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# Changes of Psychophysiological Reactivity in Affective Disorders

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**Summary.** Proceeding from a theoretical conception, it was attempted to classify intuitively—on the basis of skin resistance level (SRL) and skin resistance reaction (SRR)—depressive and depressive-anxious patients into four psychophysiological types. This was done in different settings of psychophysiological tests which measured activation or inhibition of the phasic activation system and lability or stability of the tonic activation system.

In a sample of 232 psychophysiological first examinations which permitted the rating of orientation reaction, habituation, and conditioning, scales for 18 variables were developed through factor analysis, which made it possible to define scores for each patient's degree of activation or lability.

Two methods for describing and measuring changes in the variables of SRL and SRR are presented.

There is a positive correlation between the changes of activation and self-rating in a follow-up study on depressive patients who were reexamined one year after admission. After four weeks of application, Amitriptylin significantly improved the subjective feelings of depressive patients and also significantly lowered activation in these patients. The hierarchical grouping in which patients are automatically divided into dimensional types according to their factor scores confirms empirically our conception of four psychophysiological types.

**Key words:** Affective disorders – Habituation – Conditioning – Cluster analysis – Amitriptylin.

Based on the hypothesis that the depressive syndrome, viewed in the framework of psychophysiology, is a mixture of inhibition and activation (Lader, 1975; Heimann, 1977; Heimann et al., 1977), we tested in a pilot study the orienting reaction, habituation, and conditioning of 95 unselected depressive and depressive-anxious patients.

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| Type | Tonic System | | Modulation System | | Habituation | Conditioning |
|---|---|---|---|---|---|---|
| | Difference between max. and min. skin resistances | Reaction to intensive stimuli | Reaction to minor stimuli | Spontaneous fluctuations | | |
| inhibited | small | small | none | rare | rapid | weak |
| activated | small | normal | present | frequent | slow | strong |
| labile - inhibited | large | large | none | rare | rapid | weak |
| labile - activated | large | large | present | frequent | slow | strong |

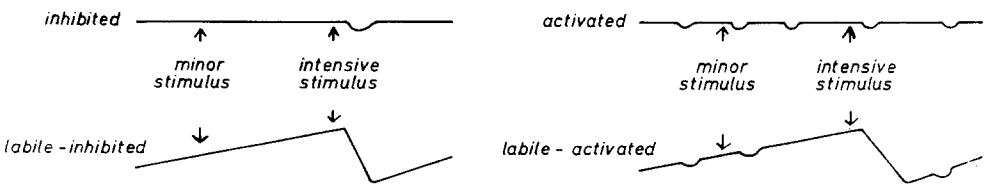


**Fig. 1.** Types of reactivity (skin resistance) in depressive-anxious syndromes

Having learned that patients with depressive syndromes show different patterns of reaction to different stimuli, for instance to simple tones other than words, we developed a standardized method of examination.

After two minutes of rest, orienting reaction and habituation are tested with a series of 11 tones of 80 db and a series of ten flashes. The effect of conditioning is tested by a combination of 80-db tone and strong white noise, which is repeated six times, the fourth tone not being followed by the white noise. In these situations the patient is passive to these external stimuli. In further tests (discrimination of a double flash and pressing a button in response to several flashes), the patient must become active. As a modification of Jung's association test, the patient has to respond to six given stimulus words with as many associations as come to his mind. As a psychophysiological variable, skin resistance is continuously recorded by an Elema-Schönander polygraph; two electrodes are attached to the palm, as described in Venables and Christie (1973). Furthermore, finger pulse, respiration, and the frontal and occipital EEG are measured.

The evaluation of the pilot study resulted in the indentification of *four different psychophysiological types* within the group of 95 patients tested (Heimann et al., 1977). They are represented in Figure 1. We can characterize these four types of psychophysiological reaction on the basis of the arousal theory of Claridge (1967), who *postulates a tonic and a phasic activation system.*

If the tonic activation system is stable, we have a constant level of skin resistance and there is no great change of intensive stimulation. If it is labile, we see great differences in skin resistance level in the course of recording, and big changes in intensive stimulation. If the phasic activation system is inhibited, the patient does not react to weak stimuli, seldom has spontaneous fluctuations,

