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DO AUTISTICS HAVE A GENERALIZED FACE PROCESSING DEFICIT?

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The study presents results from a clinical test battery (Bruyer & Schweich, 1991; Schweich & Bruyer, 1993) that is used to study components in the face recognition system of autistic children. The results of the autistics are compared with the performance of two age groups of normal children (7–10 years, 12–16 years) and an adult control group. Autistic subjects, like young children, make more errors on a task in which they have to match facial features in the context of a complete face but not when the features are presented in isolation or in a simplified facial context. Finally, the sensitivity of the battery for clinical populations other than prosopagnosics is discussed.

Keywords: face-processing, autism, children.

Faces are an important source of information. We recognize people by the face, we use lip-read information when we try to understand speech, and in social interaction we pay much attention to eye direction and facial expressions. Another reason for the growing interest in face processing is the issue of specificity. Several arguments suggest that faces are "special" for the human information processing system. For example, infants as young as 10 minutes prefer to track a moving schematic face to a scrambled face (Goren, Sarty & Wu, 1975; Maurer & Young, 1983; Morton & Johnson, 1991). The effect of inversion upon face recognition has also been proposed as evidence for a special face processing mechanism, because the decrement in recognition by turning a face upside-down is disproportionately large compared to the inversion of other stimuli (Yin, 1969; Dallett, Wilcox & D'Andrea, 1968; Scapinello & Yarney, 1970; Diamond & Carey, 1986; De Gelder, Teunisse & Bertelson, 1993; for a review, see Valentine, 1988). Another argument that there is a specialized mechanism for face processing is related to a neuropsychological impairment: patients with prosopagnosia are unable to recognize a familiar person by the face (Bruyer, Laterre, Seron, Feyereisen, Strypstein, Pierrard & Rectem, 1983; De Haan, Young & Newcombe, 1992; McNeil & Warrington, 1991). This impairment is specific for faces, as these patients are able to recognize people by other cues, such as the voice and gait. The

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ability to recognize visually presented objects also remains relatively intact in these patients. Animal studies provide a further argument for face specificity: there are cells in the temporal cortex of monkeys that react selectively to faces (Harries & Perrett, 1991; Rolls, 1992; Perrett et al., 1988, 1992).

Although it is still a subject of debate whether these arguments are robust enough to support the notion that faces indeed are special (Hay & Young, 1982; Diamond & Carey, 1986), this focus has led to some very articulate ideas about the processing of faces (Goldstein & Chance, 1981; A.W. Ellis, 1992; Carey, 1992). An important finding is that face processing depends on several modular subprocesses. For example, it has become clear that there are different forms of prosopagnosia, depending on what subprocess is deficient (De Renzi, 1986; Damasio, Tranel & Damasio, 1990; De Haan et al., 1992; De Haan, 1989). Although all prosopagnosic patients fail at overt face recognition tasks, data from skin conductance measurements (Bauer, 1984; Tranel & Damasio, 1987), eye movement scan-paths (Rizzo, Hurtig & Damasio, 1987; Renault, Signoret, DeBruille, Breton, & Bolgertet, 1989), visual evoked potentials (Renault et al., 1989) and covert recognition tasks (De Haan et al., 1992) show that some subprocesses can still be intact.

To reach a detailed description of the exact nature of a particular prosopagnosic deficit a model is needed that incorporates these different subprocesses. The model that is most widely put forward in this context is that of Bruce and Young (1986). In this functional model, which took its inspiration in part from word processing models, various aspects of face processing are represented. According to the model, the different functions of face processing (expression analysis, facial speech analysis, directed visual processing and recognition of familiar faces) are independent processes. This means, for example, that an impairment in facial speech analysis (lip reading) has no consequences for the analysis of expression or the recognition of a familiar face, as indeed observed in De Gelder, Vroomen and van der Heide (1991). Only the stages that are involved in recognizing familiar faces are specified in the model. In the first stage a structural code of the image is derived (the face is identified as a face). This code is matched with codes in the face recognition units (the face is recognized as familiar). After this the semantic information of the person is accessed (the identity of the face is recognized). Finally, the name of the person is generated. An impairment in one of the early stages in this pathway has consequences for the later stages; according to the model it is not possible to remember the name of a face but not to remember who the person is.

