

Functional Motor Asymmetries Correlated with Clinical Findings in Unmedicated Schizophrenic Patients

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Summary. Motor asymmetries were investigated in 28 unmedicated schizophrenic in-patients and 32 healthy controls. Of the patients, who were assessed as right-handers by a handedness questionnaire, 46.4% changed their motor laterality in at least one part of the tapping test series, probably because of a decrease of functional hemispheric asymmetry. These patients were characterized by more pronounced psychotic symptoms than those who did not change motor laterality. According to the tapping frequency, two groups of patients could be distinguished: the high- and the low-frequency group. In both groups certain tapping data could be correlated with characteristic clinical features. While the findings in the high-frequency group point to an enhanced activation level of the right hemisphere and appear to be correlated with the onset of positive symptoms and better prognosis, the findings in the low-frequency group may be a reflection of a disturbed function of the left frontal region and seem to be correlated with a gradual chronic development of predominant negative symptoms with worse prognostic implications.

Key words: Schizophrenia – Motor asymmetries – Correlation to clinical findings

Introduction

It is an important principle that in the central nervous system higher cognitive functions are closely integrated with motor and emotional processes. Hence, disturbances in one of these functional systems will lead to various changes in the integrated output. In schizophrenic disorders there is a coincidence of cognitive impairment, psychotic features and motor abnormalities. Motor abnormalities in schizophrenic patients include a wide range of voluntary and involuntary disturbances of different frequency and severity [23]. Supposedly, there

is a certain specific relationship between motor disturbances and schizophrenic disorders. The exact relationship of motor features to prognosis is unclear; it appears, however, that the degree of the motor disturbances depends on the severity of the illness [23]. Günther [15] describes the existence of a psychotic motor syndrome (PMS) in the endogenously depressed and in schizophrenics. These motor abnormalities also involve changes in the fine and gross movements of the dominant right hand and complex motor coordination of the extremities. The findings may be due to a specific imbalance of right- and left-sided motor neuron excitability [12] resulting from disturbances of intrahemispheric and interhemispheric processes. As the hemispheric asymmetries in various schizophrenic subgroups are different [13, 14, 16, 22], motor asymmetries are supposed to be different too. The aim of this study was to detect deviations in motor asymmetries of unmedicated schizophrenic patients and find out correlations between the motor behaviour and clinical features.

Methods

Subjects: 28 unmedicated schizophrenic in-patients (13 females and 15 males) were investigated and compared with 32 healthy controls (11 females and 21 males). Diagnosis was based on DSM-III criteria (American Psychiatric Association 1980). After grouping the patients according to the tapping results, additional clinical characteristics were selected from the case histories without using quantitative scales.

The mean age (SD) of the patients and the controls was 31.0 (10.6) years and 30.5 (7.2) years, respectively. All subjects were right-handers. At first the handedness was assessed by means of the Edinburgh Handedness Questionnaire (Oldfield 1971 [28]) and was then checked with the help of a simple tapping-test series.

Procedure

The test was performed from 9.00–10.00 a.m. and consisted of four successive parts. In all sessions, the subjects had to press a button as fast as possible for a period of 15 s, first with their right and then their left index finger. In contrast to parts a and c, in parts

b and d finger tapping was carried out with concurrent tasks. In part b the patients were asked to tap while reading aloud a passage from a text, and in part d while simultaneously humming a tune. The number of taps were recorded and right-left differences were established in percent with respect to the faster hand. Statistical calculations are based on the non-parametric Mann-Whitney U-test; for comparison of percental differences the Chi-square analysis is used.

Results

According to the tapping results schizophrenic patients were divided into the following subgroups:

1. Patients with or without change in their motor laterality during the tapping test series
2. Patients with high and low tapping frequencies

Table 1. Number of taps with right or left hand/15 s under different conditions in various groups of unmedicated patients without (subgroup A) and with changing motor laterality (subgroup B)

