Eur Arch Psychiatr Neurol Sci (1986) 235:282–291

European Archives of Psychiatry and Neurological Sciences

Impairment of Perception and Recognition of Faces, Mimic Expression and Gestures in Schizophrenic Patients*

Katharina Berndl[1], **M. von Cranach**[2], **and O.-J. Grüsser**[1]

[1]Physiologisches Institut der Freien Universität Berlin, Arnimallee 22, D-1000 Berlin 33
[2]Bezirkskrankenhaus Kaufbeuren, D-8950 Kaufbeuren, Federal Republic of Germany

Summary. The perception and recognition of faces, mimic expression and gestures were investigated in normal subjects and schizophrenic patients by means of a movie test described in a previous report (Berndl et al. 1986). The error scores were compared with results from a semi-quantitative evaluation of psychopathological symptoms and with some data from the case histories.

(a) The overall error scores found in the three groups of schizophrenic patients (paranoic, hebephrenic, schizo-affective) were significantly increased (7-fold) over those of normals. No significant difference in the distribution of the error scores in the three different patient groups was found.

(b) In 10 different sub-tests following the movie the deficiencies found in the schizophrenic patients were analysed in detail. The error score for the averbal test was on average higher in paranoic patients than in the two other groups of patients, while the opposite was true for the error scores found in the verbal tests.

(c) Age and sex had some impact on the test results. In normals, female subjects were somewhat better than male. In schizophrenic patients the reverse was true. Thus female patients were more affected by the disease than male patients with respect to the task performance.

(d) The correlation between duration of the disease and error score was small; less than 10% of the error scores could be attributed to factors related to the duration of illness.

(e) Evaluation of psychopathological symptoms indicated that the stronger the schizophrenic defect, the higher the error score, but again this relationship was responsible for not more than 10% of the errors. The estimated degree of acute psychosis and overall sum of psychopathological abnormalities as scored in a semi-quantitative exploration did not correlate with the error score, but with each other. Similarly, treatment with psychopharmaceuticals, previous misuse of drugs or of alcohol had practically no effect on the outcome of the test data.

(f) The analysis of performance and test data of schizophrenic patients indicated that our findings are most likely not due to a "non-specific" impairment of cognitive function in schizophrenia, but point to a fairly selective defect in elementary cognitive visual functions necessary for averbal social communication. Some possible explanations of the data are discussed in relation to neuropsychological and neurophysiological findings on "face-specific" cortical areas located in the primate temporal lobe.

Key words: Face recognition – Mimic recognition – Gesture recogniction – Schizophrenia

Introduction

In everyday life, besides spoken and written language, non-verbal signals are used for social communication. The knowledge of some of these signals is acquired from day to day and depends upon the socio-cultural background (e.g. certain gestures in social contact, traffic signs, signs of military rank, schematic figures characterizing a certain type of human activity, etc.). The generation of a part of non-verbal social signals is predominantly determined by inborn premotor neuronal operations controlling motor output. As a rule, such signals are "automatically" recognized by means of corresponding inborn cognitive mechanisms.

The face is not only the source of mimic signals, but also the most characteristic structure of individuality. Thus, the ability of man to recognize and discriminate thousands of different faces during his lifetime constitutes an important factor in social life. The hypothesis that mimic and gesture are partly genetically determined and caused by inborn neuronal mechanisms controlling expression, perception and recognition of such signals is deduced mainly from the fact that certain mimic and gesture signals are used and understood universally in establishing the first contacts between persons of different languages and cultures (Darwin 1872; Ekman 1973; Eibl-Eibesfeldt 1967; Salzen 1981).

It is a well-known clinical observation that many schizophrenic patients in comparison to normals have considerable difficulty in social contact, tend to be socially isolated to some extent and frequently show signs of distrust and a "paranoic" interpretation of events in their social field. In a considerable number of schizophrenic patients mimic or gestural expressions are impaired. Paramimic and paragestural movements, partially of an "automatic" type, are observed in schizophrenic patients, especially in those suffering from this disease over several years. These symptoms are not necessarily caused by neuroleptic treatment, since they were well-known to psychiatrists of the 19th century. The ability of schizophrenic patients

Offprint requests to: O.-J. Grüsser at the above address

* Dedicated to Professor D. Ploog, Max Planck-Institut für Psychiatrie, München, on occasion of his 65th birthday

to *perceive* and *recognize* non-verbal social signals and faces has to our knowledge never been studied quantitatively. Within the framework of a more extensive research program on the ability of brain-lesioned patients to perceive and understand verbal and non-verbal communicative signals we have developed a film test designed to study the perception of simple non-verbal social signals. This test has been described in a previous report (Berndl et al. 1986). To learn more about possible quantitative impairment in schizophrenia in the perception and recognition of faces, mimic expression and gestures, we applied this movie test to a large group of schizophrenic patients ($n = 81$). The results will be described in the present report. Parallel to this investigation we examined the ability of schizophrenic patients to recognize photographs of faces in a slide projection test. The data described in the present report have been previously presented (Berndl et al. 1983).

Materials and Methods

The Patient Group. Between summer 1982 and spring 1983 we studied 81 schizophrenic patients who were being treated at the Bezirkskrankenhaus Kaufbeuren, the local psychiatric State hospital in the district of Schwaben (Bavaria, Germany). All patients participated in the test on a voluntary basis. They had been informed that our test was primarily for scientific purposes. Only 4 out of 85 patients refused to participate.

Of the 81 patients, 45 suffered from a paranoic-hallucinatory form of schizophrenia, 25 from a hebephrenic, 8 from a schizo-affective and 3 from a catatonic form. The psychiatric diagnosis "schizophrenia" and the sub-classifications were controlled in all patients by at least three psychiatrists. All patients fulfilled the diagnostic criteria of the DSMIII manual. Of the patients 42 underwent an additional psychiatric examination by the senior author (O.-J. G.); all other patients were examined by the junior author (K. B.). The results of these examinations (lasting 1 to 5h) together with the case history from the clinical records formed the basis for a semi-quantitative evaluation of the psychopathological state as described in the following.