*Factor-loadings of the rotated factor-matrix*
*Extracted proportion of the total variance 67%*
*Proportion of the factor-variance in relation to the total communality*
$F_1 = 48{,}3\%$ $F_2 = 26{,}8\%$ $F_3 = 15{,}1\%$ $F_4 = 10{,}5\%$

| | | | | |
|---|---|---|---|---|
| 1. resting skin resistance level (SRL) | - 0.265 | 0.830 | 0.019 | - 0.122 |
| 2. rise of SRL in 20sec. | - 0.098 | 0.753 | - 0.004 | 0.004 |
| 3. range of SRL | - 0.031 | 0.922 | 0.066 | - 0.059 |
| 4. maximal skin resistance response (SRR) | 0.341 | 0.803 | - 0.019 | - 0.003 |
| 5. spontaneous fluctuations | 0.710 | - 0.278 | 0.030 | 0.006 |
| 6. number of SRR to tones | 0.871 | - 0.079 | - 0.140 | - 0.094 |
| 7. number of SRR to light | 0.855 | - 0.090 | 0.006 | - 0.056 |
| 8. conditioned tone-response | 0.829 | 0.001 | 0.025 | 0.127 |
| 9. response to the 1.noise | 0.633 | 0.437 | - 0.122 | 0.145 |
| 10. response to the 5.noise | 0.711 | 0.270 | - 0.043 | 0.223 |
| 11. spontaneous fluctuations during Jung-test | 0.767 | 0.021 | - 0.035 | 0.035 |
| 12. response to passive stimuli | 0.945 | - 0.04 | - 0.067 | 0.016 |
| 13. response to active stimuli | 0.754 | 0.013 | - 0.067 | - 0.043 |
| 14. number of associations in the Jung-test | 0.055 | - 0.001 | 0.034 | 0.792 |
| 15. score of axiety | 0.002 | 0.111 | 0.913 | - 0.025 |
| 16. score of depression | - 0.018 | 0.122 | 0.893 | - 0.039 |
| 17. pulse rate per minute | - 0.093 | - 0.136 | 0.327 | - 0.070 |
| 18. respiratory rate per minute | - 0.002 | 0.113 | 0.197 | - 0.720 |

Fig. 2. Results of the factor analysis. $n = 232$

habituates very quickly, and displays weak conditioning. If the system is activated, the patient shows many spontaneous fluctuations and reacts to weak stimuli, while his habituation is slowed down and his conditioning is strong. The combination of these patterns of response results in the mentioned four types.

Since the classification into the four types was done on the basis of visual analysis of the data, the procedure is somewhat arbitrary and is not suitable for quantitative analysis of changes, for example in a follow-up study during the interval in which the patient is not depressive, or for investigating the influence of thymoleptics on the activation level.

In order to measure changes, it is necessary to express on scales the degree of inhibition or the degree of activation and the degree of labilisation. For this reason it was necessary to control the interrelationship of all variables measured and their contribution to the total information.

For this purpose we calculated a factor analysis with the psychophysiological results of 232 first examinations of depressive and depressive-anxious inpatients. Besides 14 skin resistance variables, pulse, and respiratory rate in a resting period, the scores for depression and anxiety in the self-rating scale of de Bonis and the number of associations in Jung's association experiment were taken into account, in total 18 variables. The correlation matrix was calculated according to Spearman's rho-coefficients. The results of the factor matrix, extracted according to the method of principal components and rotated by Varimax, can be seen on Figure 2.

The four factors which we can interpret represent an extracted amount of 67% of the total variance. These factors show a clear separation between an activation and a lability factor. The ten activation variables of skin resistance have high

loadings on the first factor with an amount of variance of 48.3% in relation to the total communality. On the second factor, with an amount of 26.1%, we find the four variables of lability. The scores for depression and anxiety of the self-rating have high loadings on the third factor with an amount of variance of 15.1%, as well as the pulse rate in resting. The fourth factor, with an amount of variance of 10.5% may represent a certain aspect of anxiety, because the number of associations in Jung's association test shows high positive loading and the respiratory rate shows high negative loading.

In the following we restrict ourselves to the first two factors, in other words to the question, how with our method can we quantitatively measure changes in the activation and lability conditions of depressive patients?

We constructed scales for each of the 18 variables with 100 as average and 10 as standard deviation on the 'basic' sample of 232 patients. Furthermore, the results of the following two investigations with repeated measurements enabled us to test methods for measuring changes:

1) From a current study with Amitriptylin ($3 \times 50$ mg p.d.) with depressive patients we took the results of the first 18 patients who were tested according to our method, first without drugs, then again 14 and 28 days after the beginning of the treatment.

2) From the 95 patients of our pilot study who were examined first in a depressive state, 27 could be reexamined one year later. In this follow-up study we could evaluate only seven instead of ten variables of activation. The self-rating was done according to the self-rating scale (BS) of v. Zerssen (1976).

