working model, operating on thought power, and we will give him best.

ELIOT SLATER.

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PHYSIOLOGICAL MEASUREMENTS OF ANXIETY

DEAR SIR,

There has been a welcome trend within recent years for physiological indicants of anxiety to be assessed in close association with the clinical practice of psychiatry. Dr. D. H. W. Kelly and Dr. C. J. S. Walter are to be congratulated for developing the technique of forearm plethysmography to where it contributes to the routine management of an anxious patient. Their recent paper (*Journal*, May, 1968, p. 611) reports findings on the levels of blood flow and other measurements in relationship to a variety of clinical diagnoses. The technique can be readily understood and applied easily by those relatively unsophisticated in physiology or statistics; it is to be hoped that its use will soon be universal so that it can assist the evaluation of different approaches to the treatment of anxiety. However, before this takes place, I venture to suggest some alteration in the method of statistical analysis of the data.

Examination of their findings reveals that it is inappropriate to examine means and standard deviations without prior transformation to achieve a normal distribution. The distributions of "basal" blood flow given in Fig. 2 are asymmetrical and pertain more to log normal. Also there is a rectilinear relationship between the means found in each diagnostic category and their standard deviations (Table III) ($r = 0{\cdot}74$; $p = 0{\cdot}01$); such a heterogeneity of variance can be largely corrected by logarithmic transformation. This necessity to transform biological observations to logarithms before statistical analysis has long been acknowledged (Gaddum, 1945); indeed with measurements of skin resistance, it has been shown that if this is not done the conclusion is affected (Haggard, 1949).

Kelly and Walter report measurements of blood flow obtained under "basal" and "stress" conditions as if they were independent. This fails to draw attention to the common observation in psychophysiology that the magnitude of the response is dependent on the initial level; necessity to pay attention to this has been advocated in many papers by Wilder on the "Law of Initial Value", and he has even suggested that its application should be extended beyond biology to sociology (Wilder, 1967). There is a sound theoretical reason for applying it to measurements of blood flow, where the amount of increase that can take place in response to any stimulus is determined by the number of arterioles that are not already dilated, in addition to the cardiac output. Presumably dilatation of the majority of arterioles in the anxious patient under "basal" conditions precludes much further increase in blood flow under "stress", whatever the magnitude of the stimulus and his psychic response to it. The same argument in favour of examining reactivity has been applied to the measurement of change in skin conductance, where the index is the proportion of active sweat glands. In view of the evidence in favour of analysing the measurements as logarithms, it should be noted that examination of change will then be in a dimensionless unit as the difference between two logarithms is a ratio. This has another advantage as it cancels out a common denominator whose measurement may be little more than a guess (i.e. forearm muscle volume). Kelly and Walter do look at percentage increase but they do so without allowing for the diversity in initial level.

Kelly and Walter report that the "basal" forearm blood flow of normals rises with increasing age ($r = 0{\cdot}29$; $p = 0{\cdot}05$). This type of association is commonly found in human physiology; both intrinsic heart rate and vital capacity fall, and, of course, blood pressure rises. It is thus disappointing that Kelly and Walter do not provide information on the exact relationship; presumably this could be calculated by regression equation as has been done for intrinsic heart rate (Jose, 1966) and vital capacity (e.g. Campbell, 1963). This can only improve the discrimination between the diagnostic categories, especially as 17 years separate the mean ages between two of them; Kelly has chastised others for not paying attention to this (*Journal*, October, 1965, p. 1012). What a pity that analysis of variance was not used to establish the significance of the observed differences. Not only is it more elegant, but the age

effect could then have been removed as a covariate leaving less variance to be accounted for by the differences between diagnostic groups. I hope, sir, that you will join me in suggesting to the authors publication of the regression equation between age and log blood flow, as it should be a valuable assistance to others working with this measure. As in all psychophysiology, it is essential to reduce to a minimum variation from factors that influence the measure—not to do so verges on travesty when the necessary information has already been collected.

To summarize: I advocate logarithmic transformation of forearm blood flow measurements before the statistical analysis; examination of the response induced by a stimulus in terms of change from the initial level; the use of analysis of variance rather than separate tests of significance between the diagnostic groups of themselves; and the correction for age of the patient by application of the appropriate regression equation. The challenge for this technique is how far it can contribute to the clinical decisions affecting an *individual* patient with anxiety. Kelly, Walter and Sargant (*Journal*, September, 1966, p. 87) suggest that with regard to one treatment it promises well, but there is evidence now that clinical science can contribute more to the art of psychiatry.

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Dear Sir,

Dr. Aitken, in his letter, raises some interesting points about the statistical analyses used in our recent paper (*Journal*, May, 1968, p. 611). He suggests that it would have been more appropriate to have used log transformations, rather than raw "basal" forearm blood flow values. His criticism is most valuable; in our experience, however, it usually makes very little difference.

We preferred to keep our data as near as possible to observed physiological events because we felt that this would be more easily followed by the majority of clinical psychiatrists reading our paper. However, the log transformations for "basal" forearm blood flow have now been calculated (Table I). It will be seen that although heterogeneity of variance has now decreased from a Chi Square of 29·85 (Bartlett's Test) for raw data to one of 17·63 for log data, it has not disappeared altogether. (A Chi Square of 16·92 with 9 df. is required for significance at the ·05 level.)

Table I

Log "Basal" Forearm Blood Flow

	N	Mean	S.D.
Chronic anxiety ..	41	·6318	·1186
Agitated depression ..	15	·5302	·1302
Schizophrenia	20	·4883	·1686
Obsessional neurosis ..	20	·3994	·1485
Phobic state	32	·3173	·1894
Hysteria	9	·3004	·1982
Non-agitated depression	43	·3046	·1523
Personality disorder ..	15	·2564	·1506
Derpersonalization ..	8	·1900	·2810
Normal control ..	60	·3085	·1777

With regard to differences among group means, analysis of variance of the log transformation of "basal" forearm blood flow for the ten diagnostic groups resulted in a F ratio of 18·04 with 9 and 253 df. For the untransformed data, the analogous F ratio is 20·92. Both values are, of course, highly significant. Using the original raw data and applying Duncan's New Multiple Range Test to the differences among diagnostic groups, all significant differences reported in our paper remained significant at or beyond the ·05 levels with the exception of the difference between non-agitated depression and obsessional neurosis. We have never claimed that the "basal" forearm blood flow *alone* could be used on an individual basis to distinguish between diagnostic categories: to do so would be unjustifiable because of the considerable overlap between the groups.

The letter also raised the question of reactivity of forearm blood flow to stress. We reported "stress" levels but realized that these are subject to many variables that are difficult to control. Not only does the "Law of Initial Value" operate, but response specificity of a particular autonomic variable as Lacey *et al.* (1953) have shown, may mean that one person responds to a stressful situation with a large increase in heart rate, while another person may