Semi-Quantitative Evaluation of Psychopathological Symptoms. The history of illness in all 81 patients was carefully examined and the current psychotic state was scored by two independent examiners. A set of psychopathological signs considered to be important for the present study was used to classify the psychotic state (Table 1). For quantitative evaluation four categories were applied: "0" meant absence of a certain psychopathological sign, "1" presence of this sign but only recognizable on thorough psychiatric examination, "2" the psychopathological abnormality was immediately evident in the behavioural pattern or verbal expression of the patient, "3" indicated a very distinct psychopathological symptom, affecting the social interaction of the patient directly (the distribution of these scores has been published as Table 33 in Berndl 1985). In addition to the evaluation of specific psychopathological symptoms, other important data of the patients' history and treatment were noted and used for further statistical analysis: age, sex, education, overall duration of illness, total time

Table 1. Patients' data and scored psychopathological symptoms used for further analysis

1. Number
2. Ward
3. Family name
4. First name
5. Age
6. Age at illness onset
7. Duration of illness
8. Most recent diagnosis
9. Degree of schizophrenic defect
10. Sex
11. Educational level
    a. special school for slow learners
    b. primary school
    c. intermediate school
    d. secondary school
12. Social class
    a. lower class
    b. middle class
    c. upper class
13. Class mobility
14. Marital status
    a. married
    b. divorced
15. Hallucinations
    a. acoustic
    b. visual
    c. tactile
    d. coenesthetic
    e. vestibular
    f. olfactory
    g. gustatory
16. Pseudohallucinations
17. Illusions
18. Other perceptual disturbances
19. Facial perception
    a. hallucinatory
    b. while dreaming
    c. mistaken identity
    d. misinterpretation of expression
20. Feeling threatened
21. Delusional ideas
22. Delusion
    a. systematic
    b. erotomania
    c. other
23. Orientation
    a. temporal
    b. local
24. Thought disturbances
    a. formal
    b. neologism
25. Schizophasia
26. Disturbance in consciousness of self
    a. depersonalisation
    b. general changes
27. Suicide (attempts)
28. Depression
29. Motor disturbance
    a. motor stereotypes
    b. cataleptic
    c. catatonic
30. Drugs
31. Alcohol
32. Number of hospitalizations
33. Duration of hospitalization
34. Psychopharmaceuticals
35. Electroshock therapy
36. Insulin therapy
37. Familial predisposition
38. Emotional disturbance
    a. hypomanic
    b. aggressive
    c. inhibited
    d. foolish
39. Degree of psychosis

Table 2. Average age of normal subjects and patients

Normal	Total	Male	Female				
Mean $\bar{x}$	40.3	38.9	41.2				
SD	16.9	13.6	19.4				
SE	1.9	2.3	2.9				
Median	36.5	34.5	39.5				
n	78	36	42				
Patients	Total	Male	Female	PH	H	SA	K
Mean $\bar{x}$	35.9	33.1	39.1	39.5	28.7	32.4	43.3
SD	11.9	11.2	12.1	12.5	7.99	8.3	13.3
SE	1.3	1.6	2.1	1.3	1.6	2.9	7.7
Median	35.0	30.0	39.0	39.0	28.0	32.0	50.0
n	81	46	35	45	25	8	3

spent in psychiatric hospital (Table 1). The amount and type of medication and other forms of physical treatment were scored on the basis of the clinical records, which, however, were not complete for all patients. Four classes of drug therapy (0 = no psychopharmaceutical therapy to 3 = long-lasting high-dosage therapy leading to more or less pronounced extrapyramidal symptoms) were formed. As with the psychopathological classes, these also have to be considered as rough estimates. Abuse of narcotic drugs and alcoholism were also noted. In addition we estimated the "overall degree of psychotic impairment" on the day of the test, whereby 10 levels (0 to 9) were applied. For this evaluation we applied our impressions gained during the examination of the patients, whereby social interaction and contact, content and structure of verbal expression, paranoic symptoms, emotional disturbances and thought disorders in particular were observed. By means of a similar subjective evaluation the overall degree of schizophrenic defect was scored in four categories (0 to 3): 0 = no sign of schizophrenic defect, 1 = defect detectable on exploration, 2 = defect leading to impairment of social interaction, 3 = severe defect, i.e. disturbance of thought, mental order and emotional responses.

Normal Control Group. A total of 78 normal adults (36 men and 42 women) served as controls. Psychiatrically inconspicuous persons living in the city of Berlin, the small town of Kaufbeuren and in a rural region of the Bavarian Forest were asked to serve as volunteers in the tests. With this combination of normal subjects we tried to match the general social background of our patient group, about half of which had their homes in a rural region of the southwestern part of Bavaria. As Tables 2 and 4 indicate, the average age of the normal subjects was slightly higher than that of the patients but corresponded approximately to the average age of the largest patient group (paranoic-hallucinatory schizophrenics). Since age of the normal subjects correlated with error score with a slope of only 0.075% errors/year (linear correlation coefficient for the overall error score with age $r = 0.47$), our "normal" data served as a fairly safe basis for comparison with data from patients. Since the level of education slightly affected the test performance and the normal subjects had, on average, a higher educational level than the group of patients, we also compared the patients' test data with those of a sub-group of 41 normals, in which only subjects with elementary or middle school level of education were included. This second reference group of normals definitely had no educational advantage over the patient group.

The Movie Scenes and the Tests Applied. The test by which we tried to evaluate the ability of the subjects to perceive and recognize mimic and gestures has been described in detail in a previous report (Berndl et al. 1986).

Data Analysis. A digital computer (HP-1000) was used for further processing of the psychopathological and experimental data. Beforehand, each patient was identified by a code number. Age, sex, educational level, social group, the test results and the semi-quantitative psychopathological and clinical data were stored in the computer memory, altogether 184 items for each patient. No names or other personal information were stored in the data bank, which was covered by a security code known only to the authors. All computer print-out material was locked-up. Thus, the prevention of any misuse of patient or normal subject data was guaranteed.

For the data analysis standard programs computing algebraic mean, standard deviation (SD), standard error of the mean (SE), median and other characteristics of the distributions such as kurtosis or skewness, linear correlation coefficients etc. were computed (the computer programs were adapted for our purposes by Dipl. Ing. L.-R. Weiss).

Factors Possibly Influencing the Test Data. Responses in a test designed to study the ability to perceive and recognize socially relevant visual signals are dependent on factors which are not directly related to schizophrenia. Thus we had to consider or exclude the impact of such factors on the data obtained in the present study.

