Eur Arch Psychiatr Neurol Sci (1989) 239:58–61

European Archives of Psychiatry and Neurological Sciences

Impaired Performance in a Saccadic Tracking Task in Schizophrenic Patients

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Summary. The performance of schizophrenic patients in a task which requires a sequence of saccades guided by visuospatial cues is reported. A previous study recording eye movements determined a highly increased number of fixations neccessary for this task in acute schizophrenic patients compared with normal controls. The performance of normal control subjects of different age groups and the correlation between the performance in the tracking task and the results of a clinical psychological test battery are described. Schizophrenic patients in a partly remitted state and in a remitted or mildly chronic state performed this task worse than matched control subjects; this was particularly indicated by the time score. The relation to the lifetime dosage of neuroleptic medication is considered.

Key words: Schizophrenia – Visuospatial tests – Scanpath – Tracking test – Medication effects

Introduction

Schizophrenic patients seem to be impaired in tracking tasks which either depend on smooth pursuit eye movements (SPEM) (Lipton et al. 1983) or (presumably) also on saccadic eye movements (SEM) (Reischies et al. 1988) as well as, more generally, in visual search tasks (Russel and Knight 1977). These impairments may be traced to deficits within different compartments of the visuomotor system. Preliminary data regarding the scanpath of schizophrenic patients in a saccadic tracking task (Reischies et al. 1988) demonstrated a highly increased number of fixations but not prolonged fixation times. An impairment within the saccadic tracking task may possibly be related to dysmetric saccades, as found by Schmid-Burgk et al. (1983) as well as Mather and Putchat (1983). Dysmetric saccades, in turn, may be caused by many different disturbances, such as elementary afferent information processing, peripheral attention processes and perception of visuospatial relations, as well as disorders of elementary motor aspects of saccades. Their importance for exploratory eye movements and visuospatial deficits of schizophrenic patients is poorly understood.

It has been assumed that there is a top-down organization of a scanning path, giving rise to different, individually invariant, scanning styles, which may be relevant for schizophrenic patients (Gaebel et al. 1987). A defective scanpath organization has been hypothesized for visual search tasks by Russel and Knight (1977). There are no data which support the notion that schizophrenics have difficulty in extracting the information of the individual items which they search for (Royer and Friedman 1973; Russel and Page 1976; Russell and Knight 1977), but it has been assumed that a prolonged response time is related to the organization of the search itself (Russel and Knight 1977). A prolonged response time has furthermore been found to be associated with the age of the patient.

Kojima et al. (1987) found a defect in exploratory planning of a Porteus maze solution. The planning time was prolonged as well as the execution time. Some of their schizophrenic patients looked, at the beginning of the task, at the last blind alley, as normals do. Other patients, however, looked at the last blind alley only later, during the performance of the task; the authors discussed an analogy of a right frontal lesion deficit for the latter group.

The saccadic tracking task, which we have introduced, does not depend on individual scanpath organization. The scanpath is organized bottom-up, by analysing cues and integrating the information into the scanning sequence. Nonetheless, there seems to

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This article was presented in part at the Symposium on Eye Movements and Psychopathology, Berlin, 23–24 June 1988

be an impairment in acute schizophrenic patients (Reischies et al. 1988).

The task of saccadic tracking (Reischies et al. 1986) uses visuospatial cues for the sequence of saccade steps. Besides direction perception, other visuospatial elements are pertinent to this task, such as peripheral target identification and distance determination.

Schizophrenic patients obviously suffer from visuospatial disturbances. In batteries of intelligence tests schizophrenic patients seem to be impaired especially in the performance of visuospatial tests (Aylward et al. 1984; Hasse-Sander et al. 1982). Our own, as yet unpublished results have demonstrated non-verbal deficits in medicated chronic schizophrenics – resembling acute, medicated schizophrenics (Reischies 1987).

We investigated whether or not the performance of schizophrenic patients is impaired in this type of tracking-task even in the remitted state. The second aim of the study was to determine the factor structure of the saccadic tracking task by delivering the test to a sample of psychiatric patients together with a battery of other tests. Of special interest was the relation to visuospatial tasks. A third aim was to examine the possible role of neuroleptic medication in the causation of the deficits in the saccadic tracking task.

