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Autonomic Activation and Endogenous Depression

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Summary. Psychophysiologic parameters were investigated in 10 patients with endogenous depression during the course of electroconvulsive therapy. Changes in the depressive mood were assessed by the patients at regular intervals using a general mood scale. EEG and heart rate response and habituation were recorded before, during, and after E.C.T.

Prior to treatment a low variance and responsiveness and striking intraindividual stability were found in the physiologic parameters. At the start of E.C.T. there was a significant increase in the deviation values of heart rate and a significant increase in the occurrence of typical biphasic heart rate responses. The EEG showed increased amplitudes and a slowing of background activity. Treatment-dependent differences were also seen in the habituation of the EEG amplitude response.

Regarding improvement in the depressive mood, differences were found between the retarded and the agitated patients. Agitated patients demonstrated a continous gradual decline of their depressive condition, while in retarded patients the general trend toward improvement passed through a period of increased mood lability.

The results are interpreted with reference to the activation dependency of heart rate responses.

Key words: Endogenous depression – Electroconvulsive treatment – Heart rate – EEG – Activation.

Zusammenfassung. Bei 10 Patienten mit endogener Depression wurden im Verlauf einer Heilkrampf-Behandlung psychophysiologische Parameter untersucht. Die Änderungen der depressiven Gestimmtheit wurden kontinuierlich durch Selbsteinschätzung der Patienten mit Hilfe der Befindlichkeitsskala erfaßt. Vor, während und nach der Heilkrampf-Behandlung wurden Reaktivität und Habituation von EEG und Herzfrequenz bestimmt.

Vor Behandlung fanden sich geringe Varianz und Reaktionsfähigkeit und auffallende intraindividuelle Stabilität der untersuchten physiologischen Para-

meter. Mit Behandlungsbeginn zeigten sich eine signifikante Zunahme der Herzfrequenzstreuung und ein signifikant häufigeres Auftreten der typischen biphasischen Herzfrequenzreaktion. Im EEG kam es zu Amplitudenzunahme und Grundrhythmusverlangsamung. Auch die Habituation der EEG-Amplitudenreaktion zeigte behandlungsabhängige Unterschiede.

In der untersuchten Gruppe unterschieden sich gehemmt- und agitiert-depressive Patienten in der Remissionscharakteristik depressiver Gestimmtheit. Bei agitierten Patienten nahm die Depressivität kontinuierlich ab, bei gehemmten Patienten wurde ein Remissionsverlauf über verstärkte Stimmungslabilisierung beobachtet.

Die Ergebnisse werden unter Berücksichtigung der Aktivationsabhängigkeit von Herzfrequenzreaktionen interpretiert.

Schlüsselwörter: Endogene Depression – Heilkrampf-Behandlung – Herzfrequenz – EEG – Aktivation.

Introduction

The coincidence of depressive parathymia—as an expression of an affect disturbance—and disturbances of vitality *(Vitalstörungen)*—as an expression of autonomic dysfunction—is regarded as a diagnostic criterium of endogenous depression. Although various changes in the autonomic system are ascertainable in the case of endogenous depression (Loew, 1965; Bojanovsky, 1969; Pöldinger et al., 1969; Scoppa, 1970; Noble and Lader, 1971 a—d; Thiele, 1971; Hole et al., 1972; Hole, 1973), no specific disturbances of autonomic functions can be associated with complaints which are both subjective and individually variable. The depressive mood and somatic symptoms include heterogenous symptom complexes including disease-specific as well as personality- and environment-specific factors. The resultant problems of classification are further complicated by the multiplicity of nosologic concepts (Kielholz and Hole, 1973). The disturbances of vitality experienced by the patient therefore cannot be correlated directly with specific autonomic dysfunctions. The somatic aspect also implies measurement and methodic problems, since the affective factors are visible only as a modulation of the 'autonomically' controlled vegetative functions. One characteristic example of this multifactorial limitation is the heart rate control in which cardiac, peripheral and central nervous system influences interlink. Preliminary investigations were able to prove that heart rate reactivity depends on the state of activation (Strian and Dirlich, 1973 a; 1976 b). Since the degree of activation also determines affective behavior, disturbances of central activation could be the cause both of disturbed emotionality and of the associated autonomic correlate. The autonomic system can be understood as being the 'inner expression' of the emotions—similar to the environment-directed expression of mimic and gesticulative behavior which Heimann (1973) investigated in depressives.

Electroconvulsive treatment with a primary subcortical, 'diencephalic' site of action can be regarded as an intervention in autonomic control and activation. The importance of subcortical structures is inferred from the bilateral symmetric occurrence of convulsive potentials and the unimpaired effectiveness of electro-

convulsive therapy in spite of pharmacologic suppression of these convulsive potentials (Ottosson, 1974). An increase in the synthesis and release of catecholamines and indolamines is described as one possible mechanism of action (Messiha et al., 1974). A biochemical mechanism which is analogous to the effects of psychopharmacologic drugs and which is induced by physical agents is thus likely. The effectiveness of treatment is still judged predominantly on the basis of the physician's impression, since clinical-experimental investigations using adequate control groups are not feasible in principle (Costello and Belton, 1972).

Autonomic reactions during electroconvulsive therapy were examined most frequently using the mecholyl test. Ploog and Selbach (1952) found lability of blood pressure regulation in endogenous depressives during the course of electroconvulsive treatment. Gellhorn and Loofbourrow (1963) postulated a general displacement of the sympathetic-parasympathetic equilibrium towards increased parasympathicotonia. However, although the dynamics of blood pressure reactions can be formalized sufficiently (Fuchs et al., 1974), the reliability of the mecholyl test is still in question. Changes in the psychogalvanic reaction (Stern and Sila, 1959) can hardly be interpreted in the light of their importance for the central nervous system. Investigations of long-term effects of electroconvulsive treatment on other autonomic functions and their relations to the course of treatment do not exist.