(a) Visual Acuity. The test films could be correctly recognized and the tests correctly performed by normal subjects having a visual acuity of 0.1 to 0.2 (myopics without glasses). According to the clinical data, normal visual acuity (>0.5 min of arc^{-1}) was present in all our subjects. Glasses were worn when necessary. Thus, we can assume that the factor visual acuity did not affect our test data.

(b) Colour Vision. Since the actors were uniformly dressed in black and the brightness contrast of the movies was good, we assumed that subjects with a colour vision defect (anomalous trichromates or dichromates) would not be impaired in their test performance. We therefore did not conduct colour vision tests on normal subjects or patients and relied on negative clinical reports in this matter.

(c) Normal verbal understanding and the ability to read and speak, necessary requirements for this study, were tested in normals and schizophrenic subjects. We applied the trial scene SI very carefully for this purpose and demonstrated repeatedly if necessary what the patient was expected to do. Only when we had gained the impression that he had really understood the test did we proceed with the investigation.

(d) Cooperation of the Subject. The tests, of course, required good cooperation on the part of the subject. Since all our normals and patients had participated on a voluntary basis, cooperation was judged to be very good by the experimenters. Additional pauses during the tests as required by the patients were made. This was the case, however, in less than 5% of the schizophrenic patients and in none of the normals.

(e) Attention and Decision Time. For each test, a 10-s concentration period was required to inspect movie scenes. As Fig. 7

in Berndl et al. (1986) demonstrates however, much shorter periods of time were sufficient to grasp the essential message of the movie scenes. Therefore, the sequence of averbal signals presented in the 10-s scenes was highly redundant. The "decision time" in the sub-tests T1–T10 was measured by means of a stop-watch. The average decision time for each of the 120 tests was 2.0 s in normals. In schizophrenic patients the average decision time was significantly longer, 5.4 s per test. A positive correlation with error score and decision time was found in patients ($r = 0.57$) and normals ($r = 0.41$). We allotted all subjects the decision time required, however, and did not ask a "slow" subject to respond faster. It is evident from the more than double decision times required on average by the patients that the differences found between the error scores of normals and schizophrenic patients would certainly have increased if decision time had been limited, e.g. to three times that required on average by normals. Since we were anxious to avoid all unnecessary stress, we decided not to limit the decision time.

The experimenter (and/or a second observer) watched the patients carefully for signs of lowered attention or distraction of attention. Whenever a patient wished to have a movie scene repeated before the first test was started, this was done, although this was rarely necessary (in less than 1% of the schizophrenic cases). All experiments were performed in a very quiet room with a low background luminance (about 0.5 cd m^{-2}).

(f) Short-Term Momory. The individual movie scene had to be remembered for at least 1 to 3 min depending on the overall time required by the patients to perform the 5 sub-tests following. Judging from the clinical records and the results of the psychopathological examination none of our patients or normals suffered from severe impairment of short-term memory. Patients suffering from organic cerebral diseases in addition to schizophrenia were not included in the experimental group.

(g) Motor Ability to Point to the Test Photographs. Normals and schizophrenic patients usually used the dominant hand to point to the figures or the word they selected from the five possibilities (Figs. 1, 2 and 3 in Berndl et al. 1986). None of the subjects had any motor impairment in this task.

Results

1. Overall Error Score

Figure 1 displays the overall error score found in normals, all schizophrenic patients and the three sub-groups of schizophrenic patients (paranoic-hallucinatory, hebephrenic, schizoaffective). The highly significant increase in errors in schizophrenic patients as compared to normals (*t*-test, $P < 0.001$) was also visible when one compares the distribution of the error scores for the normal and patient groups (Fig. 2). Analysis of the overall error distribution in the three different patient groups (the 3 catatonic patients not included) revealed no significant difference between the three classes of schizophrenic patients investigated (Table 3).

2. Error Scores in the 12 Different Movie Scenes and the 10 Sub-Tests

Figure 3a displays the average error scores in all 10 tests found in schizophrenic patients and normal subjects in the 12 different movie scenes. The linear correlation coefficient between the values of these figures obtained in the normal and patient group was 0.87.

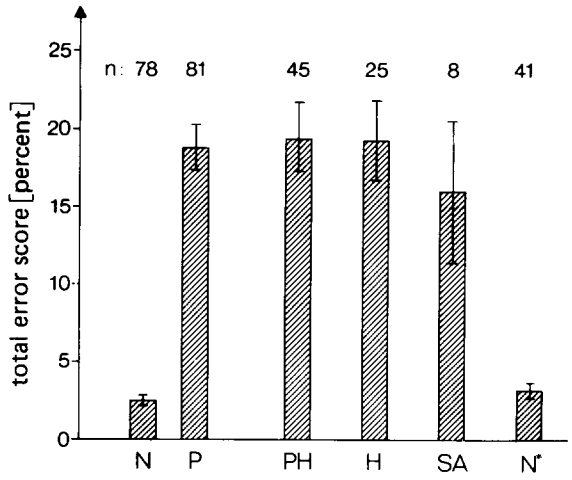


Fig. 1. Average total error score obtained in two groups of normals (*N*, *N**), all patients (*P*) and the three sub-groups of schizophrenic patients (*PH* = paranoic-hallucinatory; *H* = hebephrenic; *SA* = schizoaffective). Algebraic mean and standard error; *n* = number of subjects in each group. The group *N** ist the sub-group of *N* excluding subjects with high school and university education

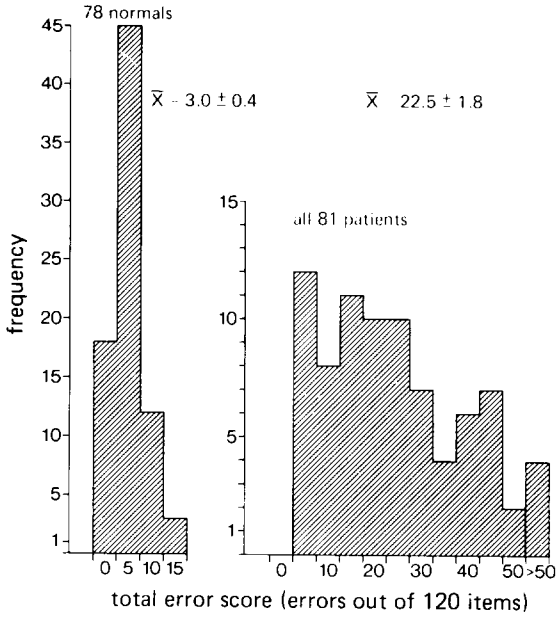


Fig. 2. Distribution of total error score in normals and all 81 schizophrenic patients

Thus the somewhat variable difficulty level of the 12 scored movie scenes affected both normals and patients in a similar manner. The overall error score for the test following the movie scenes was in all of the 12 movie scenes significantly higher in patients than in normals at a $P < 0.001$ level (*t*-test).