On the basis of this model Bruyer and Schweich (1991) developed a clinical task battery to investigate face processing by prosopagnosia patients. This battery consists of 6 basic tests tapping the several stages in the Bruce and Young model. When a basic test suggests a specific impairment, subtests for that stage provide a possibility to look at the disorder in more detail. There are 13 optional subtests. They tested 72 normal subjects varying in age, sex and education with the battery. The performances of these subjects became the standard for evaluating the performances of prosopagnosia patients; a given score on a test was considered defective if it fell below the lowest score of the normals. One patient (PC) was described who appeared to have very selective impairments. With the help of the task battery it was possible to locate the deficiencies of PC in the architecture of the functional model.

Bruyer and Schweich (1991) suggested that the task battery can be used not only to investigate confirmed or suspected prosopagnosia, but that it can also be employed to explore other kinds of person recognition deficits. In this perspective, it is interesting to use the battery on a different clinical population. Subjects with autism have problems in the recognition of facial expressions (Hobson, Ouston & Lee, 1988; Weeks & Hobson, 1987). It can be questioned whether this deficit is specific to facial expression or that other stages in the face processing system are also impaired. Several studies suggest that autistic children have difficulties in remembering (De Gelder, Vroomen & van der Heide, 1991; Boucher & Lewis, 1992) and matching (Tantam, Monagham, Nicholson & Stirling, 1989) new faces, and that they are less sensitive to inversion of photographs in a face recognition task (Langdell, 1978; Hobson et al., 1988; Tantam et al., 1989). On the other hand, lip reading seems to be unimpaired in autistics, although they make less use of this visual information than normal children while listening to speech (De Gelder et al., 1991). The task battery can help to clarify which face processing stages are affected in people with autism and which are not.

Autism is a developmental disorder. Perhaps their face recognition system is not qualitatively different from that of normals but only slower in its development. In that case their performance on face recognition tasks would be similar to those of children. Recent evidence suggests that children, also, are much worse than adults in recognizing faces (Carey, 1981, 1992; H.D. Ellis, 1992). Especially when the faces have undergone some sort of transformation (age, expression) children find it very difficult to recognize a face (Carey, 1992). They are easily distracted by clothes (Diamond & Carey, 1977), although this difference is reduced when the faces are very dissimilar (Flin, 1980) or familiar (Diamond & Carey, 1977). A change in environmental context between study and test also confuses the child (Markham, Ellis & Ellis, 1991). Between the age of 5 and 10 years old the ability to recognize people gradually improves (Feinman & Entwistle, 1976). Surprisingly, between ages 10 and 12 years this improvement comes to a halt, sometimes followed by a decline in performance, to reach the adult level only after puberty (Carey, Diamond & Woods, 1980; Flin, 1980). The reason for this developmental dip is not known. Carey (1981) suggests that in this period the children shift to a different encoding strategy for faces going from piecemeal to configurational encoding. Another possibility is that the dip is a reaction to hormonal changes in puberty (Diamond, Carey & Back, 1983). The dip is not typical to face recognition; it is also found for the recognition of voices (Mann, Diamond & Carey, 1979), pictures (Flin, 1980) and tones (Spreen & Gaddes, 1969).

In this paper, the task battery for face recognition (Bruyer & Schweich, 1991) was used to study two issues in face processing in autistics. In the first place, an answer is sought to the question whether the face deficit is localized in specific subdomains of processing or whether it extends over the whole face processing system. Moreover, the impact of developmental factors is investigated by administering the battery to children. In order to examine the developmental dip, the children are split into two age groups: a pre-dip group (7–10 years old) and a post-dip group (12–16 years old). Both the scores of the autistic subjects and the normal children are compared to the adult group. If the pattern of scores between the autistic subjects and the children is different then the face processing deficit of autistics is not just the result of a slow development, their face processing system would function qualitatively different from normals.

