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# A Psychophysiological Study of Breathing Behaviour

By ANDREW SKARBEK

The idea of a relationship between respiration and mental functioning can be traced back to ancient superstition that the diaphragm is the centre of the soul as well as of emotion.

It was John Perceval in his book first published in 1840 entitled *A Narrative of the Treatment of a Gentleman During a State of Mental Derangement* who stated that mental illness and health are closely connected with respiratory processes. He writes 'I suspect the health of the mind and the health of the body, particularly the operation of the lungs . . . to be essentially connected and believe the healthy state of mind depends very much upon the regulation of inspiration and expiration . . . that in controlling the spirit you must control your respiration'. He asserts that he has found that 'well regulated breathing is essential to bodily health and mental restoration'.

Since then a number of investigators have been intrigued by this relationship between breathing and mental functioning. My interest in this field originated from investigation of breathing behaviour in speech, reflecting the emotional state of individuals while engaged in experimental situations designed to stimulate different levels of cognitive functioning under the influence of neuroleptic drugs (Goldman-Eisler, Skarbek and Henderson, 1966). In the course of these investigations attempts were made to account in terms of breath rate for the selective action of chlorpromazine on pauses of hesitation which were shown to accompany complex cognitive activity during speech. It was found that the direction of the change in pause time affected by chlorpromazine, i.e. whether pause time and cognitive achievement increased or whether they were diminished under the drug, was related to the initial resting breath rate (RBR) of an individual.

This relationship was discovered by means of a factor analysis; subjects with high RBR responded to chlorpromazine by delaying speech action under intellectual challenge, taking more time for pausing and, as was subsequently shown, for thinking. On the other hand subjects with RBR on the low side became intellectually less successful when under the influence of chlorpromazine than in their normal state.

These investigations led further to the question whether breathing rates of subjects at rest while not engaged in speech might not be a personality characteristic and a measure of the initial excitation/inhibition state of an individual; a question which has so far not been investigated. A review of the relevant literature relating to the relationship between personality characteristics and breathing pattern was presented by Skarbek (1967).

Sutherland, Wolf and Kennedy (1938) maintain that spirogram tracings are characteristic of an individual, and they go further, suggesting that they are an objective gauge of a patient's mental state—a convenient and easy method by which to follow a patient's mental progress.

The improvement in cognitive functions found in normal subjects with high RBR when they were given chlorpromazine under experimental conditions reported by Goldman-Eisler *et al.* (1966) was thought to be relevant to the therapeutic effects of this and other psychotropic drugs in the treatment of psychiatric patients. It was therefore decided to study a large sample of patients under treatment in order to discover correlations between RBR and type of treatment and diagnostic classification of the patients.

## Method and Sample

Patients in a large acute admission unit attached to a mental hospital were studied. In this unit most patients stayed between four to eight weeks; they were all seen, examined and



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diagnosed by consultant psychiatrists and were under their care whilst in hospital. The catchment area which this hospital serves is rather extensive, covering both urban and rural areas; patients from various occupational, social and intellectual backgrounds were admitted.

Physical treatments, drugs and electrotherapy, were used primarily but there was also some group and occupational therapy. The unit consisted of 24 female and 24 male beds, and was housed in a modern well-furnished and well-appointed block. There was a very quick turnover, with an admission rate of about 500 patients per annum. The aim of the present research was to observe approximately 100 consecutive admissions from the point of view of their RBR, excluding from the sample only those patients with physical conditions which could affect the RBR.

The measurement of RBR was obtained by using the following method: The patient was asked to recline in a restful quiet side-room in a comfortable position, was asked to shut his eyes, relax completely and try not to engage in any problem-solving thought. Time was allowed for the patient to settle down, usually between four to five minutes, after which the observer counted the number of respiratory cycles by observing chest expansions for a period of five minutes using a stop watch.

All patients were seen soon after admission before treatment commenced; brief assessment of mental state was made and RBR was measured; this procedure was repeated at weekly intervals until the patient's discharge from the unit.

The purpose and nature of the investigation were explained to the patients in the preliminary session. The observer stressed that he was a completely independent, outside agent, had no say in the clinical management of cases, and that his sole concern was the collection of data for the research project.