There are, however, detailed investigations of the EEG changes during the course of electroconvulsive treatment. A slowing of the dominant frequency and an increase in amplitude—as occur with repeated electroconvulsive treatments—are supposed to correlate with clinical improvement (Small et al., 1970; Turek, 1972; Volavka et al., 1972; Volavka, 1974; Stroemgren, 1973; Fink, 1974).

The objective of the present investigation was to analyze cardiac frequency as an autonomically regulated function in endogenous depression, with respect to the following questions:

1. Do parameters of the spontaneous heart rate level or of the evoked heart rate response differ in endogenous depressive as compared to normal subjects?
2. Is there a change ('normalization') in the deviated heart rate parameters in depressives during electroconvulsive treatment?
3. Is there a relationship between the heart rate parameters and an activation level defined on the EEG?
4. Can process-dynamic psychophysiologic criteria be found to differentiate subgroups of the depressive syndrome?

Method

Subjects. Ten depressive patients were examined. They were in-patients in the psychiatric wards in the clinic of the Max Planck Institute of Psychiatry in 1971. Their age varied from 27 to 58 years, the average age being 37 years and the median age 39 years. There were eight female and two male patients. The symptom of depression was predominant in all patients. A diagnosis of schizoaffective psychosis was made in the case of one patient, puerperal psychosis in the case of another, and endogenous depression in the rest of the patients. None of the patients had experienced a manic phase in their previous histories. Two of the patients reported depressive

diseases in their family histories. The possibility of a reactive trigger mechanism or neurotic mechanisms had to be considered in the case of two patients. Three patients showed psychomotor inhibition, three showed psychomotor agitation and the rest of the patients showed a mixed picture.

The duration of the actual illness prior to the start of treatment amounted to between 3 days and 3 months. The duration of hospitalization varied between 3 and 10 weeks.

Electroconvulsive treatment was performed in the wards according to the Braunmuehl procedure using a Siemens Convulsator. DC pulses with a converted DC value of an average of 50 mA were employed. Electroconvulsive treatment was performed during muscle relaxation (1 mg/kg of body weight of Suxamethonium chloride) and short anesthesia (60—80 mg of Methohexital sodium). The number of electroconvulsive treatments varied from 1 to 12 treatments (an arithmetic mean of 8.4 and a median of 9). All patients received night medication of 25—50 mg of Melleril. On the basis of clinical assessment, an inprovement in the depressive symptoms occurred in all patients except two. Neurotic factors came into play in these two patients with therapy resistance.

Course of Examination. The patients filled out a scale indicating their general mood (von Zerssen et al., 1973; Schwarz and Strian, 1973; von Zerssen, 1976) on an average of every other day during hospitalization. This scale is based on a unidimensional depression concept. The psychophysiologic examination took place during the morning of the day preceding the first electroconvulsive treatment. The examination was repeated 1 day after the first electroconvulsive treatment with all patients. This was also done after the eighth electroconvulsive treatment in the case of six patients.

Electroconvulsive treatment was performed 3 days per week. Two electroconvulsive treatments were conducted on the same day in the case of one patient and two electroconvulsive treatments spaced 1 day apart were conducted in the case of several patients at the beginning of therapy. The intervals between the electroconvulsive treatments were lengthened after the depressive state had improved.

Data from several investigations carried out on 60 normal persons between 20 and 35 years of age were used as a basis for comparing the results in the depressive patients.

Physiologic Measurements. Physiologic examinations were carried out in an electromagnetically and acoustically shielded booth. Thirteen acoustic, nonaversive stimuli (1000 Hz sine wave, 250 ms rise time, 60 dB, 1 s duration) were supplied at random intervals (30—45 s). EEG, ECG, and respiration were registered during a period from 3 min before the first stimulus to 3 min after the last stimulus. The physiologic data were registered using an 8-channel Beckmann Type R Dynograph. The EEG was recorded in a bipolar longitudinal series. The leads over the centro-occipital region (O_1–P_3 and O_2–P_4) were used for analysis purposes. The ECG registration was done in extremity lead II. The respiratory frequency was measured using a thermistor sensor. The acoustic stimuli were supplied via a loudspeaker at a distance of 1.5 m. Time marks, stimulation triggers, and biosignals were recorded simultaneously on an 8-channel analog tape (Ampex FR 1300).

Data Analysis. The biosignals stored on the analog tape were analyzed automatically by a program package (Strian and Dirlich, 1973b) which was conceived for habituation and conditioning experiments. Data analysis is oriented on regulation-theoretic concepts and employs uniform parameter calculations for all functions. The mean, deviation and inclination (regression) parameters were calculated in fields of measurement defined in a function-specific manner (Strian and Dirlich, 1976a). The differences in the amplitude values before and after stimulation were selected as reaction characteristics in the EEG. A typology with the aid of the parameter regression was used for measuring heart rate response. The type of reaction (solely acceleration or deceleration, or acceleration/deceleration, or deceleration/acceleration) can be identified clearly in a coordinate system in which the data of the first poststimulus field of measurement were plotted on the x-axis and those of the second field of measurement were plotted on the y-axis. Moreover, the reactions can also be calculated quantitatively using the angles involved.