Subjects and Methods

Subjects. (A) Normal control subjects ($N = 95$) were recruited from the staff of the clinic and an education unit of the local police department. Subjects older than 60 years were required to copy the Rey complex figure (Lezak 1983) to exclude subjects with pronounced cognitive decline, indicating a probable dementing illness. (B) The subjects of the clinical sample ($N = 50$) were the patients who had been successively referred to the department of clinical psychology for standard evaluation of their performance level. The diagnoses were made according to ICD 9. Patients suffering from an acute psychosis were tested when partly remitted. All schizophrenic subjects of this sample ($N = 17$) were receiving neuroleptic medication. (C) The sample of remitted and chronic schizophrenic patients ($N = 32$) was investigated within the outpatient clinic for schizophrenic patients in our department. The diagnosis was made according to the RDC (Spitzer et al. 1982). Any clinical finding indicating brain damage led to the exclusion of the patients from this sample. The sociobiographic data of the schizophrenic patients are shown in Table 3. Four of the patients of this sample were not receiving neuroleptics at the time of testing.

Methods. The test is illustrated in Fig. 1. The subject is instructed first to look at the starting point. An arrow indicates the direction in which the next point is to be found. Thus the scanning is guided by the visuospatial cues until the last arrow points to one of the numbers in a circle around the points, which has to be read. To avoid short-cut strategies, items are

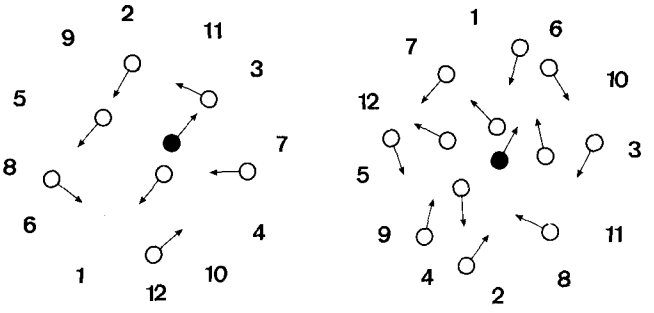

Fig. 1. Test items of saccadic tracking task

inserted that display a circular path. Training for the task is by items with arrows that actually connect the points. The arrows then gradually becoming shorter.

The items are seen at the usual reading distance; the peripheral circle consisting of numbers has a diameter of 15 cm. The test items consist of 16 figures (one 4-arrow sequence, two 5-arrow sequences, eight 8-arrow and three 13-arrow sequences, as well as two circular sequences). An error is scored when a wrong number is said, when the subject indicates that he/she is lost, or if the subject needs more than 40 s. Then a second trial is started, the time of which is not analysed. If the second trial fails, the subject is asked to indicate the path, pointing by hand.

The scores were (1) the number of items failed at the first trial, (2) the total number of trials needed, (3) the mean times for the four less difficult 8-arrow items and (4) the difference between the times for the 13-arrow items and the times for the less difficult 8-arrow items.

The clinical sample was tested additionally by subtests of the Hamburg Wechsler Intelligence test (HAWE; information, similarities, picture completion, block design and digit symbol); Wechsler Memory scale (WMS); a cancellation test for attention and concentration – d2 (Brickenkamp 1981); the Benton visual retention test (Benton 1974), corrected for estimated IQ; the Diagnosticum für Cerebralschädigung (DCS, Weidlich 1972); and a vocabulary test, MWT-B, a multiple choice test for recognition of a German word out of non-words (Lehrl 1977).

Results

The results for the healthy control group are shown in Table 1. The errors were low and seem to be constant in adulthood; they increased to some extent in subjects older than 60 years. The time score for 8-arrow sequences seemed to be constant in the early years (± 0.77 s); after the age of 60 years the variance increased considerably.

Intercorrelations between the parameters of the saccadic tracking and, on the one hand, age, sex and education, and on the other hand, the subtests of the test battery, were analysed. There was a high correlation between the error- and time scores and the visuospatial tests. In Table 2 the Pearson correlations are listed for the subtests of the HAWE picture com-

pletion and block design, together with the visual memory of the WMS, and DCS and the Benton test part E. Within this patient group the time difference seemed to have overall low correlations with the parameters assessed.