METHOD

Subjects

The 20 autistic subjects (19 male, 1 female) varied in age from 7 to 34 years. This large range made it possible to get an impression of developmental changes in autistics. There were 5 subjects between 7 and 11 years old, 11 subjects between 12 and 16 years old, and 4 subjects between 19 and 34 years old. They had been diagnosed according to DSM-III-R criteria (1987) as autistic.

There were 3 control groups: a "pre-dip" and a "post-dip" group (before and after the developmental dip in face recognition (Carey et al., 1980; Flinn, 1980)), and an adult group. The pre-dip group were 32 children (2 female) with ages varying from 7 to 10 years, with 4 left-handed children. The post-dip group (all male) varied in age from 12 to 17 years. Of the 29 subjects in this group, 6 were left-handed.

Thirty normal adult university students (12 male, 18 female), with ages varying from 19 to 34 years (mean = 25 years), were tested to make a comparison with the results of the high-educated, 20–40 age group of Bruyer and Schweich (1991). Four female subjects were left-handed, all male subjects were right-handed.

Nonverbal intelligence of the autistic and the two children groups was measured with the Raven SPM. The raw scores are given in Table 1, together with the age characteristics. The scores of the autistic subjects were lower than the scores of the post-dip group (p = .014) and somewhat higher than the scores of the pre-dip group (p = .034).

The Clinical Test Battery for Face Recognition

The neuropsychological test battery constructed by Bruyer and Schweich (1991) consists of 6 basic tests and 13 optional tests. In the present study all the basic tests were used, but only two of the optional tests (2A and 2B) were included. Test 6 (Famous Faces) was adapted to the Dutch situation.

Test 1: facial decision. The stimulus set contained computer-drawn pictures of 12 normal faces and 12 nonfaces. The nonfaces either missed a facial feature (nose, mouth, eyes), or the features of the face were scrambled. The instruction was to classify the stimuli as face or nonface under time pressure.

Test 2: visual analyses of facial features. A target facial feature (eyes, nose, mouth) was surrounded by 4 features of the same kind. The subject had to match the target feature to one of the four candidates. There were 9 items (3 per feature).

—*Test 2A: Complete Context*: The same, but the features were now included in the con-

TABLE 1
Mean Age and Standard Deviation (S. D.), the Number of Subjects in 3 Age Ranges (7–11 Years, 12–17 Years, 19–34 Years), and the Raw Scores on the Raven SPM for the 4 Groups

Group	Age (S.D.)	7–11 years	12–17 years	19–34 years	Raven SPM (S.D.)
Autist	16;0 (6;10)	5	11	4	39.3 (10.7)
Pre-dip	8;10 (1;2)	32	0	0	33.2 (8.1)
Post-dip	14;10 (1;6)	0	29	0	45.5 (5.6)
Adult	24;9 (3;9)	0	0	30	—

text of a complete face. The candidate features were placed in the same facial context as the target.

—*Test 2B: Partial Context*: The same, but the features were included in a partial context of a face (only hair, ears and chin).

Test 3: visual analysis of faces. —*Across expression*: In 12 items the subject had to match a colored photograph of a person with the photograph of this same person but with a different expression. There were 9 candidates, all of the same sex.

—*Across pose*: The same, but the target picture differed in pose (full-face or 3/4-profile) from the 9 candidates. The expression of the faces was neutral. The task consisted of 10 items.

Test 4: visually-directed semantic codes. —*Sex*: There were 10 photographs of men and 10 photographs of women (all unfamiliar). Under time pressure, the subject had to classify the photographs for sex.

—*Age*: There were 30 pictures of unfamiliar persons: 10 children, 10 adults and 10 older people. The subject had to categorize, as quickly as possible, by age.