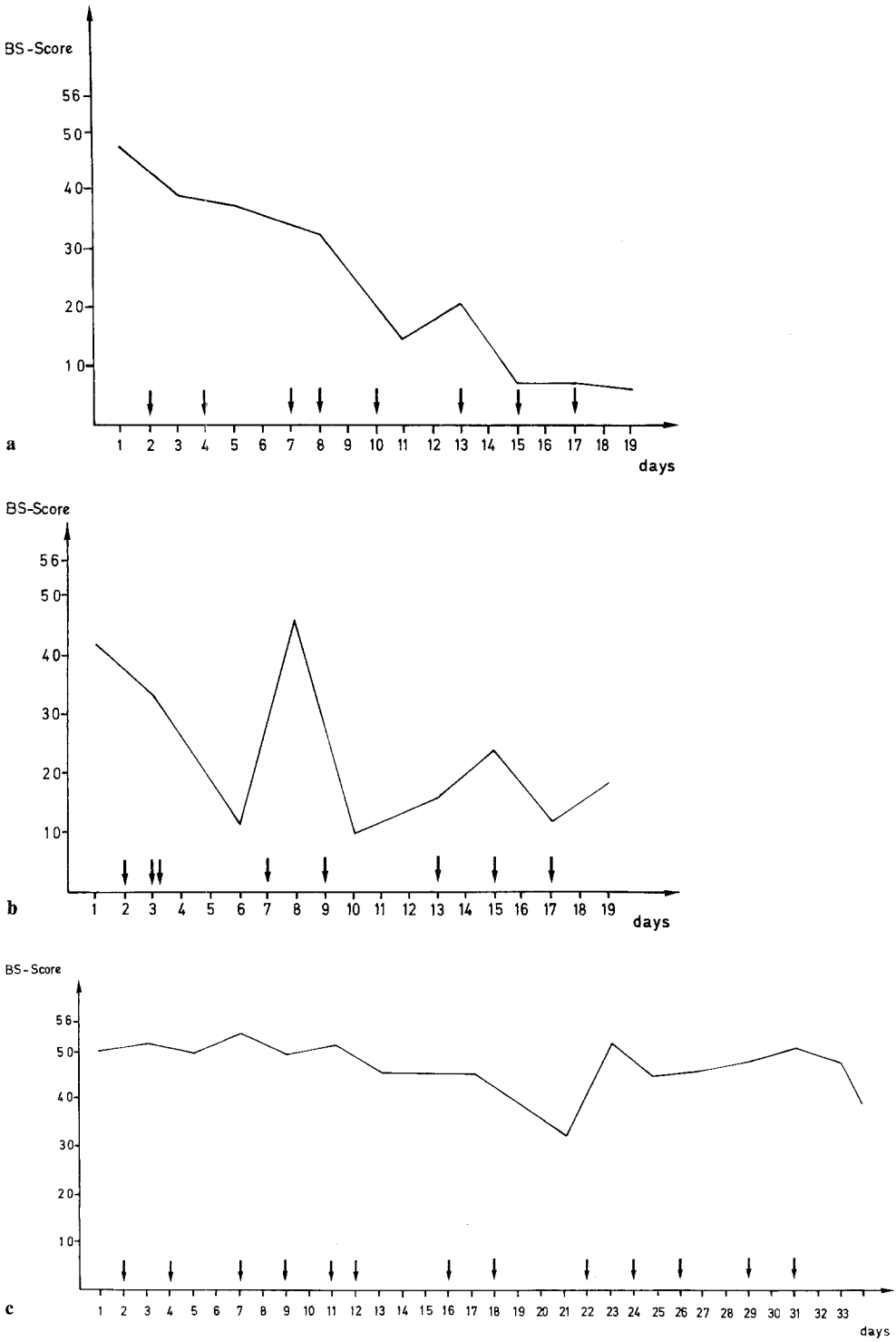

Fig. 1 a—c. Types of process of depressive mood (BS score) in patients with agitated (**a**), retarded (**b**), and 'endoreactive' (**c**) depression

Results

1. Subjective Condition during the Course of Treatment

Basic depressive parathymia as measured by the general mood scale demonstrated a different process characteristic in the examined patients during treatment. Three forms of process became apparent which coincide with the nosologic classification (Fig. 1). Agitated patients demonstrate a continuous, gradual decline in their depressive condition on the general mood scale during the course of electroconvulsive treatment. Inhibited patients and patients suffering simultaneously from depressive inhibition and agitation demonstrate a discontinuous progress of the depressive mood. A rapid decline in the depression score occurs with the first electroconvulsive treatment, but the patient's mood is subsequently

Table 1. Influence of electroconvulsive treatments on depressive mood (BS score)

		Overall improvement in BS	No. of ECT's	Improvement per ECT (all ECT's)	Improvement per ECT (1st 1/2 of ECT's)	Improvement per ECT (2nd 1/2 of ECT's)	mean extent of mood changes in degrees	mean extent of mood improvement in degrees
D_T	$\bar{X}$	28.5	8.8	3.8	3.04	4.1	61.95	59.9
	S	20.8	3.7	4.32	4.13	6.43	21.45	25.5
D_A	$\bar{X}$	39.8	8.7	2.34	4.3	0.4	50.43	37.6
	S	12.96	1.15	3.78	2.45	5.95	8.8	4.25
D_R	$\bar{X}$	30.5	7.0	4.33	3.67	2.5	73.6	76.6
	S	5.8	5.57	4.93	5.7	3.54	15.96	19.3

		T_0		T_1		T_8	
		$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
D_T	P1	36.4	8.4	38.5	7.9	39.1	6.5
	P2	15.7	3.4	15.8	3.7	16.9	3.6
	P3	19.7	9.7	20.7	10.6	24.3	8.5
D_A	P1	37.5	10.6	38.8	8.0	41.0	6.9
	P2	14.5	4.1	14.8	4.7	16.3	3.1
	P3	22.7	11.2	24.6	12.0	28.3	10.2
D_R	P1	33.3	2.9	37.3	3.8	39.2	0.9
	P2	17.5	1.5	18.1	3.1	20.3	3.2
	P3	12.7	2.8	14.1	5.0	21.4	3.9

Table 2. EEG parameters for random process samples prior to first (T 0), after first (T 1) and after eighth (T 8) electroconvulsive treatment. D_T = total group of depressive patients, D_A = agitated-depressives, D_R retarded-depressives. P 1 = EEG interval mean values. P 2 = EEG interval dispersions, P 3 = EEG amplitude mean values

subject to great fluctuations which show up as an alternating 'jagged' pattern in the general mood curve. The general mood curves of those patients in whom neurotic mechanisms were of importance differ considerably from these continuous or discontinuous improvements in depressive mood impairment. In these patients, self-estimation of depressiveness is subject to only minor fluctuations—neither as a brief change in mood nor as a continuous tendency towards a brightening of the mood.