With regard to the other tests of the battery, the error score (first trial) was significantly related only to the similiarities subtest, logical memory of the WMS and the errors of the d2 attention task; the correlation coefficients were rather low (−0.34, −0.34 and 0.29). The time for 8-arrow items was significantly related only to the performance of the d2 attention task, the digit symbol and information subtest (−0.28, −0.33 and −0.32). A strong sex effect was found with respect to more errors at first trial in female patients. An age effect was found, as expected, whereas no important education effect could be demonstrated.

Table 1. Parameters of the saccadic tracking task in four age groups

Age (years)	*N*	Errors 1st trial	Time 8-arrows (s)
18–25	35	1.43	4.30
± SD		1.07	0.77
26–40	21	1.52	4.69
± SD		1.54	1.19
41–60	24	2.21	5.38
± SD		1.72	1.60
> 60	15	4.00	11.85
± SD		3.25	6.62

For the schizophrenic patients the results are given in Table 3. The difference between schizophrenic patients and controls in the error score was marginally significant (tested non-parametrically because of variance inhomogeneity; Mann-Whitney U test, $P < 0.10$); the time for 8-arrow items was significantly different (Mann-Whitney U test, $P < 0.001$).

Whereas the first group of schizophrenic patients had partly remitted during inpatient treatment of an acute psychosis, the second sample of schizophrenic patients was in a remitted or mildly chronic state (see Table 2, outpatient group). There was a slight increase in the error score (Mann-Whitney U test, $P < 0.11$); the time for 8-arrow items, however, was significant (Mann-Whitney U test, $P < 0.0025$).

For the latter sample the lifetime dosage of neuroleptic medication was determined and the chlorpromazine (CPZ) equivalents were found to be correlated to the time for 8-arrow items and the total

Table 2. Correlations between parameters of the saccadic tracking task and sociobiographic data and performance of visuospatial tests

Variable	Errors 1st trial	Time difference	Time (8-items)	Trials total
Age	0.44***	0.25	0.32*	0.40**
Sex	0.41**	0.41**	0.26	0.45***
Education	−0.20	−0.22	−0.15	−0.23
Pict. completion	−0.36**	−0.20	−0.38**	−0.42**
Block design	−0.52***	−0.15	−0.51***	−0.56***
Vis. memory	−0.41**	−0.21	−0.43**	−0.46***
DCS	−0.43**	−0.13	−0.33*	−0.43**
Benton E	−0.42**	−0.23	−0.38**	−0.47***

* $P < 0.05$; ** $P < 0.1$; *** $P < 0.001$

Table 3. Saccadic tracking parameters of two samples of schizophrenic patients, inpatients in a partly remitted state and outpatients in a remitted or mildly chronic state

Group	*N*	Age (years)	Sex % female	Education (years)	Errors 1st trial	Time 8-arrow (s)
Control	54	36.2	48.1	10.9	1.81	4.86
± SD		11.1		1.7	1.60	1.40
Schiz. inpatients	17	37.4	35.3	11.0	3.25*	8.54*
± SD		11.7		2.2	3.04	4.91
Schiz. outpatients	32	37.3	53.1	10.3	3.53*	7.65*
± SD		11.2		2.0	4.08	5.17

* $P < 0.05$

trials score ($r = 0.49$, $P < 0.008$ and $r = 0.36$, $P < 0.057$). There was, however, also a high correlation between the CPZ equivalents of lifetime dosage and age ($r = 0.52$, $P < 0.004$). The correlations between the two saccadic tracking scores and the acute neuroleptic medication were found to be low and not statistically significant.

Discussion

Impairments in performance of the saccadic tracking task could be demonstrated for partly remitted as well as remitted or chronic schizophrenic patients. The time for the performance seems to be affected more than the error scores.

As expected, there was a strong correlation of the test scores and further visuospatial tests. However, in the saccade tracking task, unlike the usual visuospatial tests, no organization of an individual scanning path is needed, which seemed to be impaired in schizophrenia. Schizophrenia patients might have problems with visuospatial tasks for several reasons: on the one hand, a defective organization of exploratory eye movements might impair their performance; on the other hand, as our results might suggest, an insufficient elementary analysis and/or integration of visuospatial information into a saccadic sequence occurs.

