

Circadian Body Temperature in Chronic Schizophrenia

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Summary. The 24-hour oral temperatures of 51 chronic schizophrenic patients, 19 non-schizophrenic chronic psychiatric patients and 14 non-patients have been measured and compared. The chronic schizophrenics have an earlier peak temperature and differ significantly from the other groups. Compared with the non-schizophrenic patients their hourly mean temperatures reach significantly higher levels in the morning. Compared with the non-patients their mean temperatures fall to significantly lower levels in the evening after 5.00 pm.

INTRODUCTION

Chronic schizophrenic patients tend to be early all through the day. They cannot wait for their meals. Many of them arrive early at work. In a study of their sleep habits (Morgan and Drew, 1970) we have described how early they insist on going to bed and how they get up long before they have to. These observations of powerful drives in otherwise very passive inert obedient people have led us to wonder if chronic schizophrenics have some abnormality of their circadian rhythms which it might be within our limited scope to identify.

The first factor we have been able to investigate is body temperature. This varies diurnally in everybody. Blake (1967) showed that introverts' temperatures rise earlier in the morning than those of extraverts. Verma and Eysenck (1973) have suggested a connection between introversion and the social withdrawal which is a prominent feature of chronic schizophrenia. Our hypothesis was that chronic schizophrenics would show an earlier daily temperature peak than would non-schizophrenic patients and non-patients.

METHOD

There were 107 in-patients (37 women, 70 men) available for this study, in the sense that they were under R.M.'s clinical care, were physically well at the time and were judged to be mentally well enough to co-operate ade-

quately. They were all given an explanation of the method and purpose of the study and invited to take part in it. In the event 72 (17 women, 55 men) (67 per cent) did.

We had decided to copy Blake's (1967) method, measuring oral temperatures with ordinary clinical thermometers. Hourly readings were taken from 0500 to 2300 and two-hourly readings through the night. This amounted to 21 readings in the 24 hours. Blake took 20 readings and tested each subject on two separate 24-hour periods, using the mean of each pair of readings. We inserted an extra reading at 0600 (because patients are normally active by then) and obtained only one set of readings from each subject.

We checked in a water-bath that our twenty clinical thermometers gave similar readings. A.J.C., who is a trained nurse, did a number of experiments on the technique of obtaining valid oral temperatures. As a result of these, the thermometer was left in the patient's mouth for a standard two minutes (measured with a stop-watch), and we decided that subjects would need to avoid going out of doors, eating, drinking or smoking during the 20 minutes before each reading. One patient was a persistent mouth breather, so in his case we used readings obtained from his axilla. A.J.C. took all the readings.

The patients were members of six 20-bedded wards. Their normal weekday rehabilitation

routine involved their going to work elsewhere in the hospital from 0845 to 1715. For this study they were excused work for a day but lost no pay for this. In the first two wards temperature recording began at 0900 and continued till 0800 the next day, when the patients had to return to work after a disturbed night's sleep; their neuroleptic and other drugs were continued throughout. The spikiness of 7 of the 21 temperature curves obtained from these wards made us wonder if the oral phenothiazines were depressing some patients' temperatures for an hour or two after administration. In the patients' clinical interests we were not prepared to withhold neuroleptic drugs for long enough (weeks or months) for them to be eliminated from the body, and indeed we should almost certainly have lost the co-operation of our volunteers had we tried. As a compromise we withheld all drugs (except anticonvulsants) from patients in the last four wards for 48 hours, starting 24 hours before readings began. At the same time we changed the start of the 24-hour period under study to 1800 (until 1700 the next day). This was kinder to the patients because their rest day in the ward then followed their disturbed night. Some of the temperature curves were, however, as spiky as before. The readings were taken between 18 November and 12 December 1974.

Diagnosis was a problem. Our advantage was that these were not new patients. They had all been in this hospital for months or years, during which they had been interviewed many times and their behaviour had been thoroughly observed. Before transfer here many of them had been for many years in other hospitals, and clinical records from those hospitals had in every case been read and summarized; so we possessed information going back to the start of each illness. However, early records were often scanty, many patients had never been observed by us except under the stabilizing influence of their tranquillizers, a number of other patients no longer had any sign of active psychosis, and schizophrenia can be an elusive concept anyway. In the end it seemed best to use all the available evidence, past and present, and divide the patients into four diagnostic groups, (a) definitely schizophrenic, (b) pro-

bably schizophrenic, (c) possibly (though probably not) schizophrenic, (d) definitely not schizophrenic.

Table I shows the diagnoses of the patients in the available population and in the volunteer sample. Although a total of 72 patients volunteered, two men became increasingly agitated by the procedure and after 12 hours they were withdrawn from the experiment, leaving 70 patient subjects. Among those who declined to volunteer, we had lost an undue proportion of (a) women patients, 20 out of 37 refused, (b) definitely non-schizophrenic patients, 12 out of 19 refused, (c) possibly schizophrenic patients, 9 out of 21 refused, and (d) non-paranoid patients, 10 out of 22 refused.