In order to determine these process characteristics quantitatively and to correlate them with other factors, a few characteristic values were established: the angles between successive random samples on the general mood curve indicate the direction and intensity of the change of mood; the slope in the rise of the gradient of the general mood curve differentiates various types of progress, e.g., the group differences for patients with agitated, retarded, or neurotic depression (Table 1). The comparison of the total effect of the electroconvulsive treatment and the individual effect of the electroconvulsive treatment on the general mood of the patient, which was calculated on the basis of these characteristic values, shows that in the examined patients the time of treatment is of no significance for the total effect of the treatment. On the contrary, however, there was proof of a significant correlation between the effectiveness of one individual electroconvulsive treatment and the effectiveness of the entire electroconvulsive treatment (rho = 0.65 according to Spearman's rank correlation test).

2. Physiologic Correlates during the Course of Treatment

EEG. The analysis of the EEG data measured in the 10 s intervals prior to the acoustic stimuli showed a clear trend in the course of treatment (Table 2). The EEG interval mean values increase as treatment progresses, i.e., the EEG frequency decelerates ($P<0.05$ according to the U-test). Similarly, the EEG amplitude mean values increase also as treatment progresses, i.e., the EEG amplitudes become greater (Fig. 2). In the case of the retarded patients, this effect was most pronounced ($P<0.02$ according to the U-test). The frequency slowing, however, was less evident than the amplitude increase and was less uniform in the nonretarded patients, particularly after the first electroconvulsive treatment. In one patient with 'endoreactive' depression, there was an EEG frequency which departed from the 2-sigma limit.

The differences in the logarithmic amplitude values were examined as a measure of the EEG reaction to the acoustic stimulus sequence. This produced the habituation curves of EEG amplitude blocking or activation for the random samples before and after the first electroconvulsive treatment as well as after the eighth electroconvulsive treatment (Fig. 3). The habituation prior to treatment demonstrates a rapid but inconsistent amplitude blocking. After the first electroconvulsive treatment, the amplitude blocking still appears regular, but is protracted to beyond the sixth stimulation. At the termination of treatment the progress of the reaction with an initial amplitude blocking and subsequent minor amplitude activation approached the habituation curve in normal persons. A statistical evaluation of the EEG reactions is not possible however due to the low number of random samples.

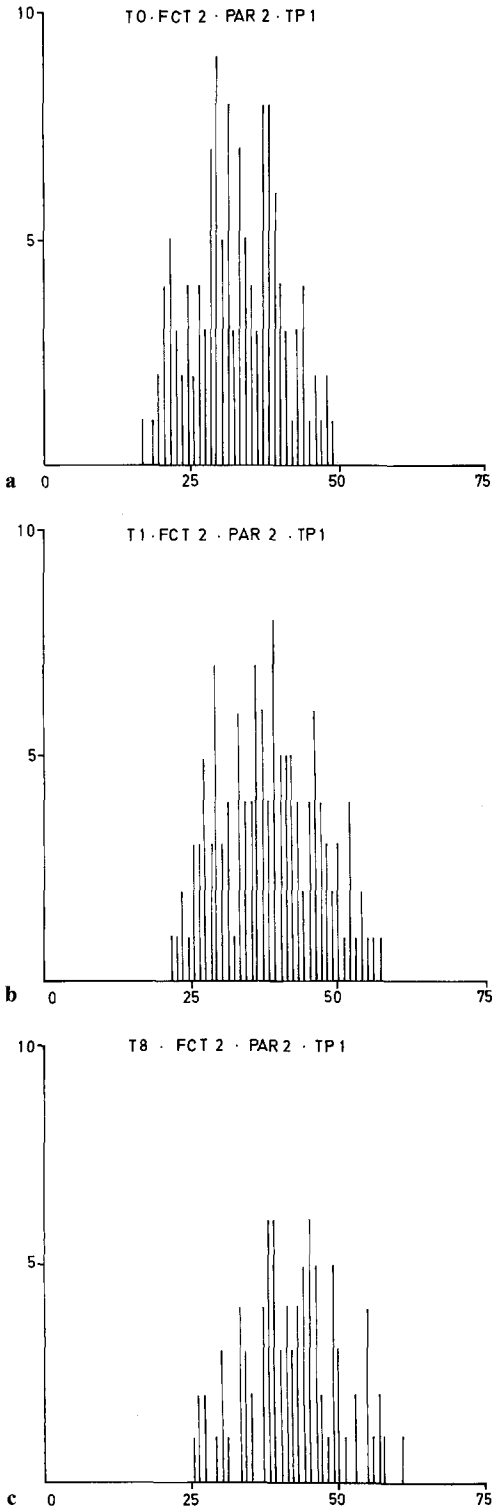

Fig. 2 a—c. Histograms of frequency distributions of EEG amplitude mean values for random process samples T 0, T 1 and T 8

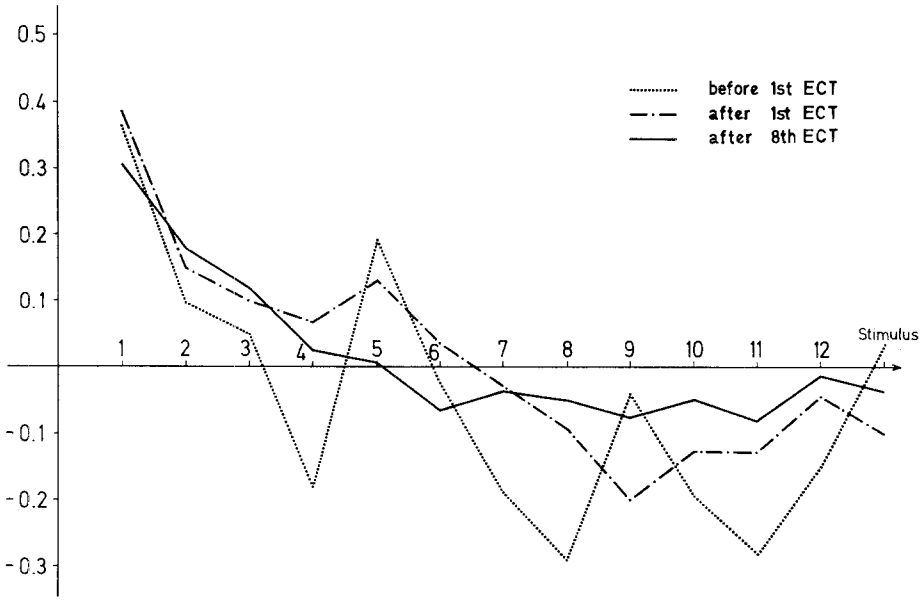

Fig. 3. Habituation process of EEG amplitude reaction in total depressive group for random process samples T 0, T 1 and T 8. Differences of logarithmic amplitude mean values from pre- and poststimulus field of measurement were determined as reaction values

