A CONTRIBUTION TO THE OBJECTIVE MEASUREMENT OF THE CATHARTIC PROCESS—I

By

FRIEDA GOLDMAN-EISLER, Ph.D.

Medical Research Council Unit for Research in Occupational Adaptation, Maudsley Hospital

I. Introduction

In previous work (8, 9) the writer has found that measures of breathing activity during speech, and of output of speech per breath are related to the emotional intensity and to the extent to which emotions are restrained or given free expression in the exchanges during psychiatric interviews. A high level of ventilation, i.e. high breathing activity with low output of speech per breath was shown to belong to content implying outgoing affect (jealousy, appetite, sex, aggression, wishes and hopes), and a low level of ventilation in speech to be associated with topics of restricted emotionality, such as fear, inhibition, deprivation, as well as to reasoning.

Tension states as rated by physicians or as experienced subjectively, as well as anxiety states and other emotional disturbances have been shown to be associated with physiological changes in the muscular system as measured by the electromyograph (15, 19, 21). Increased muscular tension was also found to accompany hyperventilation (1, 6) and increased muscular tension as well as inhibited breathing have been reported to accompany intellectual effort (11, 22, 23). Rising gradients of tension from forehead and chin have recently been shown to accompany sustained attention when listening to read material (26).

II. The Problem

It seemed desirable at this point to study how during the process of interviewing the fluctuation of speech output and breathing activity were related to the changes in the action potentials of muscular activity, and how these physiological changes were related to the content of the interview.

In approaching this problem it is well to be aware that respiration and activity in the muscle tissue are physiologically closely related events with a varying phase relation according to the effort expended. There seems to be a correspondence between the phenomena of "oxygen debt" of muscular tissue in the phase of contraction, and the reported relation between increased muscular tension and inhibited breathing. It has been argued, however, that lack of oxygen in the tissues is not the immediate stimulus which sets off the normal respiratory mechanism. ". . . in normal life we breathe for psychologic reasons before we have to breathe of physiologic necessity" (16).

In fact, little is known about the pattern of respiratory action and muscular activity in the tissues accompanying mental effort and emotion. The quantities relevant to muscle tension as distinct from movements are on a far more reduced scale, the measurements being those of sustained muscle potentials, obtained under experimental conditions of rest and exclusion of high-voltage bursts of activity produced by movement.

The purpose of the present investigation was therefore to learn how the relationship between respiratory and tissue activity may vary with different individuals, with different stages in the interview, and with different content.

III. Experiment

Seven subjects, including five patients at the Maudsley Hospital and two non-patients, were interviewed by the writer, who adopted a fairly passive role to encourage the subject to talk freely. A certain degree of guidance was, however, exercised usually when the subject had come to a pause, and there was some prodding once a topic promising display of affect was broached.

The subjects were seated at a table opposite the interviewer with the microphone between. They were requested to rest their arms on the table with hands clasped and refrain from gesturing. The interviews were recorded on the speech recorder, while the action potentials of the subjects' forearm muscles were continuously recorded on the electromyograph. Dr. P. Sainsbury, who assisted in the setting up of this part of the experiment, has described his method elsewhere (21). The muscle groups of the forearms were chosen in preference to the facial or neck muscles, as the latter were much more likely to be affected by speech movements.

Apart from the microphone which fed the tape recorder, a throat microphone was fixed round the subject's neck and the speech movements were fed into the same polygraph. Thus a record of the voice tracing ran synchronously with the muscular tension tracings, and their integrator. One pen recorded seconds and half-minutes. A signal between each 30 seconds was fed into the tape recorder, and coincided with the half-minute pen mark. There was also a signal between the interviewer and the technician which was worked whenever the subject disobeyed the instruction not to move his arms. These passages which were, however, few and short were removed from the record.

The speech recordings were transcribed, the subjects' utterances timed, the syllables in each utterance counted, and the inspirations which were clearly audible on good quality recordings (8) were also counted for each utterance. The concomitant changes of the measures were studied separately for each individual record.

The data at our disposal were as follows:

(*a*) number of syllables in each utterance = Ns
(*b*) total duration of each utterance in minutes = t
(*c*) inspirations in each utterance = Ni
(*d*) action potentials of muscular tension = AP

The following measures were derived from these quantities:

$\frac{Ns}{t}$ = speech rate (SR)

$\frac{Ni}{Ns} \times 100$ = ventilation percentage (V) or degree of ventilation in speech

$\left(\text{reciprocal of output of speech per breath} = \frac{Ns}{Ni}\right)$

$\frac{Ni}{t}$ = respiration rate (RR)

The action potentials of muscular tension were recorded in the following way: the integrated units were counted for each utterance and divided by the number of seconds in the utterance. This measure will be referred to as AP.

IV. Treatment of Data

To study the changing relationships of the measures described above each interview was treated separately. The data are derived from utterances following upon each other in sequence as the interview progressed. They can therefore

not be treated as random occurrences but each interview is to be regarded as a series of temporal events.

The statistical methods for analysing changes taking place over time have been largely developed by economists under the name of Time Series Analysis.

"Time series are sequences, discrete or continuous, of quantitative data assigned to specific moments in time and studied with respect to the statistics of their distribution in time. They may be simple, in which case they consist of a single numerically given observation at each moment of the discrete or continuous base sequence; or multiple, in which case they consist of a number of separate quantities tabulated according to a time common to all" (27). The time series composed of our data will be multiple ones. They will be analysed in order to arrive at an empirical description, not to provide a basis for prediction or extrapolation.

Certain assumptions underlying the analysis of time series and certain problems with which the statistics of time series are concerned derive from specific conditions connected with economic data, which are not necessarily reasonable if applied to the analysis of longitudinal data in psychology (2). Thus temporal trend, which economists will often remove as giving a spurious bias to correlations of temporal series, reflecting a general fact whose effect is misleading, is often a very interesting object of study in its own merits.

The correlation of trends signifies that there is an underlying common condition which affects both quantities correlated. If therefore for example respiration rate (RR) and muscular tension (AP) correlate, and both show a clear trend of progression at increasing rates, obviously neither RR nor AP are independent quantities but their covariation is due to an underlying condition affecting them both. Their correlation with time implies a correlation with an underlying condition changing in time, as will be seen later. This supposed underlying condition—we shall take it to be the degree of activation of the organism as it changes in the course of the interview—is the main object of interest. The correlation of AP and RR serves as its indicator; their correlation is therefore from our point of view not "spurious" but helps us to understand and serves to define the mental state as the interview progresses in terms of these quantities. Because of the non-random character of the data the term used to describe the relationship between the time series will be "covariation". Regression lines will be used to give a fit which is "the best fit" from the point of view of the method of least squares, but they will not be interpreted in terms of tests of significance.