	Case number	Rest		Reading		Rest		Humming	
		Right	Left	Right	Left	Right	Left	Right	Left
High-frequency group									
Subgroup A	1	101	98	88	81	107	98	93	85
	2	117	90	110	90	116	88	112	107
	3	100	93	83	75	98	89	90	85
	4	105	93	90	85	115	92	106	94
	5	100	76	86	71	100	79	90	73
	6	104	87	102	94	112	89	101	97
	\bar{X}	104.5	89.5	93.2	82.7	108.0	89.2	98.7	90.2
	\pm SD	6.5	7.6	10.5	8.8	7.7	6.2	9.2	11.8
Subgroup B	7	101	88	79	81	100	84	84	77
	8	97	81	75	79	96	86	91	80
	9	107	96	79	90	104	96	101	100
	10	113	97	79	87	107	107	92	110
	11	112	105	87	87	111	93	92	93
	12	104	91	95	76	99	100	97	98
	13	94	95	98	93	95	85	103	90
	\bar{X}	104.0	93.3	84.5	84.7	101.7	93.0	94.3	92.6
	\pm SD	7.2	7.6	8.9	6.2	5.9	8.6	6.5	11.5
	Low-frequency group								
Subgroup A	14	95	87	89	78	89	79	78	71
	15	95	75	85	75	92	77	95	79
	16	66	51	58	44	60	48	65	44
	17	89	64	77	52	73	55	82	56
	18	80	76	72	68	81	70	80	79
	19	71	61	59	55	77	72	58	57
	20	85	62	71	64	83	63	73	69
	21	83	53	78	62	71	59	69	56
	22	79	70	59	50	73	67	67	63
	\bar{X}	82.5	66.5	72.0	60.9	77.7	65.5	74.1	63.8
	\pm SD	9.9	11.6	11.5	11.6	9.8	10.3	11.0	11.7
Subgroup B	23	53	40	32	33	51	36	32	30
	24	43	36	27	29	47	42	39	41
	25	87	78	80	85	88	89	83	91
	26	87	94	92	94	94	88	91	95
	27	76	74	56	51	70	63	68	70
	28	77	71	64	52	68	69	60	57
	\bar{X}	70.5	65.5	58.5	57.3	69.7	64.5	62.2	64.0
	\pm SD	18.3	22.8	25.8	26.7	18.9	22.3	23.5	26.3

Table 2. Relationship between shifts in motor laterality (subgroups B) and selected individual clinical features

Selected traits	Patients without drugs							
	High-frequency group				Low-frequency group			
	Subgroup A (n = 6)		Subgroup B (n = 7)		Subgroup A (n = 9)		Subgroup B (n = 6)	
	n	%	%	n	n	%	%	n
Manifestation of predominant symptoms								
Pronounced	1	16.7	57.1	4	0	0	33.3	2
Less pronounced	3	50.0	28.6	2	2	22.2	50.0	3
Slight	2	33.3	14.3	1	7	77.8	16.7	1
Clinical response to drugs								
Pronounced	6	100.0	42.85	3	1	11.1	0	0
Less pronounced	0	0	42.85	3	4	44.4	50.0	3
Slight or without	0	0	14.3	1	4	44.4	50.0	3
Abnormal EEG findings	0	0	42.85	3	2	22.2	33.3	2
Defect syndromes								
Absent	6	100.0	85.7	6	2	22.2	0	0
Dubious	0	0	14.3	1	5	55.5	16.7	1
Present	0	0	0	0	2	22.2	83.3	5

1.1. Characteristics in the Tapping Frequencies of Patients with Changing Motor Laterality

During the investigation it became obvious that unlike all controls, who always tapped faster with their right hands, many patients, though right-handers according to the questionnaire, showed a higher left-hand tapping frequency in one or two parts of the test. This is shown in Table 1 (see patients of subgroups B). The effect was detected in 7 patients with high and 6 with low tapping frequencies. Overall, 46.4% of the patients revealed such a shift in their motor behaviour. In both groups this phenomenon occurred far more frequently during simultaneous reading and humming than under rest conditions ($P < 0.01$ for both concurrent tasks). No sex differences could be detected.

In addition to this, it is evident from Table 1 that right-left differences of both subgroups B in contrast to subgroups A are significantly lower ($P < 0.01$). This effect includes males and females. Furthermore, right-left differences are somewhat lower during concurrent tasks, since the right-hand tapping frequency decreases slightly more than the left.

1.2. Relationship Between Shifts in Motor Laterality (Subgroups B) and Selected Individual Clinical Features

As shown in Table 2, in both subgroups B the manifestation of predominant symptoms is more pronounced; while in the high frequency group this result is near the significance level, in the low-frequency group it is significant ($P < 0.05$).