In order to evaluate changes in activation and lability, we calculated factor scores with the scales constructed by means of the basic sample.

In a first step we were interested in the change in dimension of activation (factor 1) after 14 and again after 28 days of treatment with Amitriptylin, as well as between the first examination during a depressive state and one year later. These standardized factor scores are advantageous in that the different groups of variables may be compared directly if we represent them in figures.

In a second step we performed a cluster analysis. With the factor scores of activation and lability, an automatic classification was made via the method of hierarchical grouping (Veldman, 1967; Ward, 1963). We proceeded step by step to the level of four clusters and determined then the number of patients in each cluster and the changes of group membership at retesting.

Because of the small number of patients in the Amitriptylin study, we proceeded to the three-cluster solution.

1) On Figures 3 and 4 we can see the results of the Amitriptylin study. Figure 3 shows on the left side the change in factor scores of 17 subjects before, 14, and 28 days after treatment with Amitriptylin. The course of the curves of the individual subjects shows different patterns, but the cases with lower activation after treatment with Amitriptylin are preponderant. This may be an effect of the sedative action of the drug. These changes in the activation scores are significant on the 5% level (Wilcoxon test).

On the right side of the figure we can see the scores for the third factor, the self-rating in anxiety and depression. The changes in this factor are also

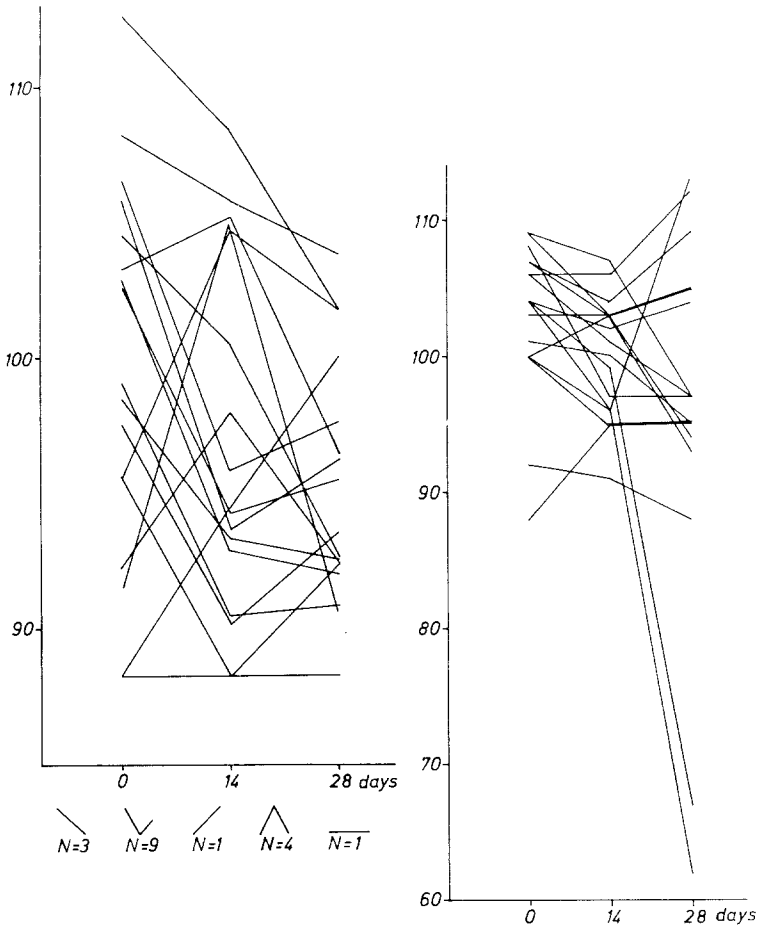


**Fig. 3.** Left: change of the activation variable under treatment with amitriptylin (factor scores), $n = 17$. Right: change in self-rating of depression and anxiety under treatment with amitriptylin (factor scores), $n = 17$

significant on the 5% level (Wilcoxon test), corresponding to a clinical improvement.

Figure 4 shows the centers of three automatically classified clusters first without drugs, then 14, and 28 days after treatment. The abscissa corresponds to the lability dimension and the ordinate to the activation dimension. Center I represents the group of activated and stable patients, Center II the stable and inhibited subjects. Center III shows the group of labile and activated patients. If one investigates the changes in group membership, it is striking that the majority of patients change from the activated Group I to the inhibited and stable group, which corresponds to the sedative action of the drug.