Figure 3b shows the error scores in the 10 different tests applied. In all tests the significance level for the difference between the data of normals and patients was again significant at the 0.1% error level (*t*-test). The linear correlation coefficient between the average data obtained in patients and in normals shown in Fig. 3b was $r = 0.53$.

Table 3. Error scores for the 10 different sub-tests. Patients, different types of schizophrenia

Patients	Error score (%)	T_1–T_{10}	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
PH ($n = 45$)	$\bar{x}$	19.4	21.7	16.7	21.7	12.5	25.8	18.3	25.0	18.3	18.3	15.0
	SD	17.2	2.0	1.9	2.1	1.9	2.3	1.8	2.5	2.7	2.5	2.3
	Median	19.5	16.7	16.7	8.3	8.3	25.0	16.7	25.0	8.3	16.7	8.3
H ($n = 25$)	$\bar{x}$	19.3	15.0	11.7	20.0	10.0	17.5	20.0	35.0	21.7	22.5	20.0
	SD	15.2	1.7	1.4	1.6	1.3	1.8	2.6	3.5	2.8	2.7	2.6
	Median	21.0	16.7	8.3	16.7	8.3	16.7	12.5	16.7	16.7	16.7	16.7
SA ($n = 8$)	$\bar{x}$	16.1	11.7	8.3	8.9	7.5	15.0	11.7	34.2	27.5	28.3	9.2
	SD	15.3	1.9	0.9	0.9	1.4	2.6	2.1	2.5	3.9	3.8	1.5
	Median	15.5	8.3	8.3	8.3	4.2	8.3	4.2	33.3	12.5	16.7	8.3
Total ($n = 81$)	$\bar{x}$	18.8	17.9	14.5	19.6	11.1	21.7	18.4	29.3	20.1	21.2	16.2
	SD	16.5	2.0	1.7	1.9	1.6	2.2	2.1	2.9	2.8	2.7	2.3
	Median	19.5	16.7	8.3	16.7	8.3	16.7	12.5	25.0	8.3	16.7	8.3

Figure 4 summarizes the average error scores for the averbal tests T1 to T5 and the verbal tests T6, T8 and T9 in normals and the three groups of schizophrenic patients. A tendency to less errors in the averbal tests and more errors in the verbal tests existed in the group of patients suffering from schizo-affective psychosis as compared to the two other groups of schizophrenics, but since only 8 schizo-affective patients were investigated, these differences were statistically not significant. In the 10 different sub-tests the differences in error scores between the 45 paranoic hallucinatory and the 25 hebephrenic patients were not statistically significant (5% error level as criterion, Table 3).

3. The Effect of Age and Sex on Error Scores

The 81 patients were further divided into 5 age groups. In the patient group and in the control group the overall error score increased with age (Fig. 5). The linear correlation coefficient between age and overall error score was found to be 0.47 in the normal group and 0.25 in the group of patients. As judged from the linear regression equation the increase in error score with age was on average 0.08% per year in normals and 0.28% per year in the schizophrenics. The effect of age on the test results will be analysed in detail in a later paper (including data obtained in another group of adolescent schizophrenics).

In normals the overall test performance of female subjects was somewhat better than that of male subjects, but did not reach any significance level (t-test, $P<0.05$, Fig. 6a). In schizophrenic patients the reverse was true, but male superiority did not reach a significance level (Fig. 6b). When, however, the impairment of perception and recognition of mimic and gesture expression in schizophrenic patients was expressed in units of error score found in normals, the relative reduction in test performance was considerably stronger in the female schizophrenic patients than in male patients (Fig. 6c).

4. Duration of Illness and Treatment in Psychiatric Hospitals

The time between the onset of clinically evident schizophrenia in our patients and the present investigation could be determined fairly reliably from the patients' clinical records. We formed 5 different groups under "duration of illness". The distribution of the average error score in these 5 groups indicated a slight effect of this factor. The linear correlation coefficient between average error score and duration of schizophrenic disease was fairly low ($r = 0.33$) for all 81 patients, indicating that at the most 10% of the errors can be attributed to factors depending on the duration of illness. The correlation coefficients found for test data and duration of treatment or illness in the different subgroups are shown in Table 4.

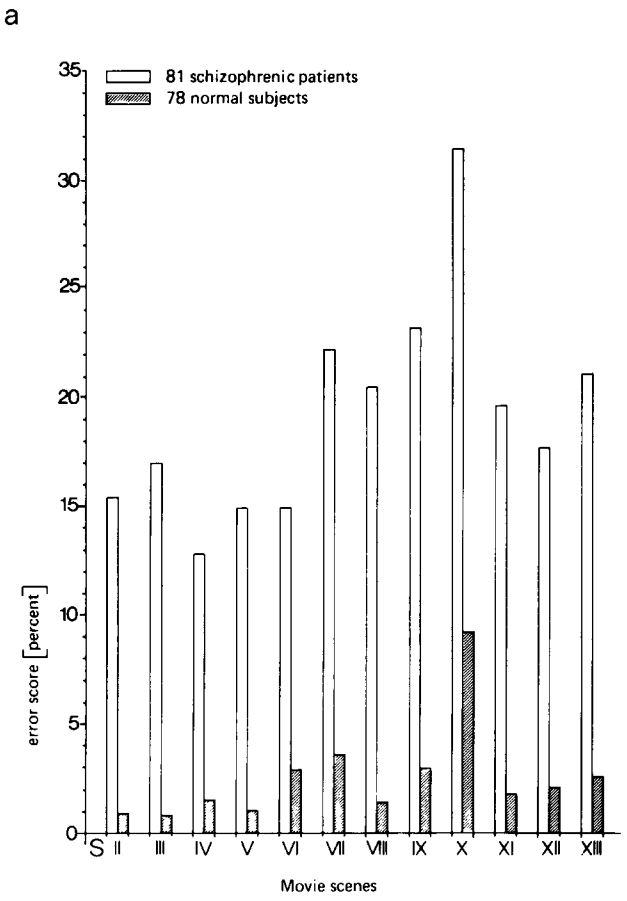
The overall length of treatment in psychiatric hospital also loosely correlated with the error scores (Table 4).