The reciprocal innervation of biological and psychological activities (12, 18) will often mask the relatedness of two processes. Complex processes taking place in temporal sequence and involving mechanisms which dovetail can be expected to run their course with a lag of varying intervals. Each dependent process may therefore be expected to show the effect of the related process with a certain varying time lag provided the continuity of the process is not interrupted by interference, e.g. intervention of the interviewer. In the fast running stream of speech activity the mechanisms or activities we are interested in, namely muscular tension, respiration and verbalization with the accompanying thought processes move at different rates and rhythms. The electrical activity in the muscular tissue is a continuous phenomenon with instantaneous reactivity, breathing a periodic activity fluctuating in intensity in relation to effort and excitement, and the output of speech although seemingly continuous fluctuates under the influence of emotion as well as of voluntary control. These differences in the rhythms and rates of output are most relevant facts in studying the covari-

ation of these activities. The units of measurement had to have a minimum duration so as to allow for reliable rates (RR and SR) and ratios (AP). As a result of this averaging some lags might disappear while those which are consistent in their order of sequence would emerge. Such lags would probably depend on the degree in which the verbalization of the areas of tension or inhibition becomes more charged with "excitement breaking through the coordinating centres" (4), i.e. more cathartic in character. They should disappear as the various processes involved gain momentum and become synchronized in rhythmic discharge.

Consequently the question of the relation of the trends, i.e. the long-term movements of the sequences under investigation, is meaningful in the light of our problem. We ask whether there is a consistent tendency for the rate of respiration to rise as the interview progresses, and themes charged with affect enter the discussion, and whether this is accompanied by a similar tendency of the muscular tension, or by an opposite tendency, or neither. The trend values will be obtained by the method of moving averages (see p. 85), eliminating the short-term movements (cycles) which represent the non-permanent causes that are working on the time series (24).

The nature of these non-permanent causes would depend on the nature of the trend. Thus, if the trend is towards confession and abreaction, transient defences and escapes into irrelevant themes would be as non-permanent as are the deviations due to the interviewer's interference. If the trend is one of growing resistance transient bursts of emotion are to be regarded as non-permanent. We shall also be interested to see how the original quantities enveloping short-term cycles as well as long-term trends are related.

V. Units of Measurement

The units of measurement are not equal time units but utterances, i.e. periods of speech lasting from a preceding question or utterance of the interviewer to the next, which is usually occasioned by the subject having come to a natural stop or pause. These may vary in length but they seem to be the natural and genuine units of conversation. Short utterances, provided they are long enough to secure reliable measurements, often reveal explosively significant and most vital states of emotion, whose intensity makes up for the duration analogous to Lashley's "whipsnapping" movements (18).

Information theory also points towards the same approach (10). In terms of the latter some short utterances may contain as much and more information as some long ones. And while our choice is not based on a quantitative measure of amount of information we have a better chance of dividing speech output according to the latter criterion using as our unit utterances emerging naturally in conversation than by using passages of speech of equal duration as measured by objective time.

VI. Results

1. *General*

On inspection of the seven multiple time series (Figs. 1 and 2) showing the trends of respiration rate, action potentials, ventilation percentage and speech rate for the interviews recorded the following was observed. In the different interviews the above variables, and particularly respiration rate and action potentials, are differently related. Also the nature of the relation changed, in some instances, radically in the course of the interview and, as we shall see later, at significant points in the series, i.e. significant from the point of view of the content.

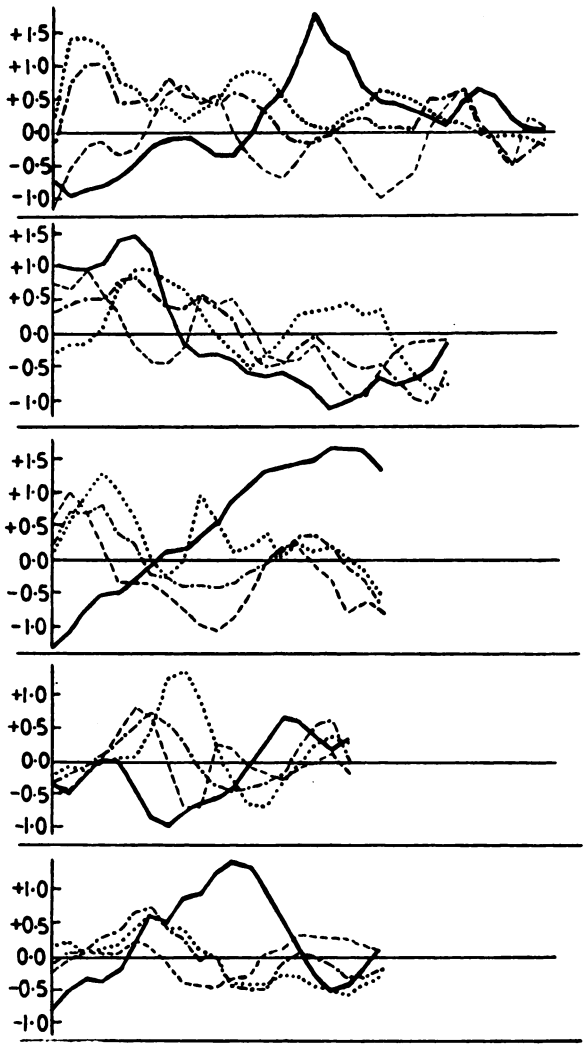

FIG. 1.—Moving average trends of multiple series of Muscular Tension (AP——), Respiration Rate (RR— · —), Ventilation Percentage (V· · · ·) and Speech Rate (SR– – –) obtained from subsequent utterances of five subjects during interviews.

Two of the interviews (S.I., B.I., Fig. 2) stand out, as may be seen from the diagrams, because they offer at first inspection a very similar profile, respiration rate, action potentials and ventilation percentage progressing towards a simultaneous peak while speech rate reaches a minimum; after the peak of the curve of respiration rate, ventilation and muscular tension these drop radically and muscular tension reaches a level below the initial one.

Of the remaining interviews two are variants of these two profiles; the rest differ in two aspects: (*a*) the multiple time series of measurements derived from these interviews is not so centred about a peak, and (*b*) the trends of respiration rate, action potentials, ventilation percentage and speech rate are not so clearly related.