		T_0		T_1		T_8	
		$\bar{X}$	S	$\bar{X}$	S	$\bar{X}$	S
D_T	P 4	154.2	*23.0*	145.6	*22.6*	152.0	*26.3*
	P 5	3.9	*3.0*	4.4	*3.2*	6.2	*3.7*
D_A	P 4	146.5	*17.8*	139.1	*14.8*	149.8	*17.3*
	P 5	2.9	*1.9*	2.5	*1.8*	3.6	*3.0*
D_R	P 4	159.3	*16.0*	151.7	*20.3*	155.6	*21.8*
	P 5	4.1	*3.1*	5.1	*3.4*	7.1	*3.2*

Table 3. Heart rate parameters for random process samples T 0, T 1 and T 8. P 4 = Heart period mean values, P 5 = Heart period dispersions

Cardiac Frequency. The initial heart rate values of depressive patients do not reveal any significant differences as compared to nondepressive, normal persons. In the case of agitated patients, a slight acceleration in the pulse rate can be observed. The prominent feature, however, is the slight variance in the baseline values. During electroconvulsive treatment a slight acceleration in the heart rate is revealed as a trend in a few patients; in the entire group, however, it cannot be placed on a conventional level of significance. After the first electroconvulsive treatment, there is a uniform tendency—not significant either—to heart rate acceleration in agitated and retarded patients, which again recedes as treatment progresses (Table 3). The initial heart rate values before and after a series of electroconvulsive treatments do not demonstrate any appreciable differences.

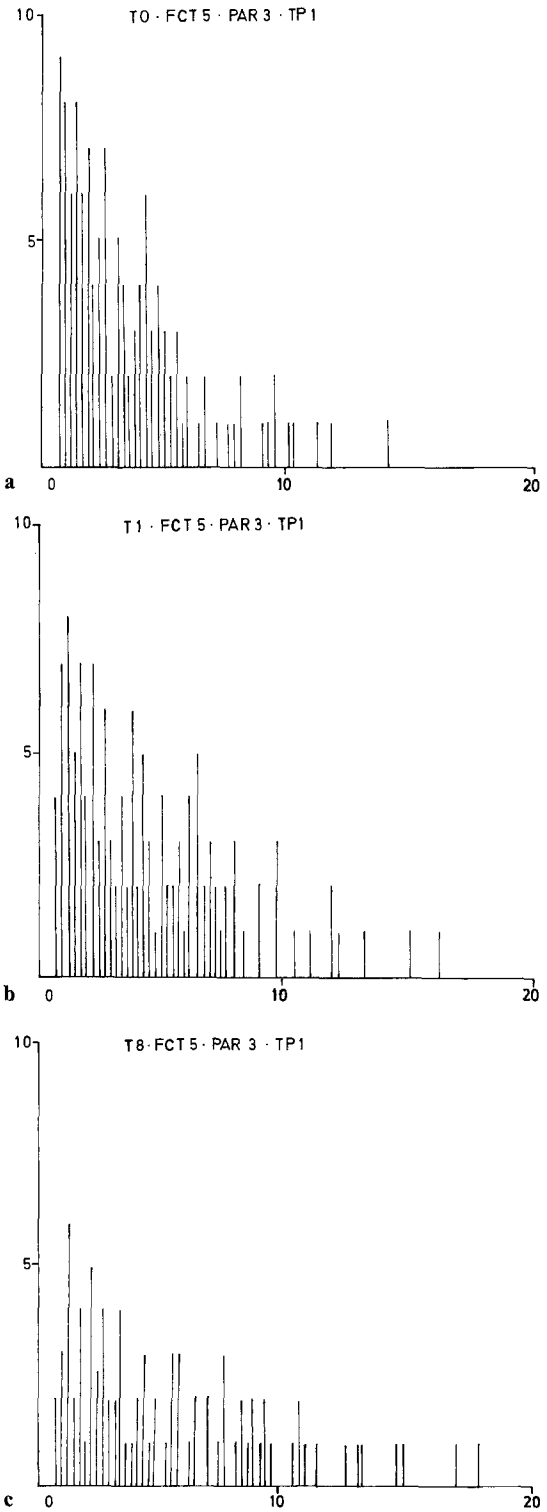

Fig. 4 a—c. Histograms of frequency distributions of heart period dispersions for random progress samples B 0, B 1, and B 8

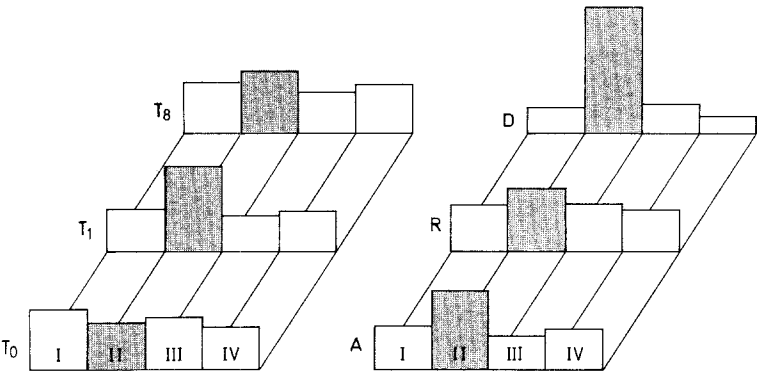

Fig. 5. Frequency distributions of heart rate response types in total depressive group for random process samples (T 0, T 1, T 8) and in a control group for the activated (A), relaxed (R), and drowsy (D) state

There were marked changes, however, in the heart rate variance during the course of treatment (Fig. 4). This shows an increase in the total group, the greatest increase being in the case of the retarded patients ($P<0.05$ according to the *U*-test), a lesser increase in the case of the agitated patients ($P<0.1$ in the *U*-test). These findings are underscored by the expected large interindividual differences in the means and deviations of heart rate.