5. Error Scores, Schizophrenic Defect, Acute Psychotic State and Overall Psychopathological Abnormality

As mentioned in Materials and Methods, all psychopathological evaluations depended necessarily on the subjective decision of the two investigators. Their classifications were based on qualitative decisions and should be taken as a result of estimates and not measurements. The evaluations were performed, of course, before the tests were applied. None of the individual psychopathological abnormalities scored (Table 1) gave evidence of a major impact on the outcome of the test results, with the exception of the degree of schizophrenic defect. Dividing the patients into 4 groups of different degrees of schizophrenic defect (Fig. 7a), a clear tendency to increase in error score with increase in degree of schizophrenic defect became apparent. The estimated "degree of acute psychosis" was of little consequence to the overall error score. When we took the overall "sum" of psychopathological abnormalities, this sum, not unexpectedly, correlated with the degree of acute psychotic state. Hence, the overall psychopathological score only loosely correlated with the error score (Fig. 7b and Fig. 30 in Berndl 1985).

6. Psychopharmaceuticals, Narcotic Drugs, Alcohol

As described in Materials and Methods, we divided the patients into 4 groups with respect to treatment with psychopharmaceuticals. Hereby the overall amount of psychopharmaceuticals, the acute treatment during the 2 months preceding the test and the neuroleptic efficiency of the different psychopharmaceuticals administered were considered. No sig-



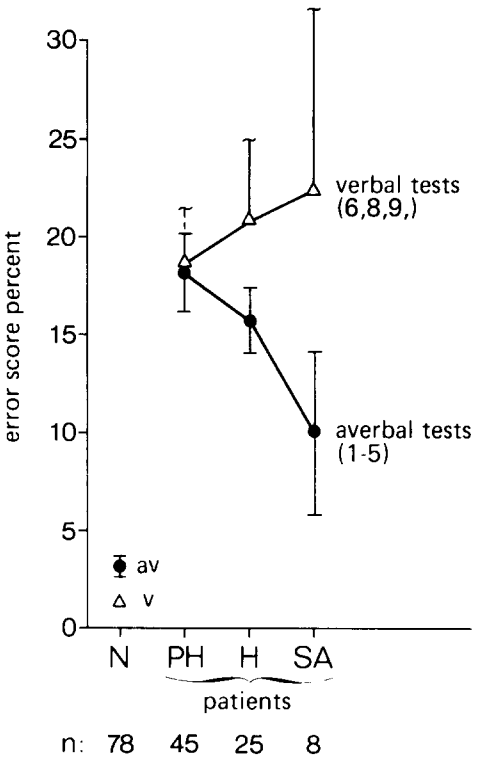


Fig. 4. Comparison of the average error scores in all *verbal* tests (T6, T8, T9) and all averbal tests (T1–T5) for normals and the three groups of schizophrenics

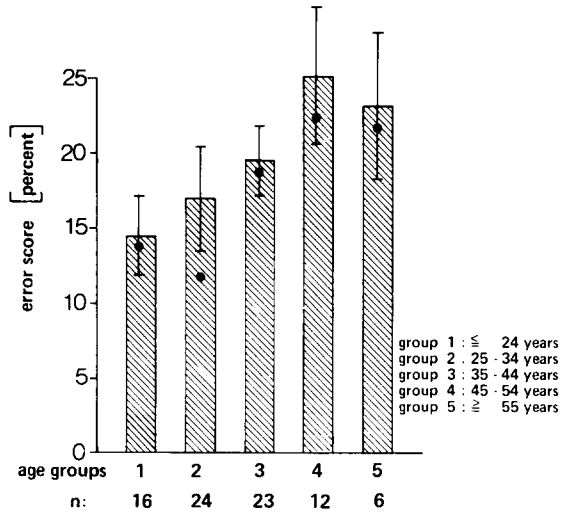


Fig. 5. The group of patients (81) was subdivided into 5 age groups; error score (algebraic mean ± SE, ● = median) showed an increase with age

Fig. 3. a Overall error scores from the 12 different movie scenes (SII–SXIII). Data from 81 schizophrenic patients and 78 normal subjects. **b** Overall error scores in the 10 different sub-tests (T1–T10) from 81 schizophrenic patients and 78 normal subjects. *P* = recognition of person, EP^+ = recognition of person and mimic expression, EP^+ = recognition of mimic expression in another person, PE^- = recognition of person with the same mimic expression, PE^- = recognition of person with another expression than that seen in the movie, *V* = verbal description, *S* = correlation to a sketched scene, *VR* = correlation to word read, *VH* = correlation to word heard, T10 = identical to T3.

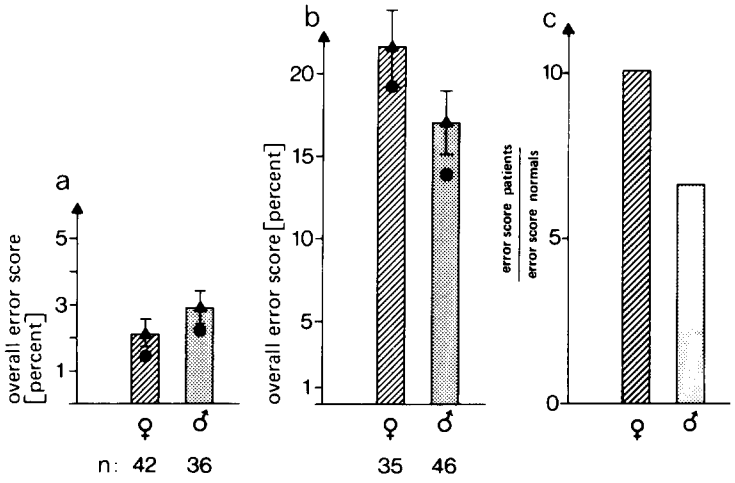


Fig. 6a–c. Comparison of the overall error score of male and female subjects in normals (**a**) and schizophrenic patients groups (**b**). In **c** the fraction of the patients' error score and the normals' error score is displayed, indicating a stronger increase in error scores in female patients than in male patients (relative to the normal control group) (▲ = algebraic mean ± SE, ● = median)