As all interviews, although recorded more or less under the same external conditions, were fairly spontaneous phenomena, it seems an interesting fact

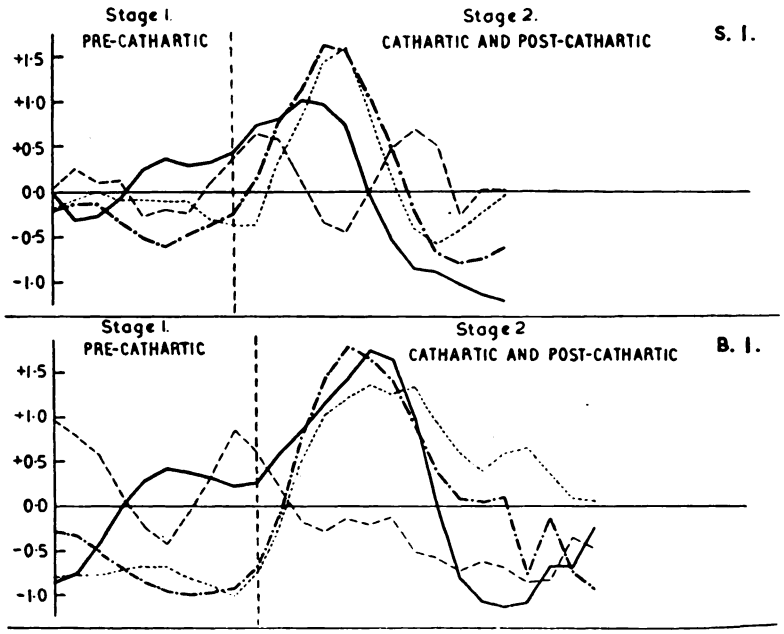

FIG. 2.—Moving average trends of multiple series of Muscular Tension (AP——), Respiration Rate (RR— · —), Ventilation Percentage (V····) and Speech Rate (SR – – –) obtained from subsequent utterances of S.I. and B.I. during interviews.

in itself that there should have emerged two such nearly identical profiles of speech-breathing and electromyographic measures as those of S.I. (a normal woman) and B.I. a depressed patient. This fact is the more interesting as the two profiles correspond very closely to the picture of the process of abreaction through verbal expression that may be derived from the literature. This paper will therefore concentrate on the analysis of these two records only. It will be useful before we turn to the theoretical model to analyse the two records in some detail, and see how far they represent a common phenomenon.

2. *Analysis of records S.I. and B.I.*

S.I. Female, 30, who volunteered for the experiment. S.I. had had some psychotherapeutic treatment, but was, on the surface, a well-adjusted individual. She was asked by the experimenter to think of a number of experiences, topics, or fantasies charged with a variety of emotions such as pleasure, anger, anxiety, joy, excitement, etc., to talk about. She reported that no other themes but aggressive ones occurred to her and suggested on her own initiative that this might have something to do with her ambivalent relation with the experimenter, in fact that the compulsive choice of the motive of aggression against women was a transference phenomenon.

The subject's record contains 25 utterances for which we have the measurements of respiration rate, speech rate, ventilation percentage and action potentials. The subject's mean values and standard deviations are given in Table I. Fig. 3 shows the four measures for comparison transformed into sigma scores as they progress from utterance to utterance. Utterances of less than 40 syllables were not included. The total duration of the 25 utterances was 15 minutes, and their mean length 161 syllables ranging from 61 to 539 syllables.

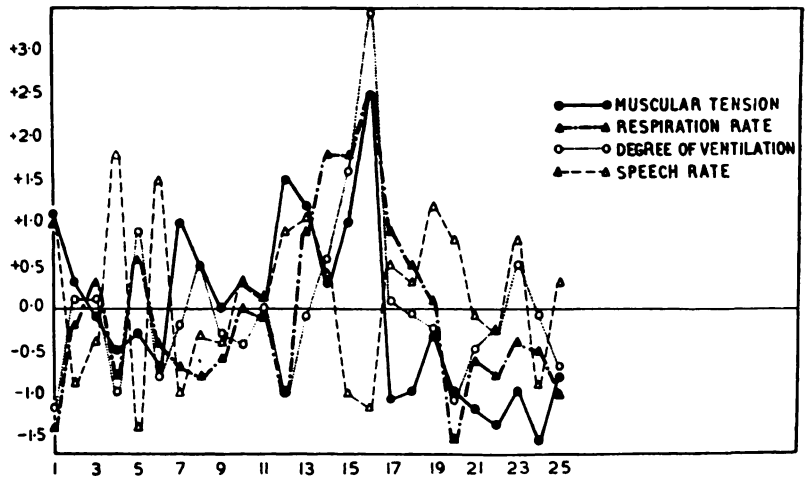

FIG. 3.—Standard scores of Muscular Tension (AP), Respiration Rate (RR), Ventilation Percentage (V), and Speech Rate (SR) for series of 25 utterances in interview of S.I.

TABLE I

Means and Standard Deviations of SR (Speech Rate), RR (Respiration Rate), V (Ventilation Percentage), and AP (Action Potentials of Muscular Tension) for subjects S.I. and B.I.

		Means	S.D.
SR	S.I.	4·3	0·78
	B.I.	2·3	0·81
RR	S.I.	7·5	1·80
	B.I.	7·8	3·00
V	S.I.	3·1	0·98
	B.I.	6·2	3·15
AP	S.I.	3·4	1·30
	B.I.	4·4	1·64

Action Potentials are not strictly comparable as the calibration of the apparatus could not be kept constant.

As mentioned before the rate of respiration (RR), muscular tension (AP), and the ventilation percentage (V) all progress, with a varying degree of fluctuation, towards a peak. The speech rate (SR) fluctuates in the first stage of the interview, in large cycles inversely to respiration rate and ventilation percentage. Increase in speech rate in this initial part of the interview is therefore achieved by a decrease in breath rate. In the next part of the interview after the interviewer has broached the theme of the subject's aggressive phantasy, which is followed by a sharp rise in the subject's muscular tension (utterance 12), there is a steady rise in speech rate (utterances 11–13). This continues while the respiration rate remains at a lower level. The speech rate recedes (utterance 14) after the sharp rise in respiration rate, and the synchronous mounting of respiration rate, ventilation percentage and muscular tension coincides with a trough in the speech rate (utterances 15–16). The peak of the interview (utterance 16) as emerging in the movements of the respiration rate, ventilation percentage and muscular tension lines and the trough of speech rate accompanies an explosive

utterance by the subject giving vent to a phantasy of extremely aggressive content.

Fig. 2 (top) presents the same sequence smoothed by moving averages of three subsequent utterances. This record shows clearly that, disregarding an initial point of somewhat higher tension, there is a fairly steady and slow rise in the tension state, the curve reaching its peak with the aggressive phantasy, and that after the peak there is a consistent but considerably steeper drop in the tension state to a level of relaxation which is considerably below the initial tension state.

The sequence of respiration rates accompanying the tension sequence shows stability in the first stage of rising tension (Fig. 2). As Fig. 3 shows there is a clearly decreasing trend between utterances 2 and 9. In the second stage the trend line of respiration rises steeply together with muscular tension, and descends more gradually. On the smoothed curve of moving averages this appears in the form of a shift in the crest of the curve of respiration. In fact, its true peak is in the same utterance as that of tension, as may be seen from Fig. 3.

The initial period of rising tension is thus accompanied by a slightly restricted breathing rate—whereby the two upward cycles of AP with peaks in utterances 7 and 12, are countered by downward cycles of RR. We also see (Fig. 2) that up to the point of change in the slope of RR the speech rate maintains its level. The same may be said about the ventilation percentage, with the difference that the latter retains its constancy with less fluctuation and for longer, rising from its preferred level by two utterances later. Its balance is maintained for so much longer by virtue of the rising speech rate, as the figure shows. This behaviour of the ventilation percentage (V) is in accordance with our hypothesis concerning its psychological significance (8); namely that it is a measure of balance or control maintained by virtue of speech activity, notwithstanding a certain excitation of the neuromuscular and autonomic systems.