Test 5: expression analysis. On Table 3 written labels were displayed: "triest" (sad), "vrolijk" (happy), and "zegt 'O'" (says 'O'). Every label corresponded to 4 colored photographs of unfamiliar persons (12 photographs in total). The task was to classify, under time pressure, the photographs into the 3 categories.

Test 6: famous faces. The material consisted of 48 photographs of faces, half famous people and half unfamiliar people. First the subject classified the photographs into familiar-unfamiliar categories. Then the subject was asked to name the people that were sorted as famous.

RESULTS AND DISCUSSION

The mean scores of the 4 groups are given in Table 2. Because the performances are near ceiling a statistical analysis on the mean scores is not appropriate. Therefore, the comparison of the means of the groups is on a descriptive level. Individual scores of the autistic subjects were set against the lowest score of the normal groups.

Normal Subjects

The performances of the adult subjects are near perfect on every test. There are not many differences with the results of the high-educated, 20–40 age group of Bruyer and Schweich (1991). The only differences that were found are caused by one subject, a 24-year old male student, who had low scores on test 2A, 2B and 4B.

The post-dip group (12–17 years old) was not much different from the adult group. These subjects were only somewhat worse on the naming task of famous faces (test 6b), but this is probably due to their knowledge of famous people and not to a different way of processing, as the correlation with age within this group illustrates ($r = .56$, $p < .01$).

TABLE 2
Maximal Score, Random Performance, and Observed Performance (Mean Value, the Lowest Value Between Parentheses) for Each Test of the Clinical Battery

Test	Max.	Rnd.	Adult (n=30) Mean (lowest)	Post-dip (n=29) Mean (lowest)	Pre-dip (n=32) Mean (lowest)	Autist (n=20) Mean (lowest)
1. FACIAL DECISION	24	12	23.60 (21)	23.34 (21)	22.84 (20)	23.40 (22)
2. FACIAL FEATURES	9	2.25	8.97 (8)	9 (9)	8.75 (7)	8.95 (8)
2A. complete context	9	2.25	8.63 (6)	8.34 (6)	6.56 (2)	7.00 (2)
2B. simplified context	9	2.25	8.57 (6)	8.59 (7)	7.97 (4)	8.20 (6)
3. EXPRESSION-INDEPENDENT DESCR.	12	1.33	11.93 (10)	11.97 (11)	11.16 (8)	11.40 (10)
POSE-INDEPENDENT DESCR.	10	1.11	9.97 (9)	9.97 (9)	9.28 (7)	9.55 (8)
4. VISUALLY DERIVED CODES: gender	20	10	19.57 (19)	19.79 (19)	19.13 (18)	19.25 (18)
age	30	10	28.60 (23)	29.55 (28)	29.19 (22)	27.95 (21)
5. FACIAL EXPRESSIONS	12	4	11.67 (10)	11.90 (10)	11.56 (9)	11.60 (10)
6. FAMOUS FACES: famil. decision	48	24	45.80 (41)	42.52 (33)	30.81 (19)	34.40 (24)
naming	24	0	21.50 (15)	16.62 (7)	4.47 (0)	8.65 (0)

Although the pre-dip group (7–10 years old) made somewhat more errors than the post-dip group on almost all the tests, their performances were still extremely good. Only on test 2A (facial features in a complete context) and test 6 (famous faces) were the results significantly worse. Again, for test 6, this is probably due to the fact that most famous faces were not yet famous to these children. The correlation with age was .74 ($p < .01$).

There was also a significant correlation between test 2A and age in the pre-dip group ($r = .37, p < .05$). The younger a child is, the more difficult this task is for him/her. Their good performances on the same task but with isolated features (test 2) show that they are able to detect differences between facial features. It is the context in which the features are placed that confuses the child, suggesting that young children have problems finding the relevant features. After the developmental dip there is no longer a correlation with age, which suggests that at that time this ability has matured.

The same is true for task 3: the visual analyses of faces, both across expression and pose, is correlated with age before the dip but not after it. This confirms the finding of Carey (1992) that young children have problems with recognizing faces when the faces have undergone some sort of transformation.