A possible interfering factor is that medication of the schizophrenic patients by acute or chronic effects may be responsible for the impairment in saccadic tasks (Spohn et al. 1985). Our finding of a correlation between the lifetime dosage and the impaired performance might point to a lifetime dosage effect, but the age correlation of lifetime dosage might explain the effect on test performance to some extent. Furthermore there is possibly a complex interaction between low response to neuroleptics in relation to brain damage and a higher lifetime dosage, which makes our results difficult to interpret.

Further analysis of the eye movement pattern of schizophrenic patients at this task will possibly demonstrate specific eye movement features in these patients compared with brain-damaged patients. This and the role of elementary dysfunctions such as dysmetria of saccades and the hypothesis of a saccadic facilitation (fixation suppression defect, Jones and Pivic 1983) should be investigated.

References

Aylward E, Walker E, Bettes B (1984) Intelligence in schizophrenia: metaanalysis of the research. Schizophr Bull 10:430–459

Benton AL (1974) The revised visual retention test. Psychological Corporation, New York

Brickenkamp R (1981) Test d2. Aufmerksamkeits-Belastungs-Test, 7th edn. Hogrefe, Göttingen

Gaebel W, Ulrich G, Frick K (1987) Visuomotor performance of schizophrenic patients and normal controls in a picture viewing task. Biol Psychiatry 22:1227–1237

Hasse-Sander I, Gross G, Huber G, Peters S, Schüttler R (1982) Testpsychologische Untersuchungen in Basisstadien und reinen Residualzuständen schizophrener Erkrankungen. Arch Psychiatry Neurol Sci 231:235–49

Jones AM, Pivic RT (1983) Abnormal visual-vestibular interactions in psychosis. Biol Psychiatry 18:46–61

Kojima T, Ando H, Matsushima E, Ando K, Nakajima K, Sugano K, Ogihara R, Takahashi R, Shimazono Y, Kuwana N (1987) Schizophrenia and frontal lobe lesions – eye fixations and movements during maze test. In: Takahashi R, Flor-Henry P, Gruzelier J, Niwa S (eds) Cerebral dynamics, laterality and psychopathology. Elsevier, Amsterdam, pp 147–155

Lehrl S (1977) Mehrfachwahl Wortschatztest B Testhandbuch. Perimed, Erlangen

Lezak MD (1983) Neuropsychological assessment. Oxford University Press, New York

Lipton RB, Levy DL, Holzman PS, Levin S (1983) Eye movement dysfunction in psychiatric patients: a review. Schizophr Bull 9:13–32

Mather JA, Putchat C (1983) Motor control of schizophrenics. I. Oculomotor control of schizophrenics: a deficit in sensory processing, not strictly in motor control. J Psychiatr Res 17: 343–360

Reischies FM (1987) Neuropsychologisches Defizit Screening. Nervenarzt 58:219–226

Reischies FM, Schnurbus R, Ermer A (1986) Deficits of patients with Parkinson's disease without dementia in an eye-movement depending perceptual task. J Clin Exp Neuropsychol 8:137

Reischies FM, Gaebel W, Mielewczyk A, Frick K (1988) Disturbed eye movements guided by visuospatial cues in schizophrenic patients. Pharmacopsychiatry 21:346–347

Royer FL, Friedman S (1973) Scanning time of schizophrenics and normals for visual designs. J Abnorm Psychol 82:212–219

Russel PN, Knight RG (1977) Performance of process schizophrenics on tasks involving visual search. J Abnorm Psychol 86:16–26

Russel PN, Page AE (1976) Comparison of schizophrenics and normals on a visual search task. Percept Mot Skills 42:399–402

Schmid-Burgk W, Becker W, Juergens R, Kornhuber HH (1983) Saccadic eye movements in psychiatric patients. Neuropsychobiology 10:193–198

Spitzer L, Endicott J, Robins E (eds) (1982) Forschungs-Diagnose-Kriterien (RDC). Belz, Weinheim

Spohn HE, Coyne L, Lacoursiere R, Mazur D, Hayes K (1985) Relation of neuroleptic dose and tardive dyskinesia to attention, information-processing, and psychophysiology in medicated schizophrenics. Arch Gen Psychiatry 42:849–859

Weidlich S (1972) Diagnosticum für Cerebralschädigung (DCS). Huber, Bern

Received October 17, 1988