A more steady and radical decline in speech rate from utterance 14 to utterance 16 coincides with the synchronous volley of AP, RR and V (Fig. 3).* It recovers a relative balance after the final and simultaneous drop of these three variables.

B.I. A depressed patient of good intelligence given to bouts of weeping, agitation, feelings of exhaustion, inability to cope and futility. The diagnosis was one of affective disorder—manic-depressive psychosis. She responded well to treatment by E.C.T.

This subject's record contains 29 utterances of sufficient length to yield reliable measurements of RR, SR, V and AP. The mean values and standard deviations are given in Table I. Fig. 4 shows the four measures in sequence of time. Again utterances of less than 40 syllables were not included. The total duration of the 29 utterances was 19 minutes and 15 seconds, and their mean length was 89 syllables ranging from 42–255 syllables.

As in the record of S.I. the rate of respiration (RR), muscular tension (AP), and ventilation percentage (V) progress, with a varying degree of fluctuation, towards a peak. Speech rate fluctuates rather more violently about the mean up to utterance 14 which also marks the beginning of the rise to a peak of respiration rate, muscular tension and ventilation, and from thereon speech rate fluctuates about a lower level (about one sigma below the mean). The initially decreasing trend of the speech rate (SR) accompanied by the decreasing trend of the rate of respiration (RR), and increase of muscular tension (AP) comprising the first utterances up to number 8, in which the subject discusses her

* There is no mechanical relation between respiration rate and speech rate.

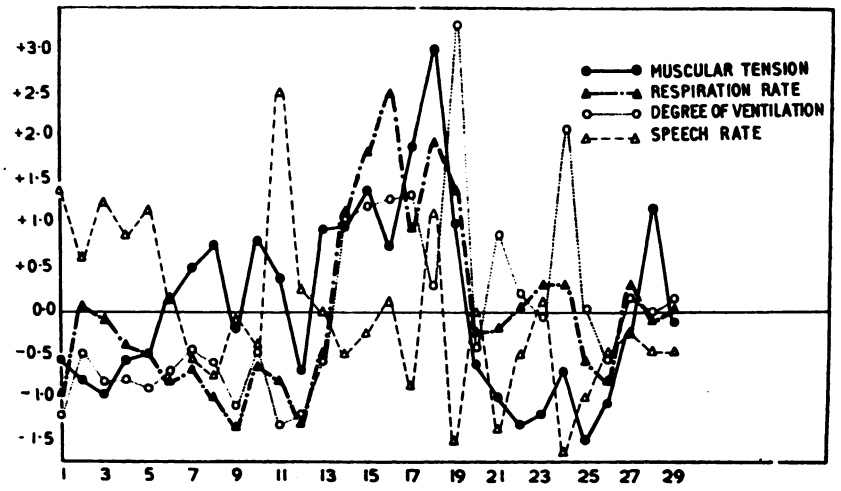

FIG. 4.—Standard scores of Muscular Tension (AP), Respiration Rate (RR), Ventilation Percentage (V), and Speech Rate (SR) for series of 29 utterances in interview of B.I.

father's physical and mental illness, pass into a fairly stable condition with RR, V and AP keeping an even keel, while the speech rises steeply. In these utterances (8–11) the topic changes from the father's to the patient's own condition, of which she gives a descriptive and rather detached account in general terms. After utterance 11 the interviewer asks her to give a more specific and concrete example of her experiences. The patient still tries to describe, rather than produce material (utterance 12). Continuing (utterance 13) she comes to remember a certain event and hesitates. At this point her muscular tension rises steeply, accompanied by a rise in breath rate (RR) and in ventilation (V), and a drop in speech rate (SR). From there on the subject brings out, with much hesitation and under continuous prodding by the interviewer, the story of her father's suicide and discusses her resistance to telling the story (utterance 13). The interviewer prods the patient to tell her thoughts on finding her father while he was lying under the gas oven (having tried to commit suicide) and the patient confesses guilt feelings (utterance 15) and elaborates in utterances 16 and 17 on them. This part of the interview is accompanied by rising tension. In utterance 18 she blurts out that her father's suicide had seemed to her desirable, in some ways. In utterance 19 the patient admits fear of her father. At this point the speech becomes extremely hesitant (slow) and while the respiration rate drops a little from utterance 18 the ventilation percentage reaches its peak. The muscular tension drops simultaneously and continues from this utterance on to do so consistently, descending by a steep slope to a new low level of muscular tension below the initial level. At a slow rate of speech (low SR) and with a considerable degree of ventilation the patient now volunteers how her husband reminds her of her father, being as unsatisfactory as the latter (utterances 20, 21, 22) and how she felt guilty about making demands on both (utterances 23, 24). There is a long pause (11·6 seconds) after this utterance, perhaps indicating that the momentum of the series had come to an end. The interviewer introduced a new subject (of how the patient met her husband) and from there on we can observe a gradual re-activation of the whole system (AP, SR and RR rising again), the theme of this passage being the patient's marital relationship. It evolved to a point when the patient described her doubts

about her feelings towards her husband, but as the interview had already lasted long enough this theme was not pursued.

3. *Comparison of records S.I. and B.I. in terms of the relation between their respiration rates and muscular tension*

In comparing the two records (S.I. and B.I.) it is interesting to observe that in both the system, as represented in the form of speech-breathing and tissue activity, enters the excitatory phase when the interviewer insists that the subjects should proceed from talking *about*, to talking *of* their experiences, i.e. to producing the actual material. Utterance 12 in S.I. and utterance 12 in B.I. mark this event.

The data of breath rate and muscular tension (RR and AP) in both records were therefore divided into two groups: For S.I. measures for the first 12 utterances before the steep rise of RR from six to ten respirations per minute were included in the first group. The second group of data comprised the subsequent 13 utterances covering themes such as the subject's phantasy of aggression against a woman rival, revealed hesitatingly at first and under the interviewer's prodding gaining momentum and final expression, and including the subsequent sequences of conversation which followed the discharge. Their content were attempts on the subject's part to discuss aggressive feelings against men. According to the subject's own observation, however, these were abortive, ". . . they turn into something sweeter".

For B.I. the first 11 utterances (1–11) before the rise of RR from 6·3 to 11·4 respirations per minute, contain descriptive accounts of her father's and her own condition. These were included in the first group of data. The following utterances are again responses to the interviewer's prodding and her insistence on actual material. Resistance passes into hesitating production of material (fear of father) at first without expressing emotion (AP and RR rising all the while), and eventually expressing emotion (fear of father and guilt admitted) and discharging tension. In the utterances following discharge the patient volunteers associations leading from her father to her husband. These utterances (from 12 to 24) are included in group 2. The material about the subject's marital relationships are not included as it is part of a new sequence introduced on the interviewer's initiative.