Autistic Subjects

The results of the autistic subjects appear to be very similar to those of the normal: they recognize more famous faces when they get older (although they recognize fewer faces than people of their own age), their visual analysis improves, and they also show ceiling effects on most tasks. There are, however, some interesting differences.

Like young children, autistic subjects made more errors on test 2A, where they had to compare facial features in the context of a complete face. But, different from these children, there was no significant correlation with age. Although Figure 1 shows that most sub-

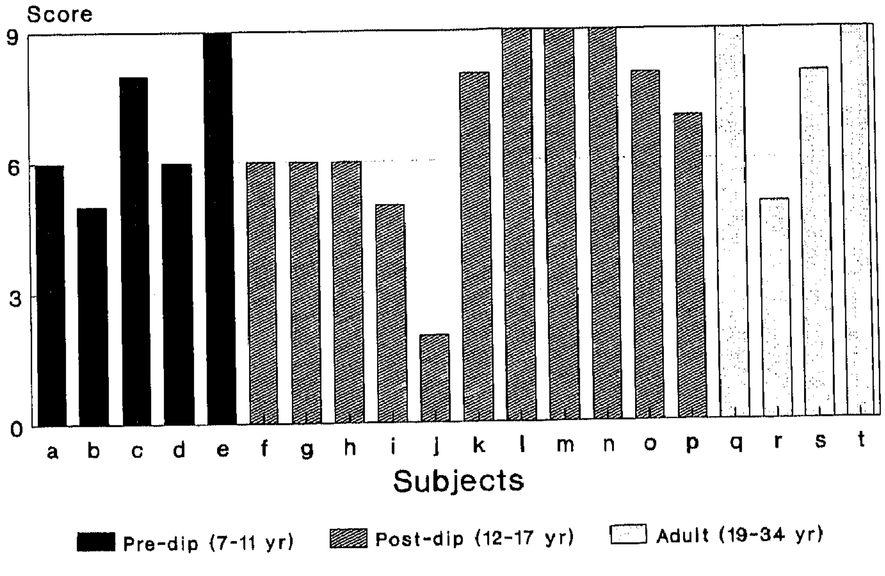

FIGURE 1 Individual scores of the autistic subjects (a t/m t) on test 2A: Complete Context.

jects older than 14 years performed better than the younger ones, there are still some subjects who failed on this test. This suggests that at least some autistics do not learn to analyze a face into its relevant details.

The autistics were not worse than the control groups on the recognition of facial expressions. One reason for this may be the type of task. In a face matching task the performance is dependent on the ability to compare faces on their physical appearance. In this particular task, there are only three different facial expressions (happy, sad and "says O"), and the physical appearances of these expressions are so different that categorization can be done without any judgement concerning the emotional content. What this task proves is that autistics are able to discriminate faces, but this may not be based on the recognition of facial expressions.

CONCLUSION

The goal of this study was to study the face processing system of autistics and children, using the task battery for face recognition developed by Bruyer and Schweich (1991). The main result is that the performance on a task concerning the matching of facial features in the context of a complete face is worse for young children and autistics. The crucial factor in this task is the facial context, which makes it necessary to scan for the relevant feature before the comparison is possible. Other results were near ceiling, or dependent on age (test 6: Famous Faces). Apparently, the battery is easy for both young children and autistics. This suggests that most of the possible face modules are functioning normally at an early age. Only the recognition of faces that have been changed in pose or expression (transformation) and the scanning of a face for a relevant feature are difficult tasks for children. These processes need more time to develop, perhaps because they are not modular like the processes involved in the other tasks. The recognition over transformations and the scanning for relevant features are both tasks that could be more dependent on higher order processes which need more time to develop.

The near-ceiling performances raise the question, if the task battery, which is designed to investigate prosopagnosia, is useful for other clinical populations and young children. The tasks battery is too easy for these groups, which makes it insensitive to possible subtle differences in face processing between children and autistics.

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