Moreover, in the high-frequency group this effect is connected with a lower responsiveness to drugs ($P <$

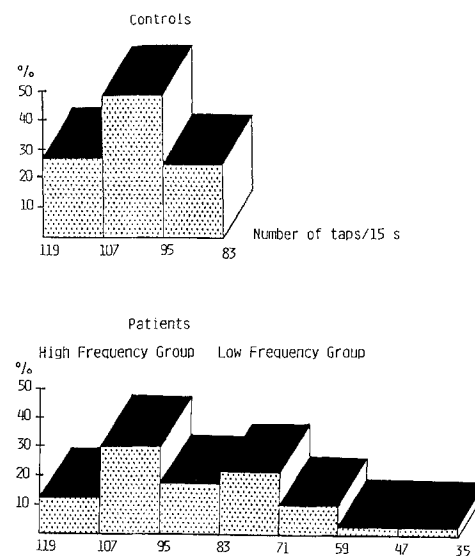


Fig. 1. Frequency distribution of right-hand taps under conditions of rest; in the controls ($n = 32$) above, and in the patients without drugs ($n = 28$) below

0.05) and in the low-frequency group with a greater amount of defect syndromes ($P < 0.05$).

In conclusion, it can be said that patients with changing motor laterality are characterized by different selected clinical features: a more pronounced manifestation of their clinical symptoms was combined with a worse prognosis (lower responsiveness to drugs or more defect syndromes).

In addition to this, in the high- and the low-frequency groups abnormal EEG findings are slightly more often present in patients with shifting motor laterality.

2.1. Characteristics in the Tapping Frequencies of the High- and Low-frequency Groups

Figure 1 shows that in the controls the frequency distribution of the right-hand taps under rest conditions forms a Gaussian curve, with the most frequent values in the range between 107 and 96 taps per 15 s. In the untreated patients this distribution is different. While in some schizophrenics the frequency of right-hand tapping is similar to that of the controls, tapping frequency is markedly lower in quite a few of them. For this reason,

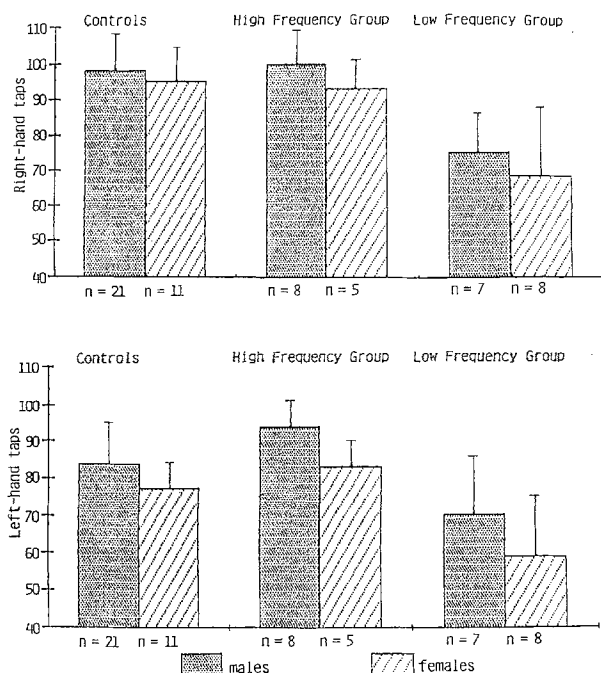


Fig. 2. Above: total number of right-hand taps (mean values and standard deviations) and below: total number of left-hand taps (mean values and standard deviations) in the controls and in different tapping groups of unmedicated patients

the patients were divided into two groups: the high-frequency group with a right-hand tapping frequency in the range between 119 and 96 taps/15s and the low-frequency group with a lower tapping frequency. This differentiation was made without considering any other findings. If all patients were included in one group only, we would merely find out that the frequency of the right-hand taps is lower in the patients.

Figure 2 indicates group and sex differences in the tapping frequencies. It became evident that in all groups the male patients show faster right- and left-hand taps than the females. This is a significant effect ($P < 0.05$) with only one exception – the right-hand values in the low-frequency group.

In addition to this, marked group differences can be detected. While the right-hand taps of the high-frequency group do not differ significantly from those of the controls, the left-hand taps of the female and male patients show significant higher values than the controls (females – $P < 0.05$; males – $P < 0.01$).

Patients of the low-frequency group in comparison with the controls are characterized by a significant decline in right- and left-hand taps regardless of sex ($P < 0.01$). The decrease in the right-hand taps is more pronounced.

2.2. Correlation of the Tapping Results of the High- and Low-frequency Groups with Clinical Characteristics

Table 3 shows that the clinical pictures of the high- and the low-frequency group are different.