Regression lines were calculated for RR and AP (raw scores) of groups 1 and 2 separately for both S.I. and B.I., and Fig. 5 shows that they are in inverse relation to each other. The rising muscular tension in the first part of both interviews is accompanied by a steady maintenance to slightly decreasing level of respiratory activity (AP = 9·87 − 0·61 RR for S.I. and AP = 5·78 − 0·30 RR for B.I.).

In the second part, again in both interviews, the respiration rate follows the rise and fall of muscular tension (AP = 5·22 + 1·16 RR for S.I. and AP = 0·23 + 0·47 RR for B.I.).

Figs. 3 and 4 also illustrate the principle of asynchronous flux (5, 17) in the various responses interacting in the course of the initial stages of the interviews. This picture passes rather dramatically at utterance 12 in S.I. and 14 in B.I. into one of synchronous activation of speech-breathing behaviour and muscular tension.

At the same time, if we group our data without reference to the dynamic aspect of serial order and compare the action potentials of muscular tension for states of low, medium, and high breathing activity we again obtain very comparable results for the two interviews, as may be seen from Table II.

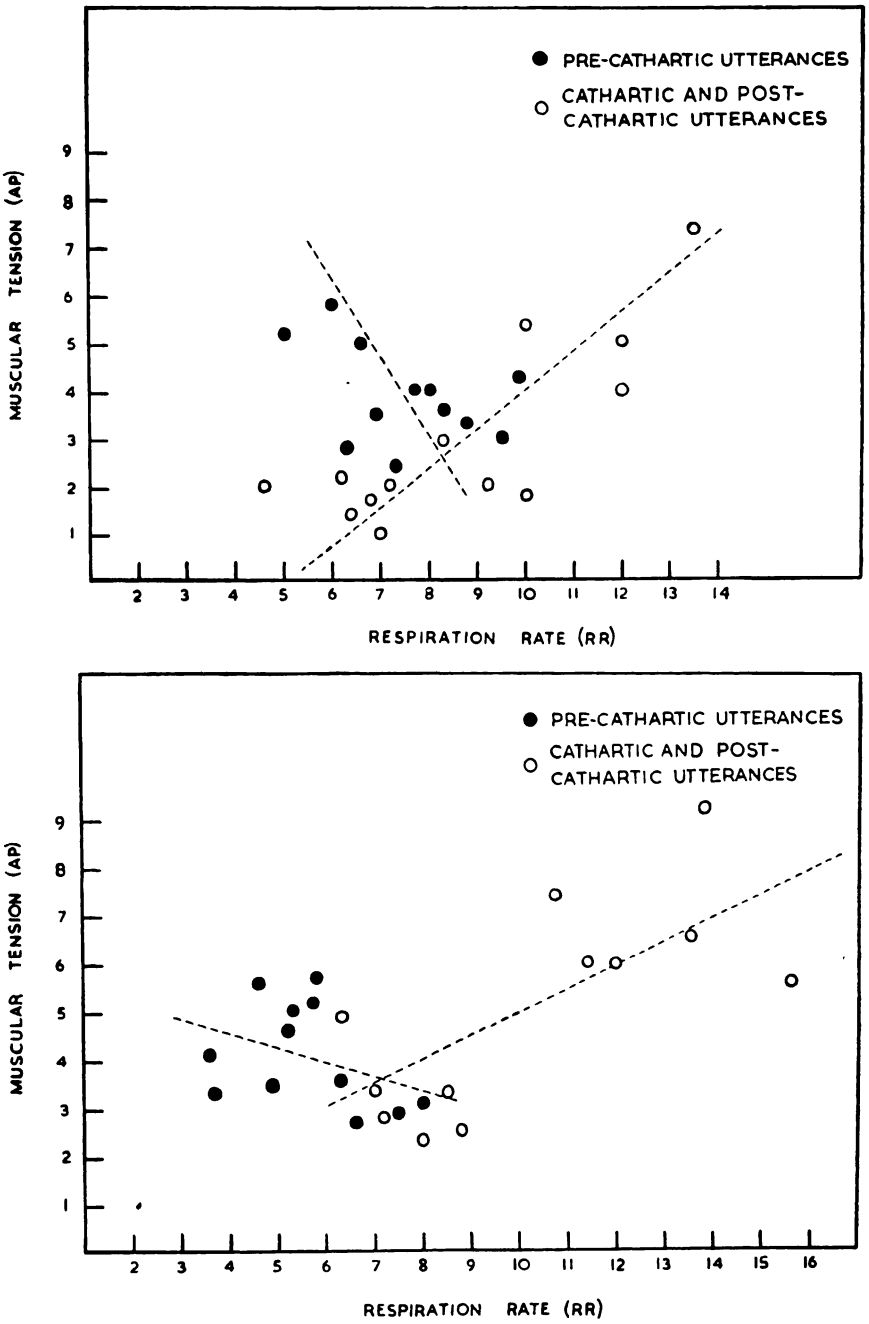

FIG. 5.—Regression lines for AP and RR (raw scores) of pre-cathartic, and cathartic plus post-cathartic utterances for S.I. and B.I.

From Table II we can see that reduced breathing activity accompanied, in these records, a state of increased tension, that a moderate or normal rate of breathing was associated with a relaxed condition of the muscles, and that a high breath rate accompanied states of high muscular tension. This was more

https://doi.org/10.1192/bjp.102.426.78 Published online by Cambridge University Press

pronounced in the case of B.I. whose gradient of rising tension was considerably steeper than that of S.I. It might be recalled that B.I. was a patient and S.I. a normal woman. There is besides the fact that there were only three utterances with reduced breathing (less than 6·0 p.m.) in the record of S.I. The actual values were 5·8, 5·2 and 2·0 respirations per minute.

TABLE II

Means and Standard Deviations of action potentials of muscular tension (AP) for utterances of low, medium, and high respiration rates for subjects S.I. and B.I.

Respiration Rates		Mean	S.D.	N
x . . . less than 6·0 p.m. . .	S.I.	4·00	2·36	3
	B.I.	4·36	0·97	10
y . . . 6·0–9·0 p.m.	S.I.	2·84	1·10	14
	B.I.	3·47	1·06	16
z . . . 9·0 p.m. and more . .	S.I.	4·11	1·75	8
	B.I.	6·41	1·49	7

F—ratios: S.I. $F=2·62$ n.s.

B.I. $F=14·81$ dfs.=2 and 30 P=0·001

$t_{xz} = 3·47$ P=0·001

$t_{yz} = 2·56$ P=0·02

An analysis of variance was carried out on the means of action potentials in the three respiration groups for each subject and Table II shows that the F ratio was highly significant in the case of B.I. but did not quite reach significance level in the case of S.I. T-tests were carried out for B.I. to see which of the groups were mainly responsible for the differences. The significant differences were between the group of utterances spoken at a rate of 9·0 and more respirations a minute (hyperventilated group), and each of the two other groups.