Table 4. Linear correlation coefficients between overall error score and age (A), duration of illness (DI) and duration of treatment in psychiatric hospital (DH)

	Patients			Sub-groups		
	Total	Male	Female	PH	H	SA
A	0.25	0.22	0.21	0.29	−0.03	0.62
DI	0.33	0.26	0.35	0.38	0.09	0.17
DH	0.21	0.31	0.09	0.29	0.10	−0.09

nificant difference in error scores was found for these 4 groups. On the other hand, patients with heavy drinking habits (only 2 out of 81 patients) exhibited a slight tendency to increased error scores, although none of the patients had shown signs of alcohol consumption during the 4 weeks prior to the investigation. Patients with longer periods (2 months) of drug abuse showed no increase in error scores. The average errors of the 61 patients who presumably never took drugs were not significantly different from the errors in the 20 patients who did (marijuana, amphetamines, LSD, mescaline, opium) before their admission to hospital. None of the patients investigated, however, had taken any of the drugs mentioned during the last 4 weeks before the test.

7. Error Score and School Education

As described in Berndl et al. 1986, school education had some impact on test performance. Normal subjects who had finished high school ("Abitur") performed the test with an error score of 1.8% ± 0.3% (SE), those who finished middle school ("Realschulabschluß") with 1.8% ± 0.5% and those who finished elementary school ("Hauptschulabschluß") with 4.2% ± 0.7%. All subjects of the normal group had attained at least elementary school education level. In patients this was the case for 8 subjects, but the error score (17.8% ± 3.6%) did not differ significantly from that of the patients with elementary school level (22.0% ± 2.3%) or middle school level (19.1% ± 2.6%).

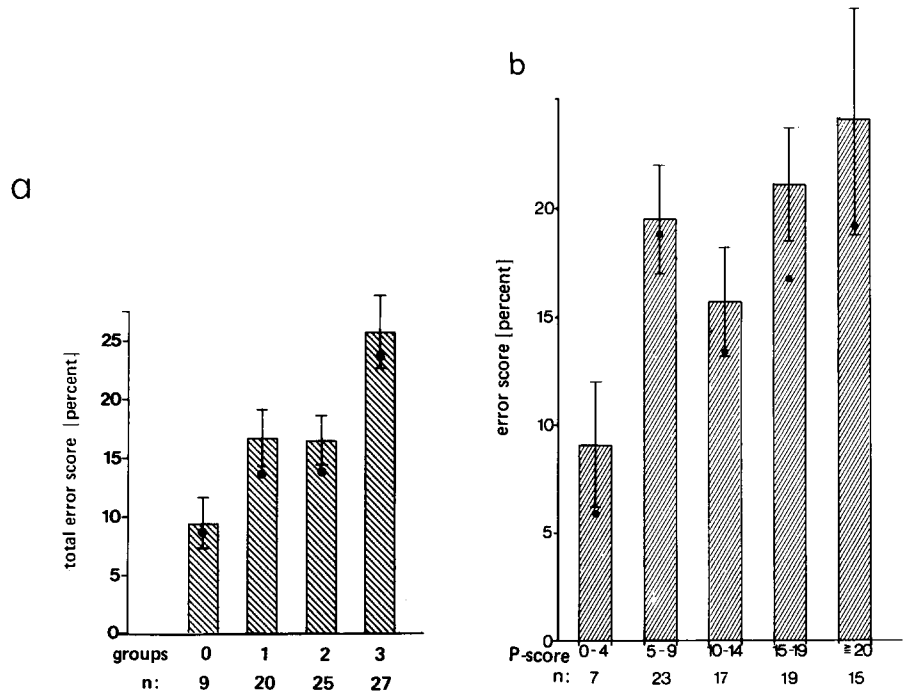


Fig. 7. a Overall error score increases with the degree of schizophrenic defect. For details see text. **b** Overall error score increases with the sum of all scored psychopathological abnormalities. Mean ± SE; ● = median

Patients who graduated from high school had a significantly better error score (9.9% ± 3.2%) than the other patients. The relative impairment of schizophrenic patients in the test performance, however, was about the same for all groups. Patients with a high school diploma had a 5.7 times higher error score than the corresponding group of normals, and patients with a school education below high school level had a 6.2 times higher error score than the corresponding group of normals.

Discussion

The data collected in the present study indicate a strong impairment of schizophrenic patients in recognizing faces, mimic expression and gestures. On the basis of everyday clinical observations we expected some alterations in these functions but were surprised by the amount which became evident in our study. The first question which comes to mind, of course, is whether our findings were due to a general, "non-specific" impairment of cognitive functions in schizophrenics or whether they should be interpreted as specific symptoms of this disease. Evaluating all factors analysed in the present study we finally came to the conclusion that the defect is probably specific for the disease and can also not be explained as an "artefact" of treatment, hospitalization or duration of illness. Our prediction therefore was that the same deficiencies should appear within the first weeks of the appearance of other schizophrenic symptoms, i.e. they should be present in adolescent patients suffering from schizophrenia. In the meantime we have applied the same tests in a follow-up study on adolescent schizophrenic patients. The results presented in a later report indicate that adolescent schizophrenics investigated during the first 2 to 3 years of their illness are, relative to the performance of normals in the same age group, even more impaired in their ability to recognize faces, mimic and gestures than middle-aged schizophrenics. Our conclusion that schizophrenic patients suffer a specific loss of correct perception and recognition of averbal social signals has to be evaluated relative to other observations and experimental findings in such patients.

(a) From the study of Jost (1977) it is known that schizophrenic patients need more time to grasp the meaning of visual stimuli, especially when auditory hallucinations interfere with the external set of stimuli. Thus one could expect schizophrenic patients to have more difficulty than normals in paying sufficient attention to the movie scene. We therefore selected a movie scene length (10s) far beyond that necessary to obtain a 95% correct response level in normals. Small fluctuations in attentiveness on the part of our patients were presumably compensated by the fairly lengthy movie scenes.