Patients of the high-frequency group are predominantly characterized by delusions (in most cases within a limited range), derealization, depersonalization and coenaesthetic hallucinations. But they do not show a blunted affect or motor retardation. The patients of this group were diagnosed as suffering from onsetting schizo-

Table 3. Correlation of tapping groups with clinical diagnosis

Diagnosis	Total <i>n</i>	Patients without drugs (<i>n</i> = 28)			
		High-frequency group		Low-frequency group	
		Sex	Sex	Sex	Sex
		Male <i>n</i>	Female <i>n</i>	Male <i>n</i>	Female <i>n</i>
Onsetting schizophrenic psychosis	3	2	1	—	—
Schizoaffective paraphrenia	2	2	—	—	—
Paranoid schizophrenia	2	2	—	—	—
Coenaesthetic schizophrenia (according to Huber)	3	1	1	1	—
Schizophrenia with paranoid-hallucinatory symptoms	8	1	3	1	3
Schizophrenia with paranoid-hallucinatory and occasional catatonic symptoms	1	—	—	—	1
Catatonia	2	—	—	2	—
Hebephrenia	4	—	—	—	4
Simple schizophrenia	3	—	—	3	—

Table 4. Relationship between tapping groups and clinical features

Selected traits	Patients without drugs (<i>n</i> = 28)				
	High-frequency group (<i>n</i> = 13)		χ^2 analyses <i>P</i>	Low-frequency group (<i>n</i> = 15)	
	<i>n</i>	%		%	<i>n</i>
Deviating premorbid personality	3	23.1	0.05	66.7	10
No deviating premorbid personality	10	76.9	0.05	33.3	5
Onset of disease:					
0.5–2 years before	8	61.5	0.01	6.7	1
More than 2 years before	5	38.5	0.01	93.3	14
Onset of symptoms:					
Acute	9	69.2	0.001	0	0
Subacute	4	30.8	—	33.3	5
Gradual	0	0	0.001	66.7	10
Predominant symptoms:					
Positive	12	92.3	0.001	0	0
Mixed	1	7.7	—	26.7	4
Negative	0	0	0.001	73.3	11
Clinical response to drugs:					
Pronounced	9	69.9	0.001	6.7	1
Less pronounced	3	23.1	—	46.7	7
Slight or without	1	7.7	0.05	46.7	7
Defect syndromes:					
Absent	12	92.3	0.001	13.3	2
Dubious	1	7.7	—	40.0	6
Present	0	0	0.01	46.7	7

phrenic psychosis, schizoaffective paraphrenia, paranoid schizophrenia, coenaesthetic schizophrenia or schizophrenia with paranoid-hallucinatory symptoms.

In contrast to this, the low-frequency group shows prevailing negative symptoms such as affective flattening, emotional withdrawal, motor retardation, anergia and poverty of speech. They were diagnosed as schizophrenic patients with paranoid-hallucinatory symptoms including the group with occasional catatonic symptoms and those with catatonia, hebephrenia and simple schizophrenia.

A gender preference was found neither in the high- nor in the low-frequency group. Sex differences in clinical diagnosis are difficult to determine, because the groups are too small. It should be noted, however, that in the hebephrenic group there are only females, while in the schizophrenia simplex group there are only males.

Table 4 corroborates the group differences which are described in Table 3 and makes clear that clinical traits related to good prognosis and positive symptoms (no premorbid dysfunction, disease of short duration, acute onset of the symptoms, responsiveness to neuroleptic drugs and no defect syndromes) occur far more frequently in the high-frequency group, whereas clinical traits associated with bad prognosis and negative symptoms (deviating premorbid personality, long-lasting disease, gradual onset of the symptoms, low responsiveness to neuroleptic drugs and performance deficits) are much

more pronounced in the low-frequency group. In all the features mentioned there were significant differences between the opposite groups.

Discussion

Characteristics in the Patients with Changing Motor Laterality

Of all unmedicated schizophrenic patients, though definite right-handers according to the questionnaire, 46.4% showed a higher left-hand tapping frequency in at least one part of the tapping test series. This was more pronounced during concurrent tasks because in these conditions the tapping frequency of the right hand decreased slightly more than the tapping frequency of the left. The effect of a shifting in the faster tapping hand cannot be considered to be an expression of a simple change in handedness. According to our investigations — not described here — unequivocal left-handers demonstrate stable faster left-hand tapping in all tests. For this reason, this result cannot be compared with those of Lishman et al. [21] and Fleminger et al. [9] who found more left-handers in psychotics, especially in males.

The phenomenon of changing motor laterality on tapping tests may more likely be related to reduced hemi-

spheric asymmetries occurring during psychosis [6, 27]. Laterality scores in dichotic listening tasks decrease when psychotic symptoms are marked and increase during the period of improvement [17, 33, 34].