Although this time our data were grouped without consideration of any chronological order, according to degree of breathing activity as measured by respiration rate, there is an obvious link between the stages of the cathartic process (pre-cathartic, cathartic and post-cathartic) and the levels of respiratory activity. The utterances spoken with a reduced breathing rate belong to the pre-cathartic section of the series, those uttered at a very high rate of respiration constitute the crest of the curve (section of discharge or catharsis), and the utterances in which breathing was relatively normal came after the apex, when tension had relaxed to a very low level (post-cathartic section).

4. *The Cathartic Loop*

Figs. 6 and 7 present the function that holds between respiration rate and muscular tension (AP) as it evolves in sequential order of utterances in the course of the interview. To eliminate all non-permanent changes and obtain clear trends moving averages of moving averages were calculated all based on three items. By this the curves were smoothed without allowing distant items to influence the values. The resulting dots on the diagram were then connected by a line following the order of the utterances to which they belonged as these occurred in the interview.

The resulting curve shows that from the beginning there was a steady rise in muscular tension while breath rate remained either constant (S.I.) or decreased (B.I.). Towards the end of this stage there was a static period lasting four and five utterances respectively in which neuromuscular as well as respiratory activity remained more or less unchanged, and this was followed by a break-

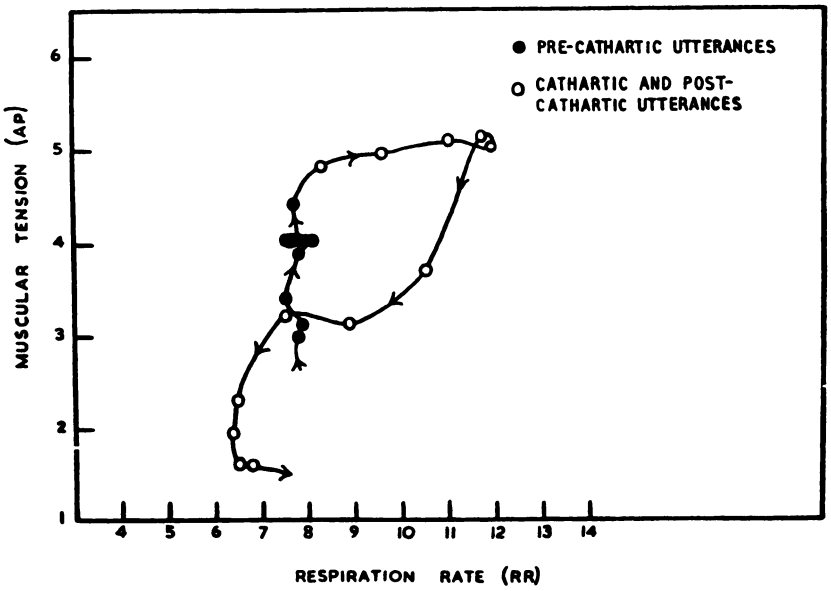

FIG. 6.—Function holding between RR and AP for subsequent utterances of S.I. Arrows indicate order of sequence in time.

through, with both variables, respiration and muscular tension, rising. The function then reached a point of maximal activity which at the same time was the turning point in the movement of the curve, taking the shape of a loop, and from thereon both muscular tension and respiration rate decreased. The curve of return, however, does not coincide with the rising curve but descends in a far steeper slope. If we look upon the three directions which the function takes during the process as the three sides of a right-angled triangle, the curve reaches the starting level of activity by the direct route of the hypotenuse.

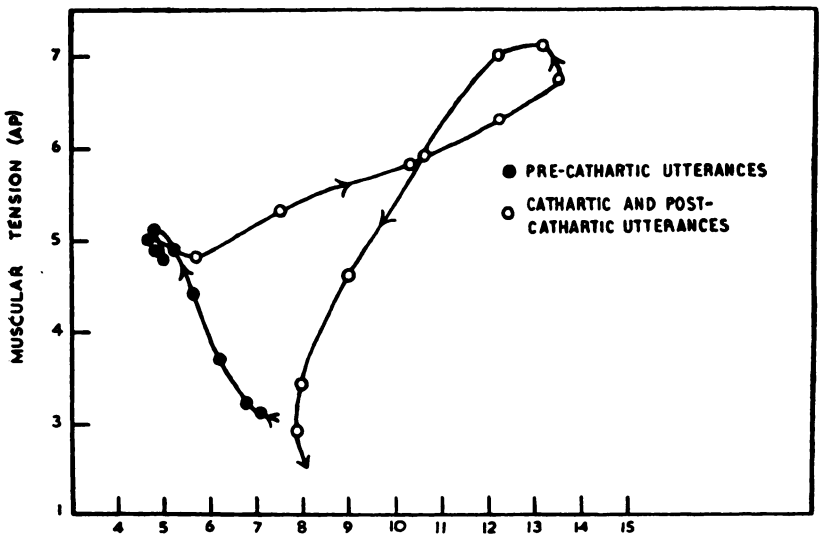

FIG. 7.—Function holding between RR and AP for subsequent utterances of B.I. Arrows indicate order of sequence in time.

https://doi.org/10.1192/bjp.102.426.78 Published online by Cambridge University Press

We have seen from the time series that the arousal of the respiration rate lagged behind that of muscular tension, and the loop-curve is the characteristic of a function in which the effect lags behind the cause. We are reminded of the hysteresis loop representing the relation of magnetic induction and the magnetizing force in a ferro-magnetic substance, and showing how the former lags in effect behind the latter.

The three stages in the two interviews discussed, represented by the different functional relationships of the neuromuscular and respiratory activities as measured, have thus been shown in evolution.

VII. Discussion

The chance occurrence of two nearly identical profiles of interview measurements among seven sets of measurements, each for a different individual, calls for an explanation. What is the factor or factors, or condition common to the interviews S.I. and B.I. which is not equally shared by the rest?

As we could not repeat the interviews with the same person we do not know whether it is a personal one. From the personalities of S.I. and B.I. we may make some speculative observations. Although S.I. is a normal person and B.I. a patient, both women are classifiable as cyclothymes. B.I. is a manic-depressive capable of affective discharges with a great deal of weeping. S.I. also discharged affect readily in speech, though her way of ventilating excitement during speech was laughter. The rest of the subjects in the experiment included one schizoid personality with difficulties of concentration, one depressed patient with symptoms of hypertension, one case of a depressive reaction in a compulsive personality, one non-patient undergoing analysis for character neurosis with anxiety symptoms, and one atypical case of anorexia nervosa. The only criterion determining the selection of these subjects for the experiment was that of their verbal capacity.

S.I. and B.I. also resembled each other in their positive response to the interviewer's prodding in traumatic areas after initial resistance. Three steps may be distinguished which are common in the process of both interviews:

(*a*) In both interviews the subject's attention became focussed on a central problem, a traumatic theme, partly in the course of the subject's conversation as a result of free association, but then developed as a result of the interviewer's questioning and prodding.