TABLE I
Population and sample by diagnostic sub-groups

	Total population	Refused	Withdrawn from study	Net sample
Definitely schizophrenic ..	40	7		33
Probably schizophrenic ..	27	7	2	18
Possibly (probably not) schizophrenic	21	9		12
Definitely not schizophrenic ..	19	12		7
Total	107	35	2	70

It proved more difficult to collect non-patient controls. It soon became clear that we would get few to volunteer if we insisted on two-hourly night time temperatures, so we had to be satisfied with one 0300 reading between 2300 and 0700. In the end we were able to assemble 14 sets of readings, from some of the staff of this hospital, some of their relatives and friends and some medical students and student nurses of another hospital.

The final composition of the sample of 84 subjects is set out in Table II which includes all the relevant information we have about them.

In view of Blake's (1967) work on the influence of extraversion-introversion on temperature curves, we considered administering the Eysenck Personality Inventory to all our subjects. A pilot

study was carried out on patients, but their replies were found to be so much at variance with the observed truth (e.g. very withdrawn schizophrenics portraying themselves as keen party-goers), that we could have had no confidence in the findings, and so we abandoned the attempt.

RESULTS

Mean hourly readings were calculated for each of the four diagnostic sub-groups of patients, and for the non-patient controls. Inspection of the resulting curves for the 7 Definitely non-schizophrenic patients and the 12 Possibly schizophrenic patients showed them to be similar in shape, so we felt justified in joining those patients together into one sub-group of 19 Non-schizophrenics. By the same process we amalgamated the Definitely and Probably schizophrenic patients into another sub-group of 51 Schizophrenics. Fig 1 contains the curves derived from the means of the raw data from these patients.

The differences between the means of Schizophrenic and Non-schizophrenic patient sub-groups are significant in the case of three of the morning readings, but at no other time of day:

	t	P
0800	2.376	<0.02
1000	2.518	<0.02
1100	2.932	<0.01

Fig 1 also shows the mean temperature curves of the 51 Schizophrenic patients compared with the 14 Non-patient controls. The curves are close together through the morning and afternoon, but diverge after 1700. This is the Schizophrenic group's peak, but the Non-patient curve continues to climb to a peak at 2000. Mean readings were significantly different at the following hours:

	t	p
1800	2.035	<0.05
1900	2.608	<0.02
2000	3.870	<0.001
2100	3.665	<0.001
2200	3.763	<0.001
2300	2.733	<0.01
0300	2.044	<0.05

DISCUSSION

Although the mean data by diagnostic sub-groups (shown in Fig 1) yielded differences which supported our hypothesis and were satisfactory both pictorially and in terms of their statistical significance, we were not happy that the use of mean data was entirely legitimate or told the whole story. Our view of Fig 1 is that the curves for non-schizophrenic patients and for non-patients are roughly in phase and of similar shape, but for some reason the mean temperatures of the non-patients are $0.2-0.3^{\circ}\text{C}$ higher throughout. However, compared with these two curves the schizophrenic temperature curve is phase-shifted to the left, as predicted. This happens to cause the schizophrenic curve to follow closely the non-patients' curve until 1700 and the non-schizophrenic patients' curve for the remainder of the day. It follows that significant differences between means emerge at times when two respective curves diverge in the vertical dimension. This seemed to us to be a poor way of providing statistical support for the existence of a phase shift, which in terms of Fig 1 is a difference in the horizontal dimension.

Seeking a better way to validate and present our findings we used the technique of Fourier transformation to fit sine curves to the individual raw data of all our subjects. (This was possible in the case of all but four subjects, all schizophrenic, whose temperature curves were not sufficiently sinusoidal in form). Using the individual peak temperature times yielded by this technique, we calculated mean peak times by diagnostic sub-groups. The schizophrenic peak (1612) was a mean 1 hour 51 minutes earlier than the non-schizophrenic peak (18.03), which was itself 1 hour 17 minutes earlier than that of the non-patients (1920). If the subjects are split into two sub-groups with peak temperatures before or after 1800, Table III shows the result. The non-schizophrenic patients are intermediate between the other two diagnostic sub-groups, and differences are significant only when the non-patients are included. This may be evidence that the institutional environment has some influence on the temperature cycle. If this were so we would have expected an association between peak temperature times and length of stay in hospital, but there was none.