It took about five months to collect and complete the observations on 100 patients.

The composition of the sample, according to the original diagnostic classification made by consultants, is shown in Table I.

One patient in the depressive group had to be excluded because he developed signs of congestive cardiac failure.

The ages of the male patients ranged from 19 to 78 (mean 43·1) and those of the women from 18 to 72 (mean 44·9).

## Results

The mean RBR before treatment from the 101 patients studied was 18·9 (S.E. = ± 1·9). This was significantly higher than the mean result from 50 normal subjects (see Fig. 1), but there was no evidence of any systematic difference among patients depending on diagnostic category, nor was there any sign that patients' age affected the RBR.

Overall, the mean RBR for patients dropped by 1·54 units following treatment. A series of multiple regression analyses, designed to identify factors influencing this reduction, led to the following conclusions.

1. Neither age nor sex of patients affected the change in RBR following treatment.

2. Improvement in patients' condition was significantly associated with a decrease in RBR, estimated as 3·40 units ($p<0·001$) see Tables I and II.

3. Treatment with phenothiazines tended to decrease RBR while the opposite tendency

Table I

*Changes of RBR in diagnostic groups following treatment*

| | n= | Initial | Post treatment |
|---|---|---|---|
| Depression .. .. .. .. | 61 | 19·4 | 17·6 |
| Schizophrenia .. .. .. .. | 18 | 18·2 | 17·2 |
| Personality disturbance .. .. .. | 8 | 16·7 | 15·7 |
| Anxiety state .. .. .. .. | 8 | 19·2 | 16·4 |
| Obsessional state .. .. .. | 6 | 19·0 | 18·0 |

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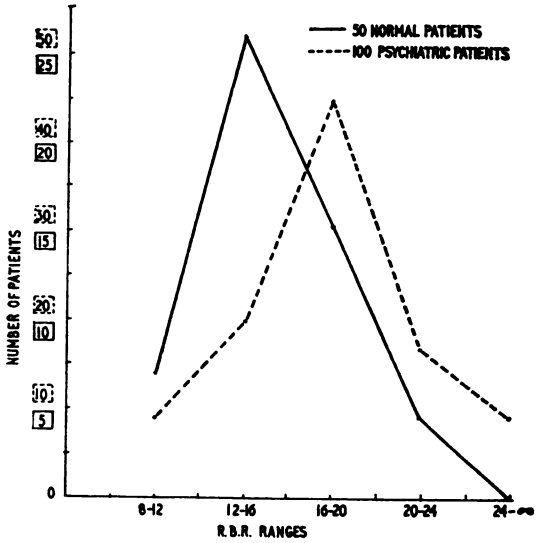



FIG. 1

was observed following ECT. However, the observed difference in the effects of these two treatments might be expected to have occurred by chance about 15 times in 100.

4. There was no evidence that such treatment effects as were observed differed according to diagnostic group.

The mean results are shown in Tables I, II and III. Estimated effects from the multiple regression are given in Table IV.

## DISCUSSION

The nature of RBR was previously extensively investigated by Skarbek (1967) in normal subjects and this measure was thought to be reflecting the initial basic tension state of the individual. Subjects were found to differ significantly not only in their overall mean level of RBR but also in the way their RBR varied from one test to the next. This variability was thought to be associated with their particular ways of adaptation and stability.

Investigations presented in this study have shown that successful treatment of psychiatric patients is associated with a significant fall in RBR as demonstrated by multiple regression analysis (Table IV). Patients with high initial breath rate tended to decrease their level while

TABLE II

*Mean scores for RBR pre- and post-treatment in the clinical change groups*

| Patients | n | RBR pre-treatment | RBR post-treatment | n increased | n decreased | No change |
|---|---|---|---|---|---|---|
| Considerably improved .. .. | 40 | 19·89 | 16·33 | 7 | 29 | 4 |
| Improved .. .. | 22 | 19·47 | 17·47 | 5 | 15 | 2 |
| Slightly improved .. | 25 | 17·10 | 17·37 | 9 | 8 | 8 |
| Not improved .. | 14 | 19·01 | 19·13 | 5 | 4 | 5 |