(*b*) A period of dénouement—in psychoanalytic terminology "working through the material"—followed this opening, and

(*c*) This dénouement, varying in complexity, dependent on withdrawals and interspersed resistances, eventually led to a relatively unreserved, even explosive, verbal expression of the disturbing content with discharge of tension, i.e. to "catharsis".

The impact of focussing a subject's attention on a traumatic theme seemed to be this: that his tissue activity was activated first and breathing activity was restrained. At this stage with the content remaining peripheral speech accelerated (utterances 7–12 for S.I. and 8–11 for B.I.) with a relatively poor level of ventilation (high SR, low V): as the crucial content was focussed (12 for S.I. and 14 for B.I.) and RR leapt up, SR in both interviews slowed down and became highly ventilated.

The two series (S.I. and B.I.) are of particular interest because they reflect in terms of objective measures a sequence of events closely corresponding to what in the literature has been described as the process leading to catharsis or "abreaction".

The general assumption underlying all psychotherapy is that beneficial effects are obtained from talking out, or ventilating in speech, traumatic experiences. Freud's original formulation of this assumption stresses that verbal expression must be given to affect. "Recollections without affects are almost utterly useless. The psychic process which originally elapsed must be reproduced as vividly as possible so as to bring it back into the statum nascendi, and then thoroughly "talked out". Breuer and Freud (4, 5) came to the conclusion that it is of great consequence whether there was an "energetic reaction" to the affectful experience or not. "By abreaction we understand a whole series of voluntary or involuntary reflexes, ranging from crying to an act of revenge, through which according to experience affects are discharged. If the success of this reaction is of sufficient strength it results in the disappearance of a great part of the affect. Language attests to this fact of daily observation, in such expressions as 'to give vent to one's feeling', to be 'relieved by weeping', etc. If the reaction is suppressed the affect remains united with the memory."

The authors close the introduction to their "preliminary notes" with the following remark on psychotherapy:

"We can now understand in what manner the psychotherapeutic method propounded by us exerts its curative effect. It abrogates the efficacy of the original non-abreacted ideas by affording an outlet to their strangulated affects through speech."

From the writer's previous studies of speech output in relation to breathing during speech (8, 9) it has become evident that the term "ventilation" or giving "vent to one's feelings" carries more than a metaphorical meaning. The measures of breath rate during speech in conjunction with the measure of output of speech (number of syllables) per breath were, as mentioned before, found (9) to be reliable objective indicators of the degree of emotional intensity and of the extent to which emotions were restrained or given free expression in the exchanges during psychiatric interviews.

It was shown that the higher the ventilation percentage (V) is the lesser the efficiency with which the respiratory activity was transformed into verbal activity. The degree in which the V remains constant through the fluctuations of the respiration rate (RR) shows the extent to which balance is maintained by virtue of increased speech activity, i.e. it shows the extent of control or affect or of defence against affect through speech, or the degree of its ventilation or uncontrolled discharge.

We therefore seem to have in V the objective corollary to what Freud and Breuer seem to have had in mind when they used such terms as "verbal expression of affect", or giving "vent" or "outlet" to one's feelings.

The rate of respiration during speech was shown in the previous study (9), in which validation was undertaken against content, to measure the intensity of emotional expression or repression of affect. Outgoing affect was shown to manifest itself in increased breath rate, excitement in high breath rate, whereas repressed affect, attention, caution, and fear was shown to be revealed in inhibited breathing. Breuer and Freud's "strangulated affect" would belong to the last category.

The beneficial effects expected from the "verbal expression of affect" are usually described as release of tension. Apart from considerable evidence (15, 19, 21) to the effect that states of emotional tension and anxiety are accompanied by rising electrical activity in the muscles (muscle tension) as measured by the electromyograph, it is clear from the literature that discharge of tension has been conceived by psychoanalysts as a relaxation of the muscular tonus. Thus

W. Reich holds that "the rigidity of the musculature is the somatic side of the process of repression, and the basis for its continued existence" (20). He also stresses the connection between muscular tension and respiration. Reich holds that inhibition of respiration is the physiological mechanism of the suppression and repression of emotion, and consequently the basic mechanism of the neurosis in general.

The breaking through of this "muscular armour" of resistance and character attitudes is envisaged by the same author as determined by the amount of "vegetative energy" (respiration) accompanying the process. While Reich may in the view of orthodox psychoanalysis be over-emphasizing the role of the vegetative energy, it is obvious from the remarks made by Breuer and Freud that they postulated for the discharge of tension a high degree of vegetative energy accompanying the process of verbalization.

With the measures of speech-breathing activity (RR, V and SR), and muscular tension (action potentials as measured on the EMG), it becomes possible to construct a model of how the process of catharsis and abreaction takes its course, according to psychoanalytic theory and in harmony with some dynamic principles of neuro-physiological action which seem relevant to the speech process. These are the principles of temporal integration in sequences of actions which are involved in language and speech as in other skills.

In terms of psychoanalytic theory a traumatic theme coming up for discussion would at first be prevented from being ventilated in speech (stage of defence) by repression or suppression which we expect to manifest itself in increased muscular tension and decreased respiration. As the material would enter the "working through" phase resistance and tension should increase together with increasing excitation or, as Freud (7) calls it, with "a quantitative increase of pressure" of which "unpleasure . . . would be the perceptual sensation". As the verbalization of the areas of tension or inhibition becomes more charged with excitement the latter breaking through the co-ordinating centres (4, 5), i.e. as utterance becomes more cathartic in character, the "asynchronous flux" (17) of the various activities measured (speech output, respiration, muscular tension) characteristic of "the state of dynamic equilibrium" (4, 5), will gain momentum and they will organize themselves into a pattern.

With the synchronous rise of expressed affect (respiration and ventilation) and tension (AP) the maximal point in the sequence will be approached and the discharge should be in the form of "synchronized and rhythmic volleys" (16). After this the muscular rigidity should be broken, and the affect should subside. A similar picture emerges from Hughlings Jackson's (14) description of emotional speech. "Emotion appropriates and subordinates an intellectual utterance. . . . We see in the utterance itself that with a fall in the intellectual there is a rise in the emotional one. There may be an equal, no doubt a greater, liberation of energy during these utterances, but it is directed more strongly on the vocal (including respiratory) organs, i.e. to those organs which serve especially during emotions."

On the physiological side this phenomenon has been described by Hoagland (13) under the name "relaxation oscillator". This type of oscillation depends upon a discharge taking place when some limiting potential or intensity is reached. "Its essential nature is (*a*) that some state, some potential, some intensity is built up by a continuous process, and the condition becomes less and less stable until one is reached in which discharge must take place, and (*b*) this discharge once started forms a path for itself by which (as in a siphon

or electric arc) further discharge is facilitated until what has been built up gradually has been broken down and the process begins again."

The temporal sequence of the process reflected in our measurements corresponds very closely to the above descriptions. Considering that the content also points in the same direction it appears that the two profiles S.I. and B.I. represent objective illustrations of instances of the cathartic process.