(b) Our test required an intact short-term memory. According to the studies of Rose (1973), Kayton et al. (1976) and Sorgatz (1979), schizophrenia does not lead to any considerable impairment of short-term memory.

(c) The results of the studies of Carbonell et al. (1978) and Knight and Sims-Knight (1980) indicate that the processing of multimodal sensory stimuli could be impaired in schizophrenics (simultaneous visual and verbal stimulation). The use of silent movie scenes were designed to prevent such complications.

(d) Acute emotional or behavioural disturbances occurred extremely rarely during our tests. The patients were acquainted with the investigators and the test was performed on a voluntary basis. The patients' responses were always reinforced by the investigator with a positive "yes". Whenever the patients asked about their performance, the investigator answered that they were doing very well.

(e) It is well-known that the response and decision time of schizophrenics is increased as compared to normal subjects (Shostakovich 1974; Collins 1974; Bleuler 1983; Braff and Saccuzzo 1981a, b, 1982; Kornhuber 1983). Following these results we allotted the patients all the time they required to answer so that response time or decision time effects could not influence the test outcome. We are convinced that with a time limit (e.g. 10s maximum for each test response) the average error score of schizophrenic patients would have increased considerably. Since a positive correlation between error score and decision time was found in both patients and normals, we think that all our subjects took the time they thought to be necessary for the decision.

(f) Effect of psychopathological abnormalities. Notwithstanding the qualitative aspect of the evaluation of psychopathological abnormalities, our data indicate that the degree of acute psychosis had only a minor effect on the test results, while the estimated degree of schizophrenic defect showed a considerably stronger effect. The patients in whom we could not detect any signs of schizophrenic defect (group "0", Fig. 7a) had less than half the errors than those where a severe schizophrenic defect was clinically evident (group "3"; t-test; $P<0.01$). The error scores of the three diagnostic classes of schizophrenia were not significantly different, but the distribution of the errors between averbal and verbal tests seemed to differ in patients suffering from schizo-affective psychosis from those with the paranoic-hallucinatory or hebephrenic form of schizophrenia (Fig. 4).

(g) Sex, age and level of school education had some effect on the outcome of the tests but the influence of these factors was small compared to the error score differences between normals and schizophrenics. One can say that except for the reversed sex effect, age and level of school education had relatively the same effect in normals as in schizophrenics.

Thoughts on a Possible Neurobiological Basis for the Results

Recognition of faces, mimic and gestures is fairly well developed in babies and infants and evolves parallel to the ability to express mood, emotion or social needs (Leavitt et al. 1979; Barrera and Maurer 1981; Norbeck 1981; Trevarthen 1985). These observations together with the "universal" (transcultural) components existing for mimic and gestural expression indicate that expression and understanding of these averbal signals are elementary functions of human communication. These functions are, at least in part, determined by genetic factors, i.e. the operation of inborn neuronal networks, modified by experience and learning, of course. The recent discovery of "face-specific" cortical areas located in the temporal lobes of primates (Perret et al. 1982, 1984; Rolls 1984; Desimone et al. 1984) together with clinical observations on prosopagnosia (Meadows 1974; Damasio et al. 1982; Hécaen 1981; Jeeves 1984; Grüsser 1984) support the assumption that face and mimic recognition operates through specific bilateral cortical areas. Thus it seems probable that our investigation tested a very elementary and in part genetically determined function. A parallel study in brain-lesioned patients indicated

that test performance was impaired by right-sided or left-sided cerebral lesions (with some preference for lesions in the occipito-temporal region). Thus an interpretation of the present results could be the assumption that the functional "crosstalk" of the left and right hemispheres is impaired in schizophrenia. These certainly speculative ideas have been expressed by other investigators in interpreting other results (Taylor and Abrams 1983, 1984; Silverstein and Meltzer 1983; Flor-Henry et al. 1983; Niwa et al. 1983; Feer 1985).

The close functional correlation between expression and perception of mimic and gestures has been postulated since the studies of Lavater, Gall and Charles Darwin in the 19th century. Changes in mimic and gestural expressions are frequently observed in schizophrenic patients. These observations taken together with the results described in the present report emphasize again the close interaction of perceptual or cognitive abilities and motor (expressive) activity. As it is well known that schizophrenic patients also suffer from cognitive defects in the perception of their own body scheme (Hozier 1959; Fagan 1959; Sommer and Weckowicz 1960; Cleveland et al. 1962; Fisher and Seidner 1963; Fisher 1964; Arnhoff and Damianopoulus 1964; Feldman 1966), a correlation between body self-perception and perception of expressive signals from other persons seems to exist.

In summary, however, we think it premature to speculate too extensively on our data. We are of the opinion that the surprising results presented in this report should be pursued further by studies in which EEG recordings or other methods of objective evaluation are applied.

Acknowledgements. The work was supported in part by a grant of the Deutsche Forschungsgemeinschaft (Gr 161). We thank Mrs. C. Eychmüller for technical assistance and Mrs. J. Dames for help in the English translation of the manuscript.

References

Arnhoff FN, Damianopoulus EN (1964) Self-body recognition and schizophrenia. J Gen Psychol 70:353–361

Barrera ME, Maurer D (1981) The perception of facial expression by three-month-old. Child Dev 52:203–206

Berndl K, Cranach Mv, Grüsser OJ, Kiefer RH (1983) Impairment of recognition of both gestures and miming in schizophrenic patients. Neurosci Lett (Suppl) 14:27

Berndl K, Dewitz W, Grüsser OJ, Kiefer RH (1986) A test movie to study elementary abilities in perception and recognition of mimic and gestural expression. Eur Arch Psychiat Neurol Sci 235:276–281

Berndl K (1985) Wahrnehmen und Erkennen mimisch-gestischer Ausdrucksbewegungen durch schizophrene Patienten. Medizinische Dissertation, Freie Universität Berlin

Bleuler E (1983) Lehrbuch der Psychiatrie. Springer, Berlin Heidelberg New York

Braff DL, Saccuzzo DP (1981a) Information processing dysfunction in paranoid schizophrenia: a two-factor deficit. Am J Psychiatry 138:1051–1056

Braff DL, Saccuzzo DP (1981b) Early information processing deficit in schizophrenia. New findings using schizophrenic subgroups and manic control subjects. Arch Gen Psychiatry 38:175–179