The heart rate responses show characteristic distribution patterns which are dependent on the time of treatment. The subgroups 'agitated' and 'retarded' exhibit substantially uniform behavior, so that only the results of the entire group are illustrated. Prior to treatment, the reaction types with exclusively acceleration (III) and deceleration (I), as well as acceleration/deceleration (II = biphasic reaction), and deceleration/acceleration (IV), are distributed uniformly. As compared with the heart rate responses in normal subjects, the only conspicuous feature is merely the very low share of biphasic reactions (II), so that responses with exclusively deceleration (I) and with exclusively acceleration (III) predominate. After the first electroconvulsive treatment, however, the biphasic reaction (II) comes to the fore again ($P<0.05$ according to the chi-square test). After the eighth electroconvulsive treatment, the dominance of the biphasic reaction is still obvious, but can still be influenced by randomness as compared with the other reaction types. When compared to the activation-dependent heart rate responses in normal subjects, this distribution corresponds approximately to the distribution which is observed during relaxed wakefulness (Fig. 5).

Discussion

Physiologic Correlates of Retardation and Agitation

The classification of depression into retarded and agitated subgroups, made according to clinical criteria, can be associated with several physiologic differences. Although the means of the heart rate are somewhat higher in the case of

agitated depression than in retarded depression—also decribed by Lader and Wing (1969)—these differences are demonstrated to a greater extent in the intra- and interindividual variance than in initial value differences. The deviation values of heart rate are conspicuously low in retarded patients and are definitely less than the variance in normal subjects. The interindividual differences in the deviation values are also low. An analogous process characteristic can also be found in the EEG. The means of the intervals and amplitudes prior to treatment do not reveal any significant abnormalities, but rather there is a very stable, almost monotonous pattern of background activity. By contrast, patterns with great variability were observed in the controls under the same experimental conditions. The variable patterns thus can be interpreted as an expression of the changing states of activation (Strian and Dirlich, 1976a).

Although not all findings can be supported statistically—which can hardly be expected in view of the low number of test subjects—the results are striking for two reasons. The behavior of the initial values clearly demonstrates on the one hand that these must be examined together with more sophisticated parameters than merely by comparison of means. On the other hand, the resting values in EEG and heart rate reveal a certain amount of rigidity in the physiologic functions as a uniform feature in the group of retarded patients. This rigidity thus appears to be plausible as a basis of impaired reaction capacity. The initial values of agitated patients, however, can be interpreted more closely as an 'elevated excitation level' (Nobel and Lader, 1971). This conclusion, however, can only be made on the basis of the heart rate data, but not on the basis of the EEG data, in the light of our findings.

Reaction Pattern and Course of Treatment

The changes which occur as treatment progresses can be interpreted generally as an approach toward such psychophysiologic data as were obtained in the control group of healthy persons. The differences between retarded and agitated depressive patients are related more closely to a difference in the response to treatment. This becomes especially evident from the process characteristic of the depressive mood which is measured with the general mood scale. In the agitated patient, depressive parathymia decreases in a more continuous manner, possibly parallel to the decrease in the excitation level. Retarded depressive patients demonstrate an extreme lability in their emotional condition during the course of remission, from which their emotionality returns to equalization via alternating polarization. Ploog (1956) postulated an analogy with technical control systems in the light of this seemingly mechanical process and the associated blood pressure reactions in the Sympatol test. Although there can be no correlations of physiologic parameters with the psychopathologic states due to the low number of random samples, some relations can nevertheless be established between the course of depression and autonomic reactions—in this case cardiac frequency. On the one hand, there is the significant increase in the cardiac frequency variance as treatment progresses both in the total group and in particular in the inhibited-depressive patient. On the other hand, there is the increase in the typical, stimulus-induced ('biphasic') cardiac frequency reactions.

In order to interpret these results, one must take into account relationships between the cardiac frequency and cardiac frequency reactions together with the general activation level. It is known that cardiac frequency decreases with tiredness and during sleep and that, in so doing, the variance increases—also as an expression of respiratory arrhythmia. Hence, cardiac frequency reactions to environmental stimuli increase as vigilance decreases. Cardiac frequency reactions are thus not only dependent on the type, intensity and importance of the applied stimuli, but also on the state of the system (Berg et al., 1971; Strian and Dirlich, 1976b). The increase in the cardiac frequency variance and the cardiac frequency reactions could therefore indicate a trend towards lower central activation. The EEG changes during the course of treatment including basic rhythm deceleration and amplitude increase can also be interpreted in this sense. Fink (1974) views these EEG changes as an expression of a specific electroconvulsive effectiveness. Electroconvulsive treatment is supposed to produce a reduction in reticulothalamic activation.

No definite decision can be made on the basis of our findings as to whether vigilance displacement already exists before the beginning of treatment. The EEGs of the depressive patients examined, however, were characterized by the dominance of a slightly decelerated alpha activity with anterior spreading. The monomorphic form of the basic frequency and the intraindividual stability in the analysis period prior to the accoustic stimuli was also striking. Bente (1964, 1976) and Volavka et al. (1967) have described analogous EEG findings. Furthermore, a significant increase in slow alpha waves was observed during REM sleep and in the periods of wakefulness following REM sleep (Lange, 1975). Bente (1975) discussed a predominance of inhibitory processes in depressive patients as one possible interpretation. Our results of the habituation of amplitude blocking in the EEG could be considered to be at least indirect verification of this hypothesis. Prior to treatment, there is a rapid habituation of amplitude blocking, but with inconsistent subseqent reactions, however. After the first electroconvulsive treatment, habituation seems to be somewhat decelerated. The approximately exponential reaction drop that can be observed in healthy test subjects does not occur until after a longer series of treatment.