TABLE II
Composition of sample by diagnostic sub-groups and other variables

						Definitely schizo- phrenic	Probably schizo- phrenic	Possibly schizo- phrenic	Definitely not schizo- phrenic	Non- patients
Men	..	..	..	..	..	30	10	9	4	8
Women	..	..	..	..	..	3	8	3	3	6
Total	..	..	..	..	..	33	18	12	7	14
Age range	..	..	..	..	..	31-60	25-60	26-55	25-55	12-58
mean	..	..	..	..	..	48	43	44	43	34
Mean number of years since first admission	..	..	..	..	..	23	18	13.5	19	0
Mean number of years in mental hospitals	..	..	..	..	..	18.5	17	9	19	0
Mean number of months in this hospital	..	..	..	..	..	56	30	19	46	0
Wing group (Wing, 1961)	1A	..	..	..	..	1	0	2	—	—
	1B	..	..	..	..	1	7	5	—	—
	1C	..	..	..	..	17	11	4	—	—
	2	..	..	..	..	3	0	0	—	—
	3	..	..	..	..	6	0	1	—	—
	4	..	..	..	..	5	0	0	—	—
	5	..	..	..	..	0	0	0	—	—
Mean social withdrawal score (Wing, 1961)	..	..	..	..	..	3.30	1.33	2.00	0.71	—
IQ (WAIS) range	..	..	..	..	..	50-122	60-118	57-121	46-89	Not known
mean	..	..	..	..	..	81	81	86	63	—

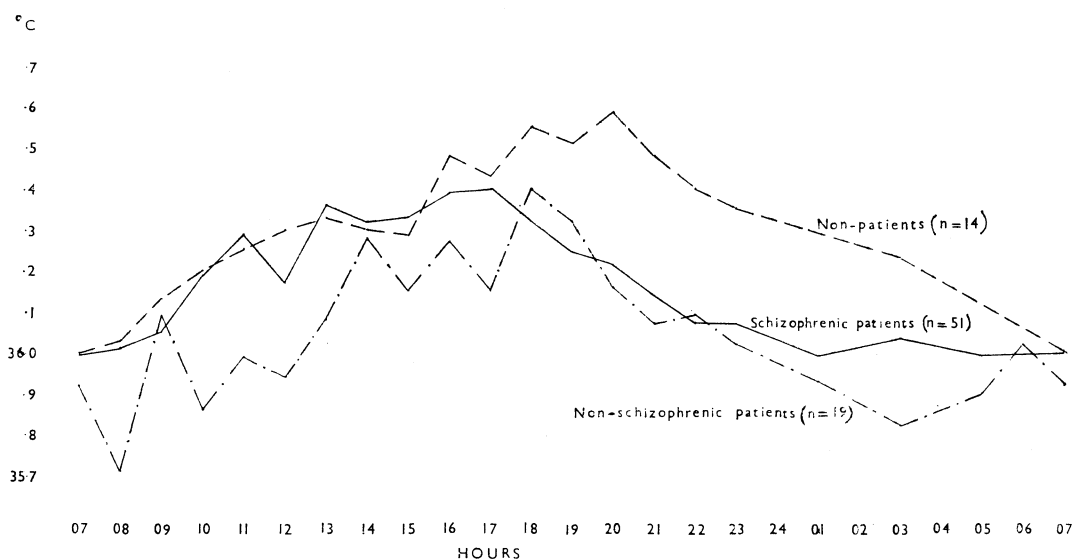


FIG 1.—Mean 24-hour temperatures by diagnostic sub-group.

Nor did we find any association between peak temperature times and age, sex, IQ, age on first admission, ponderal index, dosage of major tranquillizers, social withdrawal score (Wing, 1961) or paranoid ideas. All patients did, however, show a significant association ($\chi^2 = 4.313$, $p < 0.05$) between their current peak temperature time and the time when they were put to bed years ago in their parent hospitals (if there is any causal relation here it could be operating in either direction). There was a rather closer association ($\chi^2 = 6.14$, $p < 0.02$) with the patients' current bedtime nowadays chosen by themselves. A probable connection between endogenous rhythms of sleep and body temperature is recognized (Conroy and Mills, 1970, p 130), and our findings serve to confirm this.

Healthy subjects taking part in isolation studies have been reported (Aschoff *et al*, 1967) to reach their peak temperature abnormally early in the activity cycle. It is interesting that our schizophrenics should have done the same thing, for they too are isolated, though in a very different way from Aschoff's healthy subjects.

We cannot claim to have shown beyond all doubt that an abnormal temperature cycle is specific to chronic schizophrenia. We are aware of three weaknesses in our study; it lasted only 24 hours, we obtained only 14 non-patient controls and we have not solved the problem of diagnosis. The latter is perhaps less of a weakness than it appears. Some patients may possibly have been wrongly classified, but the classification was done before the temperatures were recorded, and it is difficult to imagine how such contamination could be responsible for the recorded differences. On the contrary, we submit that the differences will have been diminished rather than created by any diagnostic contamination that may have occurred. This may be the reason why the non-schizophrenic patients occupy their intermediate

position, though this might also be due to their illnesses or to the effect of the institutional environment, as already stated.

TABLE III
Number of people with peak temperatures before or after 1800 × diagnosis

	-1759	1800+	Total
A. Schizophrenic patients	32	15	47
B. Non-schizophrenic patients ..	11	8	19
C. Non-patients ..	3	11	14
Total	46	34	80

	χ^2	P
A v. B	0.25	ns
A v. C	7.79	<0.01
B v. C	3.02	ns
A v. B v. C	7.70	<0.025
A+B v. C	7.34	<0.01
A v. B+C	4.23	<0.05

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