Braff DL, Saccuzzo DP (1982) Effect of antipsychotic medication on speed of information processing in schizophrenic patients. Am J Psychiatry 139:1127–1130

Carbonell J, Leventhal D, Schuck J (1978) A test of the schizophrenic's ability to process information in one or two sensory modes. Br J Soc Clin Psychol 17:243–249

Cleveland SE, Fisher S, Reitman E, Rothaus R (1962) Perception of body size in schizophrenia. Arch Gen Psychiatry 7:277–285

Collins PJ (1974) Reaction time measures of visual temporal integration on schizophrenic patients, other psychiatric patients and normal subjects. Diss Abstr Intern 35:1074

Damasio AR, Damasio H, Hoesen GW van (1982) Prosopagnosia; anatomical basis and neurobehavioral mechanisms. Neurology 32:331–341

Darwin C (1872) The expression of the emotions in man and animals. The University of Chicago Press, Chicago 1965

Desimone R, Albright TD, Gross C, Bruce C (1984) Stimulus-selective properties of inferior temporal neurons in the macaque. J Neurosci 4:2051–2062

Eibl-Eibesfeldt I (1967) Grundriß der vergleichenden Verhaltensforschung. Piper, München

Ekman P (1973) Cross-cultural studies of facial expression. In: Ekman P (ed) Darwin and facial expression. Academic Press, New York, London, pp 169–222

Fagan MJ (1958) Perception of self and of normality in schizophrenics. Diss Abstr Intern 19:170

Feer H (1985) Biologische Psychiatrie. In: Glatzel J, Krüger H, Scharfetter C (Hrsg) Forum der Psychiatrie 22, Enke, Stuttgart

Feldman JJ (1966) Attitudinal relationships of paranoid schizophrenic and non-psychotic patients toward recognizing needs in themselves and in others. Diss Abstr Intern 26:4805

Fisher S (1964) Body-image and psychopathology. Arch Gen Psychiatry 10:519–529

Fisher S, Seidner R (1963) Body experiences of schizophrenic, neurotic and normal women. J Nerv Ment Dis 137:252–257

Flor-Henry P, Fromm-Auch D, Schopflocher D (1983) Neuropsychological dimensions in psychopathology. In: Flor-Henry P, Gruzelier J (eds) Laterality and psychopathology. Elsevier, Amsterdam, pp 59–82

Grüsser OJ (1984) Face recognition within the reach of neurobiology and beyond it. Hum Neurobiol 3:183–190

Hécaen H (1981) The neuropsychology of face-recognition. In: Davies G, Ellis H, Shepherd J (eds) Perceiving and remembering faces. Academic Press, London, pp 39–54

Hozier A (1959) On the breakdown of the sense of reality: a study of spatial perception in schizophrenia. J Consult Psychol 23:185–194

Jeeves MA (1984) The historical roots and recurring issues of neurobiological studies of face perception. Hum Neurobiol 3:191–196

Jost K (1977) Untersuchungen an Schizophrenen mit Hilfe des Visual-Retention-Tests von Benton (BT). Diagnostica 23:173–178

Kayton L, Koh SD, Streicher SK (1976) Short term memory for numerousness in schizophrenic young adults. J Nerv Ment Dis 163:88–101

Knight RA, Sims-Knight JE (1980) Integration of visual patterns in schizophrenics. J Abnorm Psychol 89:623–634

Kornhuber HH (1983) Chemistry, physiology and neuropsychology of schizophrenia: Towards an earlier diagnosis of schizophrenia Arch Psychiatr Nervenkr 233:415–422

Leavitt LA, Morse PA, Nelson CA (1979) Recognition of facial expressions by seven-month-old infants. Child Dev 50:1239–1242

Meadows JC (1974) The anatomical basis of prosopagnosia. J Neurol Neurosurg Psychiatr 37:489–501

Niwa S, Hiramatsu K, Kameyama T, Saitoh O, Itoh K (1983) Dichotic detection task and schizophrenic attentional deficit. In: Flor-Henry P, Gruzelier J (eds) Laterality and psychopathology. Elsevier, Amsterdam, pp 507–523

Norbeck JS (1981) Young children's ability to conserve facial identity when facial emotion varies. Nurs Res 30:329–333

Perret DI, Rolls ET, Caan W (1982) Visual neurones responsive to faces in the monkey temporal cortex. Exp Brain Res 47:329–342

Perret DI, Smith PAJ, Potter DD, Mistlin AJ, Head AS, Milner AD, Jeeves MA (1984) Neurones responsive to faces in the temporal cortex: studies of functional organization, sensitivity to identity and relation to perception. Hum Neurobiol 3:197–208

Rolls ET (1984) Neurons in the cortex of the temporal lobe and in the amygdala of the monkey with responses selective for faces. Hum Neurobiol 3:209–222

Rose RD (1973) Short term visual storage function in paranoid and nonparanoid schizophrenics. Diss Abstr Intern 34:424

Salzen E (1981) Perception of emotion in faces. In: Davies G, Ellis H, Shepherd J (eds) Perceiving and remembering faces. Academic Press, London, pp 133–170

Shostakovich GS (1974) Temporary parameters of visual perception and motor reaction in schizophrenic patients. J Neuropathol Psychiatr 74:1851–1855

Silverstein ML, Meltzer HY (1983) Neuropsychological dysfunction in the major psychoses: Relation to premorbid adjustment and social class. In: Flor-Henry P, Gruzelier J (eds) Laterality and psychopathology. Elsevier, Amsterdam, pp 143–152

Sommer R, Weckowicz TC (1960) Body image and self-concept in schizophrenia. J Ment Sci 106:17–39

Sorgatz H (1979) Biometrie in der Psychopathologie, Fortschritte der klinischen Psychologie. Urban und Schwarzenberg, München

Taylor MA, Abrams R (1983) Cerebral hemisphere dysfunction in the major psychoses. In: Flor-Henry P, Gruzelier J (eds) Laterality and psychopathology. Elsevier. Amsterdam, pp 153–162

Taylor MA, Abrams R (1984) Cognitive impairment in schizophrenia. Am J Psychiatry 141:196–201

Trevarthen C (1985) Facial expressions of emotion in mother-infant interaction. Hum Neurobiol 4:21–32

Received October 1, 1985