Interestingly, patients with reduced motor laterality in contrast to patients without this feature show a more pronounced manifestation of psychotic symptoms in their clinical characteristics possibly combined with a worse prognosis: in the high-frequency group with a lower responsiveness to drugs and in the low-frequency group with more defect syndromes.

Furthermore, the latter fact is corroborated by the presence of slightly more abnormal EEG findings in subgroups B.

In this connection it is interesting to note that Keefe et al. [18] found that patients with severe positive as well as negative symptoms are relatively unresponsive to haloperidol.

As a consequence of this, it may be said that different findings in functional motor asymmetries may be correlated to various clinical features.

Characteristics in the Patients with High and Low Tapping Frequencies

According to the tapping results, sex differentiation has to be taken into account, since it is a matter of fact that males tap faster than females [20]; and a higher percentage of males in one group could be responsible for higher tapping frequencies. Although in the present investigations significant sex differences could be established too, the most important tapping results mentioned here were, however, not effected by this.

The most important tapping result in the high-frequency group was the fact that while right-hand taps corresponded with those of the controls, the left-hand taps were significant faster. This issue is in accordance with motor studies carried out in a subgroup of schizophrenic patients by Bracha [4]. A left-prone circling behaviour was found in 10 unmedicated schizophrenic patients, whereas 85 normal controls showed equal right and left turning. In similar animal experiments, it was detected that left-sided rotations occurred together with a relative dopaminergic overactivity of the right nigro-striatal system [11]. The left-prone circling behaviour as well as the increased tapping frequency of the left hand are supposed to be related to an enhanced level of activation of the right hemisphere. At this point it is important to mention that the exact functional changes of the right hemisphere which cause faster left-hand tapping in this group remain obscure. "Enhanced activation level" is a term we suggest for describing those processes.

In the clinical characteristics patients of this group demonstrated predominantly delusions, derealization and depersonalization, and were diagnosed mainly in the groups: schizophrenic psychosis at onset, schizoaffective paraphrenia and paranoid schizophrenia. Moreover, these patients are characterized by prevailing positive symptoms with an acute onset of the disease, a good responsiveness to drugs and do not show any marked defect syndromes. These findings are in line with those

according to which in the paranoid subgroup the right hemisphere is more affected than the left [22, 24]. The present findings may be compared with the results obtained by Oepen et al. [26], who in a group of acute unmedicated schizophrenic patients with first manifestations of their symptoms found better performances in the left visual field in both the word and the face tasks. This was interpreted as an overactivity of the right hemisphere. Furthermore, it is suggested by Bracha [5] that patients showing left-prone behaviour belong to a subgroup of unmedicated schizophrenic patients presumably consisting above all of paranoid patients, i.e. those with a better prognosis and neuroleptic response than the remaining schizophrenics.

The results of the low-frequency group differ both in their tapping findings and their clinical features. This group was characterized by drastic reductions of right- and left-hand taps which had a tendency to be more pronounced in the right hand. Similar drops in tapping scores could be demonstrated in patients with left frontal lesions [20]. In these experiments, too, the right-hand taps were more markedly reduced than the left-hand taps. Additional findings support the fact that significant impairment in the movements of both arms and hands results from left-sided cortical lesions [19, 35], while right-sided lesions impair the movement in the contralateral arm only [35].

The clinical symptomatology in the low-frequency group consisted of affective flattening, emotional withdrawal, motor retardation, anergia and poverty of speech. These patients belong to these diagnostic categories: schizophrenia with paranoid hallucinatory and occasional catatonic symptoms, catatonia, hebephrenia and simple schizophrenia. In most cases they show a gradual onset of predominant negative symptoms, a lower responsiveness to drugs, as well as more defect syndromes than patients of the high-frequency group do. There is evidence that schizophrenia is associated with structural changes specifically including limbic regions [3, 30]. The left side is supposed to be more involved than the right side [7, 8, 29]. In chronic schizophrenic processes disturbances of frontal regions [10, 32] particularly in the left side could be detected [3]. Many patients with chronic processes are characterized by gradual development of the disease, a poor premorbid adjustment and predominant negative symptoms [1, 31]. The latter was found to be correlated with prefrontal impairment [25]. Thus, an interrelationship between chronic processes, negative symptoms and frontal impairment might be assumed.

As a consequence of this, it can be said that patients with high and low tapping frequencies show different functional and structural abnormalities as well as different clinical pictures.

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