The results we observed and those described in the literature can best be interpreted at present by activation models (Rossi and Zanchetti, 1957; Routtenberg, 1968; Berlyne, 1974). The activation level results from the interaction of various central nervous systems. Functions with psychophysiologic dependency on the activation level—such as cardiovascular regulation, for instance—demonstrate a variable neuronal coupling to the formatio reticularis of the lower brain stem (Langhorst and Werz, 1975) and are simultaneously determined by hypothalamic, amygdalic, frontobasal, and cortical control (Hunsperger et al., 1971; Eleftheriou, 1973; Pribram and Luria, 1973). These central nervous influences could be verified by clinical observations in organic psychoses as well. Cases of temporal encephalitis, for example, are characterized by a changing condition of activation and associated disturbances or disruptions of autonomic regulation (Strian, 1973; Cramon et al., 1975). Psychopathological patterns of behavior become evident which are ordered in themselves, but which are not suitable to meet the requirements of the situation.

Clinical Evidence

In a generalizing and more speculative interpretation these psychopathologic results appear to coincide with clinical observations. Endogenous depression is not an illness with obvious somatic findings—although somatic aspects are quite certain (Akiskal and McKinney, 1975). In the light of these somatic factors, our findings indicate an incorrect autonomic regulation as an expression of a probably overriding disorder of activation and assimilation of exitement. The narrow variance range and the restricted reaction capacity of the cardiac frequency corresponds to this extent to the psychopathology of melancholy—described by Whybrow and Parlatore (1973) as restricted spontaneity, flexibility and resonance capacity in psychic behavior. The restricted reaction capacity of the autonomic system—as a substrate of the somatic condition, emotionality, and basic mood—then appears as an analogy of the impaired psychic reaction capacity.

Thus, 'vital sadness' corresponds to a lack of emotion, an 'inner emptiness,' which is of a basically different type from the emotion due to a deeply moving or shocking experience.

References

Akiskal, H. S., McKinney, W. T., Jr.: Overview of recent research in depression. Arch. Gen. Psychiat. **32**, 285—305 (1975)

Bente, D.: Vigilanz, dissoziative Vigilanzverschiebung und Insuffizienz des Vigilitätstonus. In: H. Kranz, K. Heinrich (eds.), Begleitwirkungen und Mißerfolge der psychiatrischen Pharmakotherapie. Stuttgart: G. Thieme 1964

Bente, D.: Elektroencephalographische Gesichtspunkte zum Wach-Schlafverhalten und zur Chronophysiologie endogener Depressionen. Arzneim. Forsch. (Drug Res.) **26**, 1058—1061 (1975)

Berg, K. M., Berg, W. K., Graham, F. K.: Infant heart rate response as a function of stimulus and state. Psychophysiol. **8**, 30—44 (1971)

Berlyne, D. E.: Konflikt, Erregung, Neugier. Zur Psychologie der kognitiven Motivation. Stuttgart: Klett 1974

Bojanovsky, J.: Differenzierung der psychogenen und endogenen Depressionen. Jena: VEB G. Fischer 1969

Costello, C. G., Belton, G. P.: Depression: Treatment. In: C. G. Costello (ed.), Symptoms of psychopathology. New York: J. Wiley 1972

Cramon, V. D., Brinkmann, R., Schoeny, W.: Quantitative Verlaufsbeobachtung bei einem Fall von Encephalitis des temporalen Typs. Arch. Psychiat. Nervenkr. **220**, 201—211 (1975)

Eleftheriou, B. E. (ed.): The neurobiology of amygdala, the proceedings of a symposium on the neurobiology of amygdala, Bar Harbor, Maine. New York-London: Plenum Press 1972

Fink, M.: Induced seizures and human behavior. In: M. Fink et al. (eds.), Psychobiology of convulsive therapy. Washington: Winston & Sons 1974

Fuchs, U., Sell, H., Cohen, R.: Ein regeltheoretisches Modell zur Untersuchung differentialdiagnostischer Aspekte des Mecholyl-Tests bei Depressiven, Schizophrenen und Normalen. Z. klin. Psychol. **3**, 107—133 (1974)

Gellhorn, E., Loofbourrow, G. N.: Emotions and emotional disorders, a neurophysiological study. New York: Hoeber 1963

Heimann, H.: Psychobiologie der Depressionen. In: P. Kielholz (ed.), Die lavierte Depression. Bern-Stuttgart-Wien: H. Huber 1973

Hole, G.: Körperliche Symptome und Depressionstiefe. Nervenarzt **44**, 136—142 (1973)

Hole, G., Gehring, A., Blaser, P.: Vegetativum, Psychomotorik und Selbstbeurteilung in Längsschnittuntersuchungen depressiver Patienten. Fortschr. Neurol. Psychiat. **40**, 69—82 (1972)