TABLE III

*Number of patients and their treatments*

| | Depression | Schizophrenia | Others* | Total |
|---|---|---|---|---|
| Phenothiazine .. .. .. .. .. | 4 | 5 | 8 | 17 |
| Anti-depressant.. .. .. .. .. | 8 | 0 | 0 | 8 |
| ECT .. .. .. .. .. .. | 7 | 1 | 0 | 8 |
| Phenothiazine + anti-depressant .. .. | 13 | 1 | 7 | 21 |
| ECT + anti-depressant .. .. .. | 4 | 0 | 0 | 4 |
| Phenothiazine + anti-depressant + ECT .. | 17 | 11 | 3 | 31 |
| No medication .. .. .. .. .. | 8 | 0 | 4 | 12 |
| Total | 61 | 18 | 22 | 101 |

*Personality disorders .... 10 Anxiety states .... 8 Obsessional states .... 5

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TABLE IV

*Estimated effects from multiple regression*
On the differences: Y = (RBR before treatment) —(RBR after treatment)

| | Variable | Estimate |
|---|---|---|
| *Diagnosis* | Schizophrenia $x_1$ | −1·13 |
| | Depression $x_2$ | −0·65 |
| | Other states $x_3$ | −1·00 |
| *Treatment* | Phenothiazine $x_4$ | 1·12 |
| | Anti-depressant $x_5$ | −0·11 |
| | ECT $x_6$ | −0·91 |
| *Result of treatment* | | |
| | Improved $x_7$ | 3·40 |

Mean Y = 1·54
Residual standard deviation = ± 4·00

those with initially low rate increased it, leaving those whose initial rate was around 16 more or less unchanged. The narrowing of the range of RBR becomes apparent as a result of successful treatment.

The effect of sleep as a leveller of individual variations of RBR was described by Skarbek (1967) in normal subjects as well as to a lesser extent in psychiatric patients. The findings of the present study suggest that RBR is related to individual level of arousal and excitation, the control of which becomes disturbed as a result of a psychopathological state. Successful treatment may restore the ability of patients to cope with this arousal, either by restraining it or by letting it operate in a free-flowing manner. These changes naturally follow a more efficient reality-orientated ego functioning, which is the hallmark of clinical improvement. It is interesting to note that patients who did not show signs of improvement did not display this change in the RBR.

Taking the group as a whole it was not possible to predict from the initial RBR the result of treatment. This was probably due to the fact that a considerable number of patients showed only marginal shifts as a result of treatment, because both their readings were within a fairly narrow range in spite of their psychopathological state. The significant shift in the RBR of the sample as a result of successful treatment could be attributed to the contribution of a few patients with particularly high initial RBR in whom a fall in RBR coincided with clinical improvement. In some cases it was further observed that subsequent deterioration coincided with increase in RBR.

These findings are very much in line with those of Clausen (1951), Christiansen (1965) and Jurko, Jost and Hill (1952). Further investigation will be necessary to determine what are the special features of premorbid personality, psychopathology and physiological characteristics of those patients with initially high or low RBR, or of those able to preserve a stable level.

At present it is possible to say that there was a group of patients mostly classifiable as Depressives, in whom high breathing rate was a concomitant of their psychopathological state and who responded favourably to physical treatment, with a concomitant fall in RBR to a normal level.

The effect of phenothiazine treatment on the RBR is a lowering, as shown by the the Multiple Regression Analysis. The effect of ECT and, to a lesser degree, anti-depressant drugs in increasing RBR is difficult to interpret, perhaps because of the small sample of patients and the fact that the two treatment groups were not by any means comparable. Differences in RBR between diagnostic groups after treatment were found to be not statistically significant but the frequency distribution suggested that in the depressive group alone there was a shift from higher to lower rates of RBR. However, the depressive group was much larger than any other.

## SUMMARY

Changes in resting breathing rate (RBR) of 101 acute psychiatric patients during the course of treatment in hospital have been measured.

Clinical improvement was significantly associated with a mean decrease of RBR of 3·40 breaths per minute.

Treatment with phenothiazines appeared to decrease RBR, while ECT and to a lesser extent anti-depressants appeared to increase it. There were no statistically significant differences between diagnostic groups in degree of change of RBR.

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