated with regard to their
psychometric properties using classical test-theory. Objectivity in
administration, scoring and interpretation can be assumed being high,
as the complete implementation of the test is computer-based with a
minimum of proband/examiner interaction. In the normative sam-
ple, the internal consistency of the face-test reached a Cronbach’s
alpha $r=.95$ and the eyes-test of $r=.91$. Sixteen persons of the norma-
tive sample could be re-tested after 5 days up to 3 weeks. In this small
subsample the stability of the was $r_{II}=.92$ in the face-test and $r_{II}=.89$
in the eyes-test.

Evaluation
To evaluate the efficacy of the training module of the program, a
sample of $N=10$ male individuals with high-functioning autism or
Asperger-syndrome was collected, diagnosed using the German ver-
sions of the Autism Diagnostic Interview-Revised (24–26) and the
Autism Diagnostic Observation Schedule-Generic (27). The mean
age in this group was 27.2 years (16–40, SD=7.0), the mean IQ was
104.2 (58–126, SD=17.1). In a pre-post design, one half of the sam-
ple was randomly assigned to receive computer treatment while the
other half of the sample served to control for confounding effects.
The training ran over a period of five weeks, consisting of two hours
training a week. To determine the effect of the program, behavior
measures were taken before and after the training in each group.
Among others, these measures were the face and the eyes-test of the
same program and ratings of stimuli from the International Aflec-
tive Picture System (IAPS)(28). In addition, the cortical activity dur-
ing face processing in contrast to non-human objects was assessed in
both groups and a non-affected sample with fMRI-scans.
RESULTS
Nonparametric Wilcoxon-test (SPSS/Win. 10.0.7) showed a significant improvement in performance regarding the reading mind in the face (Z=1.9, p=.04) and eyes-test (Z=2.1, p=.03) only in the subjects with high-functioning autism or Asperger-syndrome who had been taught intensively with the training program. There was no improvement in the control sample, neither in face (Z=1.4, p=.11) nor in the eyes test (Z=.00, p=.99). Nevertheless, no other behavior parameter surveyed (e.g. IAPS) displayed a modification in behavior worth mentioning. The fMRI-studies revealed results quite in line with the findings by Schultz et al. (14). The procedure and the results of this part of the study are described elsewhere in detail (29).

DISCUSSION
Our first findings indicate the usefulness of the program to test and teach the capacity of facial affect detection. Concerning homogeneity and stability, the face and eyes-tests proved to be a reliable measures for the assessment of facial recognition. Thus, our data are consistent with recent findings by Silver and Oakes (30) who also successfully evaluated a program to teach people with autism or Asperger-syndrome to recognize and predict emotions of others. However, regarding the training module of the program, as we could not identify any significant intended behavior modification beyond the specific task fostered, it is rather unlikely that the improvements do remarkably generalise. On the other hand, it is not excluded that the better perception of facially expressed emotion in the test situation is transferred into everyday life. Furthermore, probands started imitating facial expressions, displayed signs of enjoyment during the intervention sessions and provided us new ideas for a revision of the program, which is planned together with an enlargement and enrichment. New training modules comprising more advanced social-communicative material, for instance film sequences of social stories as defined by Gray (31), will be installed.

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