Hunsperger, R. W., Bucher, V. M.: Affective behavior by electrical stimulation of the forebrain and brain stem of the cat. Progr. Brain Res. **27**, 103—127 (1967)
Kielholz, P., Hole, G.: Depression: Sonderformen. In: Chr. Mueller (ed.), Lexikon der Psychiatrie. Berlin-Heidelberg-New York: Springer 1973
Lader, M. H., Wing, L.: Physiological measures in agitated and retarded depressed patients. J. Psychiatr. Res. 7, 89—100 (1969)
Lange, H., Burr, W., Aswege, J. v.: Comparative study of sleep parameters in cyclic depression. Fast Fourier transformation versus interval analysis. In: The quantification of the electroencephalogram. II. Symposium jungny sur vevey (1975)
Langhorst, P., Werz, M.: Concept of functional organization of the brain stem "Cardiovascular Center". In: W. Umbach, H. P. Koepchen (eds.), Central rhythmic and regulation, circulation respiration, extrapyramidal motor system. Stuttgart: Hippokrates Verlag 1974
Loew, D.: Syndrom, Diagnose und Speichelsekretion bei depressiven Patienten. Psychopharmacologia 7, 339—347 (1965)
Messiha, F. S., Savage, C., Turek, I., Hanlon, T. E.: A psychopharmacological study of catecholamines in affective disorders. J. Nerv. Ment. Dis. **158**, 338—347 (1974)
Noble, P., Lader, M.: The symptomatic correlates of the skin conductance changes in depression. J. Psychiat. Res. **9**, 51—59 (1971 a)
Noble, P., Lader, M.: Depressive illness, pulse rate and forearm blood flow. Br. J. Psychiat. **119**, 261—266 (1971 b)
Noble, P., Lader, M.: An electromyographic study of depressed patients. J. Psychosom. Res. **15**, 233 (1971 c)
Noble, P., Lader, M.: Salivary secretion and depressive illness, a psychometric and physiological study. Psychol. Med. (1971 d)
Ottosson, J. O.: Systemic biochemical effects of ECT. In: M. Fink et al. (eds.), Psychobiology of convulsive therapy. Washington: Winston & Sons 1974
Ploog, D.: Der Sympatoltest im Verlaufe endogener Psychosen. Ein Beitrag zur Frage körperlich-seelischer Wechselbeziehungen. Nervenarzt **24**, 102—107 (1956)
Ploog, D., Selbach, H.: Über den Funktionswandel des vegetativen Systems im Sympatol-Versuch während der Elektroschockbehandlung. Dtsch. Z. Nervenheilk. **167**, 270—302 (1952)
Poeldinger, W., Blaser, P., Gehring, A.: Zur Quantifizierung psychopathologischer und somatischer Symptome bei depressiven Verstimmungszuständen. In: H. Hippius, H. Selbach (Hrsg.), Das depressive Syndrom. München-Berlin-Wien: Urban & Schwarzenberg 1969
Pribram, K. H., Luria, A. R. (eds.): Psychophysiology of the frontal lobes. New York-London: Academic Press 1973
Rossi, G. F., Zanchetti, A.: The brain stem reticular formation. Arch. Ital. Biol. **95**, 199—435 (1957)
Routtenberg, A.: The two-arousal hypothesis: Reticular formation and limbic system. Psychol. Rev. **75**, 51—80 (1968)
Schwarz, D., Strian, F.: Psychometrische Untersuchungen zur Befindlichkeit psychiatrischer und intern-medizinischer Patienten. Arch. Psychiat. Nervenkr. **216**, 70—81 (1972)
Scoppa, A.: Il sistema nervoso vegetativo nelle distimie. Acta neurol. (Napoli) **25**, 261—274 (1970)
Small, J. G., Small, I. F., Perez, H., Sharpley, P.: Electroencephalographic and neurophysiological studies of electrically induced seizures. J. Nerv. Ment. Dis. **150**, 479—489 (1970)
Stern, J. A., Sila, B.: Autonomic responsivity and electric convulsive treatment. J. Neuropsychiat. **1**, 100—103 (1959)
Strian, F.: Psychopathologie der Encephalitis vom temporalen Typ. Arch. Psychiat. Nervenkr. **218**, 51—65 (1973)
Strian, F., Dirlich, G.: Arousal control in autonomic conditioning. Electroenceph. Clin. Neurophysiol. **34**, 784 (1973 a)
Strian, F., Dirlich, G.: Datenerfassung und Versuchssteuerung in Habituationsexperimenten. In: G. K. Schenk (ed.), Die Quantifizierung des Elektroencephalogramms. Konstanz: AEG-Telefunken 1973 b
Strian, F., Dirlich, G.: Beziehungen von Herzfrequenz und Aktivation. Unveröffentlichtes Manuskript. MPI-Psychiatrie, München 1976 a

Strian, F., Dirlich, G.: Aktivationsabhängige Herzfrequenzreaktionen. Unveröffentlichtes Manuskript, MPI-Psychiatrie, München 1976 b

Strömgren, L. S.: Unilateral versus bilateral electroconvulsive therapy. Acta Psychiat. scand. Suppl. **240** (1973)

Thiele, W.: Psycho-vegetative Störungen bei depressiven Krankheitsbildern. Med. Monatsschr. **25**, 548 (1971)

Turek, I. S.: EEG correlates of electroconvulsive treatment. Dis. Nerv. Syst. **33**, 584—589 (1972)

Volavka, J.: Is EEG slowing related to therapeutic effect of convulsive therapy? In: M. Fink et al. (eds.), Psychobiology of convulsive therapy. Washington: Winston & Sons 1974

Volavka, J., Feldstein, St., Abrams, R., Dornbush, R., Fink, M.: EEG and clinical change after bilateral and unilateral electroconvulsive therapy. Electroenceph. Clin. Neurophysiol. **32**, 631—639 (1972)

Volavka, I., Grof, P., Mrklas, L.: EEG frequency analysis in periodic endogenous depressions. Psychiat. Neurol. (Basel) **153**, 384—390 (1967)

Whybrow, P., Parlatore, A.: Melancholia, a model in madness. A discussion of recent psychobiological research into depressive illness. Psychiat. Med. **4**, 3f51—378 (1973)

Zerssen, D. v., Strian, F., Schwarz, D.: Evaluation of depressive states, especially in longitudinal studies. Pharmacopsychiat. **7**, 189—202 (1974)

Zerssen, D. v., Koeller, D. M.: Klinische Selbstbeurteilungsskalen (KSBS) aus dem Münchner psychiatrischen Informationssystem (Psychis-München), manual: die Beschwerden-Liste, die Befindlichkeitsskala. Weinheim: Beltz 1975

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