2) Figure 5 shows the scores of the activation factor of 27 patients at the first examination and one year later. Here again we can observe very different changes, so that the averages of the samples are not significantly different from

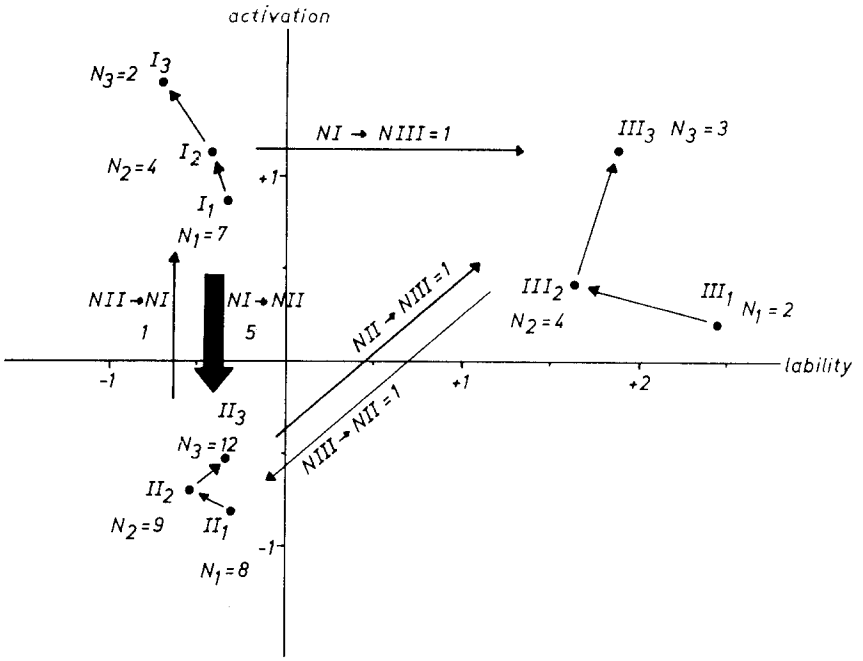


**Fig. 4.** Cluster analysis (hierarchical grouping) with factor scores of activation and lability. Three groups. Change of the group centers under treatment with amitriptylin after 14 days and 28 days in depressive patients. $n = 17$

each other. In particular, the variance of the follow-up sample is distinctly greater. In order to decide whether the change in the activation factor is in relation to the change in self-rating, we correlated the changes between the first and the follow-up examination in the self-rating scale of v. Zerssen with the changes in the activation scores. The coefficient of correlation according to Spearman's rho is equal to 0.41 and is significant on the 5% level. A relationship is therefore possible between changes on the activation scale and the change on the subjective self-rating of depression.

The result of the cluster analysis according to the method of hierarchical grouping is represented in Figure 6. The activation dimension corresponds to the ordinate, the dimension of lability to the abscissa. The centers of the groups of the four-group solution, together with the patients who belong to them are represented on the left. On the right we can see the same centers for the four-group solution at the follow-up examination, and the changes are drawn in for the patients who change clusters.

Cluster I represents the patients who are stable and activated, Cluster IV those who are stable and inhibited. Cluster III represents the groups of labile-activated, Cluster II the inhibited and slightly labilized patients. It is striking that the coordinates of the group centers have changed only slightly after one year.

If one compares the changes of the patients from one cluster to another, it will first of all be noticed that Cluster I and Cluster IV show the smallest changes,

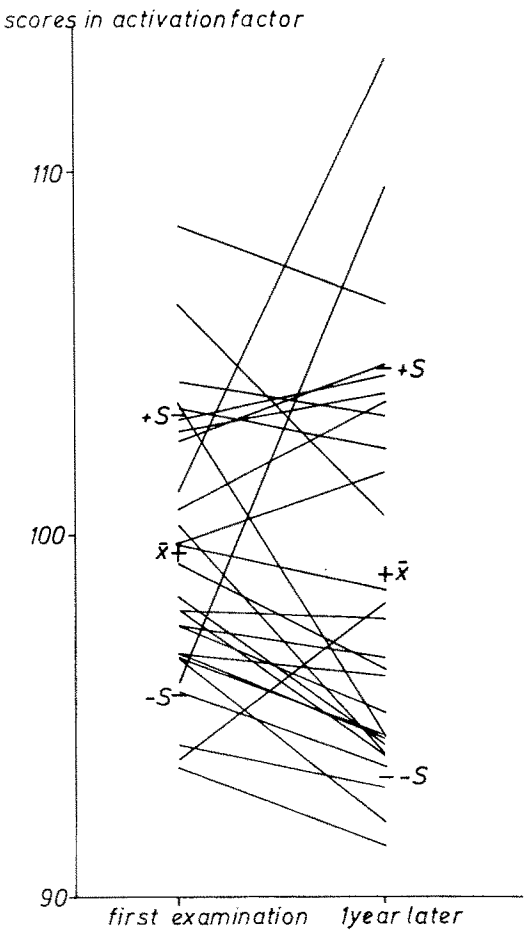


Fig. 5. Long-term changes of psychophysiological activation in depressive patients, $n = 28$