While we do not yet understand the conditions which determine the appearance of the cathartic picture in terms of objective measurements of the interview process, the fact of this close correspondence to the theoretical model constructed on the basis of the writings of the originators of the concept of catharsis through verbal expression in the interview situation seems of some significance. By demonstrating that abreaction through verbalization of emotive themes is a measurable process a step has been taken towards the study of the process of catharsis or abreaction through talking, and of the conditions which may favour or bar its evolution.

There is no mechanical relation between respiration rate and speech rate.

VIII. Summary

The covariation was studied between the fluctuations of speech output, breathing activity and the action potentials of muscular tension during the process of interviewing. These changes were also related to the content of the interview.

Seven interviews were recorded on the speech recorder and measures of speech rate (SR), respiration rate (RR), and a measure of ventilation in speech (V) were derived. These measures had previously been shown to be significant as indicators of states of affect and tension. Electromyographic measures were also taken from the subject while he (or she) was speaking.

Each interview was treated separately and regarded as a series of temporal events. Time series were plotted based on the individual utterances as well as on moving averages of sequences of utterances representing the trends in the changes which took place over time.

In the different interviews the above variables and particularly respiration rate and muscular tension were differently related.

Two of the interviews stood out being nearly identical in the shape of their curves. They are analysed and discussed in detail in this paper.

The sequences of measurements were divided into two sections, pre-cathartic, and cathartic plus post-cathartic. A reversal in the relationship between respiration rate and muscular tension as expressed by regression lines was observed in the second part of both interviews. The rising muscular tension in the first part of both interviews was accompanied by a steady maintenance or slightly decreasing level of respiratory activity. In the second part, in both interviews, the respiration rate increased and decreased together with muscular tension.

The data were also grouped without consideration of any chronological order, according to level of respiration rate, and there was an obvious link between the stages of the cathartic process and the levels of respiratory activity. The lag in the arousal of respiratory activity following behind that of muscular tension was illustrated by the loop-shaped function which showed the three cathartic stages in evolution.

The relevance of these relationships to the principles of the asynchronous flux of dynamic equilibrium, and of the rhythmic synchrony of discharge was discussed.

The similarity in the pattern of measurements for the interviews was also considered in the light of the content of the utterances from which the data were derived, and it proved meaningful when compared with the theoretical picture of the "cathartic process" as described in the literature.

Suggestions were made on the basis of content analysis about factors in the structure of interviews which might be favourable or bar the unfolding of the process of catharsis.

It was concluded that abreaction through the verbalization of emotive scenes has been shown to be a measurable process, and that thereby a significant step had been taken towards the study of the process of catharsis or abreaction through talking.

References

1. Altschule, M. D., *Bodily Physiology in Mental and Emotional Disorders*, 1953. Chapter: Respiration. New York: Grune & Stratton.
2. Baldwin, A. L., "Statistical Problems in the Treatment of Case Histories," *J. Clin. Psychol.*, 1950, **4**, 6–12.
3. Bernfield, Siegfried, Freud's Earliest Theories and the School of Helmholtz, *The Psychoanalytic Quarterly*, 1944, **13**, 341–362.
4. Breuer and Freud, "Über den Psychischen Mechanismus Hysterischer Phänomene, Vorläufige Mitteilung," 1893. Ges. Sch. I.

5. BREUER and FREUD, *Studies in Hysteria*, Chapter III: Theoretical Material Published (1944) in Nervous and Mental Disease Monographs: New York.
6. CLAUSEN, J., *Acta Psychiatrica et Neurologica*, 1951. Supplementum 68. Copenhagen, Ejnar Munksgaard.
7. FREUD, SIGMUND, *The Origins of Psychoanalysis*, 1954. Chapter: Project for a Scientific Psychology. London: Imago Publishing Co., Ltd.
8. GOLDMAN-EISLER, FRIEDA, "Speech-Breathing Activity—a Measure of Tension and Affect during Interviews," *Brit. J. Psychol.*, 1955, **46**, 53–63.
9. *Idem*, "Speech-Breathing Activity and Content in Psychiatric Interviews," *Brit. J. Med. Psychol.*, 1956, **29**, Part I.
10. GOLDMAN, S., *Information Theory*, 1953. London: Constable & Co., Ltd.
11. GOLLA, F. L., and ANTONOVITCH, B. S., "The Respiratory Rhythm in its Relation to the Mechanism of Thought," *Brain*, 1929, **52**, 491–509.
12. GRAHAM-BROWN, T., "On the Nature of the Fundamental Activity of the Nervous Centers," *J. Physiol.*, 1914, **48**, 18–46.
13. HOAGLAND, HUDSON, *Pacemakers in Relation to Aspects of Behaviour*, 1935. New York: The Macmillan Co.
14. JACKSON, HUGHLINGS, *On Affections of Speech from Disease of the Brain*, 1932. Selected Writings, Vol. II. London: Hodder & Stoughton, Ltd.
15. JACOBSEN, E., *Progressive Relaxation*, 1938. Pp. 494. Inc. ed., Chicago.
16. KUBIE, L. S., "Instinct and Homeostasis," *J. Psychosomatic Med.*, 1948, **10**, 15–30.
17. *Idem*, "The Central Representation of the Symbolic Process in Psychosomatic Disorders", *J. Psychosomatic Med.*, 1953, **15**, 1–7.
18. LASHLEY, K. S., *The Problem of Serial Order in Behaviour*, 1951. In: "Cerebral Mechanisms in Behaviour." The Hixon Symposium, New York and London.
19. MALMO, R. B., and SHAGASS, C., "Physiologic Studies of Reaction to Stress in Anxiety and Early Schizophrenia," *J. Psychosomatic Med.*, 1949, **11**, 9–29.
20. REICH, WILHELM, *Character-Analysis*, 1949. New York: Orgone Institute Press.
21. SAINSBURY, P., and GIBSON, J. G., "On Symptoms of Anxiety and Tension and Physiological Changes in the Muscular System Accompanying Them," *J. Neurol., Neurosurg. and Psychiatry*, 1954, **17**, 216–224.
22. SCHILLING, R., Über "Inneres Sprechen," *Zschr. f. Psychologie III*, 1929, 204–255.
23. SUTER, J., "Die Beziehung zwischen Aufmerksamkeit und Atmung," *Archiv. für die Gesamte Psychologie*, 1912, **25**, 78–150.
24. TINTNER, G., "The Analysis of Economic Time Series," *J. Amer. Statistical Association*, 1940, **35**, 93–100.
25. *Idem*, *The Variate Difference Method*, 1940. Bloomington, Indiana: Principia Press Inc.
26. WALLERSTEIN, H., "An Electromyographic Study of Attentive Listening," *Canadian J. Psychol.*, 1954, **8**, 228–238.
27. WIENER, N., *Extrapolation, Interpolation and Smoothing of Stationary Time Series*, 1949. New York, London. The Technology Press of the Mass. Instit. of Technology, and John Wiley & Sons, Inc., New York. Chapman & Hall, Ltd., London.