whereas all four patients of the labile-activated Group III change to another group. Out of the five patients who show subjective deterioration of nine or more points in the self-rating, three move in the direction of Cluster III.

Out of the nine patients who ameliorate nine and more points in the self-rating, four are in Cluster II, four in Cluster IV, and one in Cluster I. We can therefore conclude that an automatic classification method for determining dimensional psychophysiological types of depressive syndromes (see v. Zerssen) gives us the same four types which we found previously through visual inspection of the data of our pilot study based on the model of Claridge.

Nevertheless, it is so far uncertain what relationships exist among these types, that is, between the changes, among types, and the state of clinical depressivity, above all because we measured the latter only by means of a self-rating scale. The changes in the activation dimension of the highly ameliorated patients suggest that different patients need a different individual optimum of activation to reach a state of well being.

The present investigation shows a way of combining numerous variables of skin resistance level and skin resistance response to quantitative characteristics of

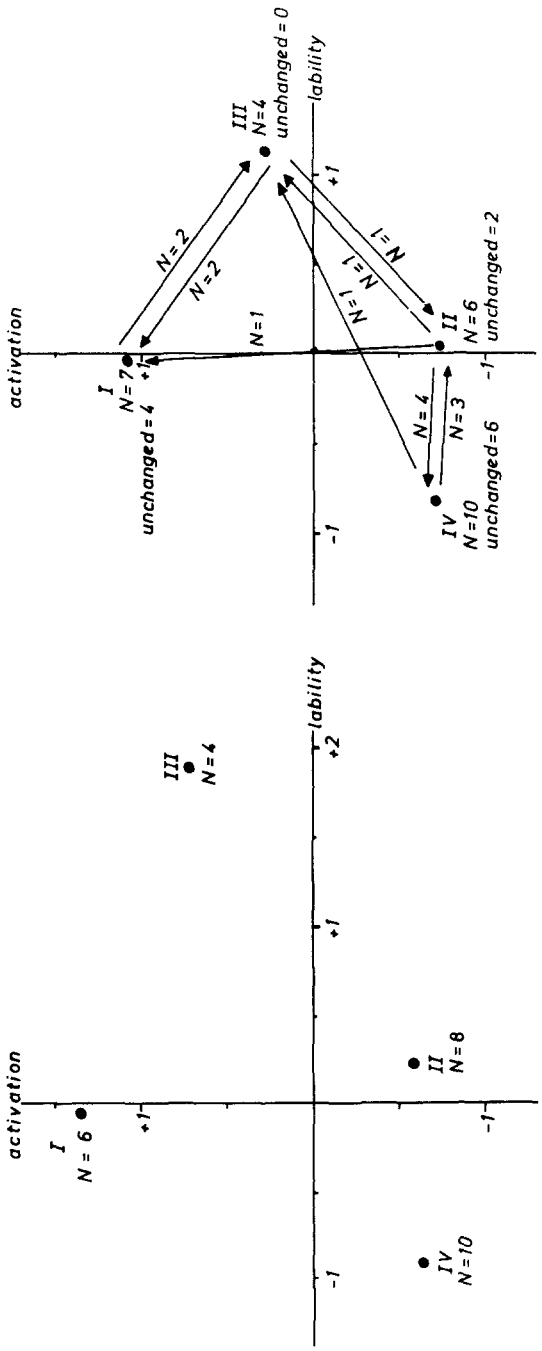


**Fig. 6.** Cluster analysis (hierarchical grouping) with factor scores. Centers of the groups, four-group solution. Changes one year after the first examination in depressive-anxious patients. $n = 28$

individual patients in order to measure changes in a given dimension, for example activation, or to classify patients empirically and quantitatively along the activation-inhibition dimension of the phasic activation system and the lability dimension of the tonic activation system. The importance of the empirical dimensional types for the clinical evaluation of depressive syndromes, that is, for a differential treatment with antidepressive drugs, remains to be clarified.

The aim of this study was only to clarify methodological questions for this purpose.

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