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A Comparison between Unemotional and Emotional Stimuli in Regard to Haggard's Ratios and Variances

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A COMPARISON BETWEEN UNEMOTIONAL AND EMOTIONAL STIMULI
IN REGARD TO HAGGARD'S RATIOS AND VARIANCES

by

Lee Francis Osborn Jr.

A Thesis Submitted to the Faculty of the Graduate School
of Loyola University in Partial Fulfillment of
the Requirements for the Degree of
Master of Arts

June

1952

LIFE

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CHAPTER I

INTRODUCTION *

One of the factors motivating this study was the fact that we have often heard students wonder what the Psychogalvanometer measures. Moreover, professors as well as graduate students have often disputed the reliability of what the instrument measures. Accordingly it was decided to formulate the following problem: To test the hypothesis that the log of the drop in skin resistance during the psycho-galvanic response is proportional to the basic resistance before the drop, for emotional as well as unemotional words. In this study, therefore, we intend to gather data, using two kinds of stimuli, in order to test the formula,

$\text{Log GSR plus } K/\text{level of skin resistance} \times 100 \text{ equal a constant,}$
proposed by Haggard ¹ as a quantitative measure of skin resistance data.

In the past, various indices or measures have been suggested and used by different experimenters in this kind of study. Such indices are:

a) Whether or not an indicator moved; ² (b) The absolute change in the ohms

* The present author wishes to express his gratitude to those who made this study possible. Special gratitude is hereby expressed to those students who willingly consented to act as subjects in this experiment.

¹ E. A. Haggard, "Experimental Studies in Affective Processes II, On the quantification and evaluation of 'measured' changes in skin resistance." J. Exp. Psychol., XXIV, 1945, 46-56.

² W. A. Hunt, & E. B. Hunt, "A Comparison of Five Methods of Scoring the Galvanic Skin Response," J. Exp. Psychol., XVIII 1935, 383-387.

resistance; ³ (c) The percentage that a given deflection is of a S's total range of deflections; ⁴ (d) The absolute change in resistance divided by the resistance level before the change; ⁵ (e) The change in conductance at the time of the reflex, which is the reciprocal of the resistance; ⁶ (f) The change in the logarithm of the conductance; ⁷ and, (g) Various ohm drops converted into standard scores. ⁸ These various measures have been useful in an evolutionary way, but when one works with these methods one finds them limited in their use and application. This does not mean that the use of these methods would not give you valid results, because they have a definite use depending upon the aims of the experimenter using them. Because of their limited application to the quantification of skin resistance data, Haggard ⁹ suggested his method of quantification as one that would be capable of being subjected to all the various statistical techniques used in interpreting experimental data. In

³ Hunt and Hunt, "A Comparison of Five Methods of Scoring the Galvanic Skin Response," J. Exp. Psychol., XVIII, 383-387.

⁴ Ibid

⁵ Ibid

⁶ Ibid

⁷ E. A. Haggard, "Experimental Studies in Affective Processes: I, Some effects of cognitive structure and active participation on certain autonomic reactions during the following experimentally induced stresses," J. Exp. Psychol., XXXIII, 1943, 257-284.

⁸ M. A. Wenger, and O. G. Irwin, "Fluctuation in Skin Resistance of Infants and Adults and Their Relation to Muscular Processes," Studies in Infant Behaviour, III, Univ. Ia. Stud. Child. Welf., XXII, 1936, I, 167-179.

⁹ Haggard, "Experimental Studies in Affective Processes II," J. Exp. Psychol., XXXIV, 46-56.

his early experiment he applied his formula to the drops obtained by the use of unemotional stimulus words, and electric shocks.

In this experiment we change Haggard's ¹⁰ procedure in one significant manner. In order to test the wider applicability of Haggard's measure, we used as stimuli, words selected for their emotional significance, in place of the electric shocks used by Haggard ¹¹ in his supplementary study.

¹⁰ Haggard, "Experimental Studies in Affective Processes II," J. Exp. Psychol., XXXV, 46-56.

¹¹ Ibid

CHAPTER II

RELATED FINDINGS

In psychology and even in physiology, measurement of recorded change in skin resistance, also known as the Psycho-Galvanic Response (PGR), or the Galvanic Skin Response (GSR) has caused considerable difficulty. The number of different methods of measurement which have been proposed is ample evidence of this difficulty. Disagreement and uncertainty have surrounded the quantification and interpretation of PGR data.

When Haggard ¹ began the work on his scale as a method of quantifying skin resistance data, he set down certain requirements which would have to be met if this scale were to be valid. These requirements are: They must enable the investigator:

- 1) " To make the necessary mathematical transformations with a maximal degree of simplicity and a minimal number of computational errors."
- 2) " To speak of individual differences among subjects under comparable experimental conditions as well as differences among groups of subjects receiving variation in experimental treatments."

¹ Haggard, "Experimental Studies in Affective Processes II," J. Exp. Psychol., XXXV, 46-56.

- 3) " To speak of the general level of background excitations (general level) independently of the particular reaction (GSR) which, as a result of a specific stimulus or set of stimuli, is superimposed on the pre-existing level of excitation."
- 4) " To use such statistical techniques as product-moment correlation tests, analysis of variance, etc. In using these methods of analysis, one makes the implicit assumption that his scale of measurement possesses units of equal size over its total range."

Previous to Haggard's measure of changes in skin resistance, Darrow and others had used as measures one of the following: the absolute drop in resistance, the drop of skin resistance divided by the general level of skin resistance just before the drop, and the standard scores computed for the worker's own group. Darrow² however, considered the ratio of drop to Basic Resistance as an indicator of the general excitation level of the individual. The ratio measure gave a fairly equal scale for responses, when the basics ranged between 5000 ohms and 25,000 or 30,000 ohms. Within this range the units of measure were of sufficiently equal size, and therefore, this measure satisfied condition number four. This measure was, therefore, comparable to

² C. W. Darrow, "The Significance of Skin Resistance in the Light of Its Relation to the Amount of Perspiration," J. Gen. Psychol., XI, 1934, 451-452.

Haggard's ³ log conductance measure. (See Fig. 1)

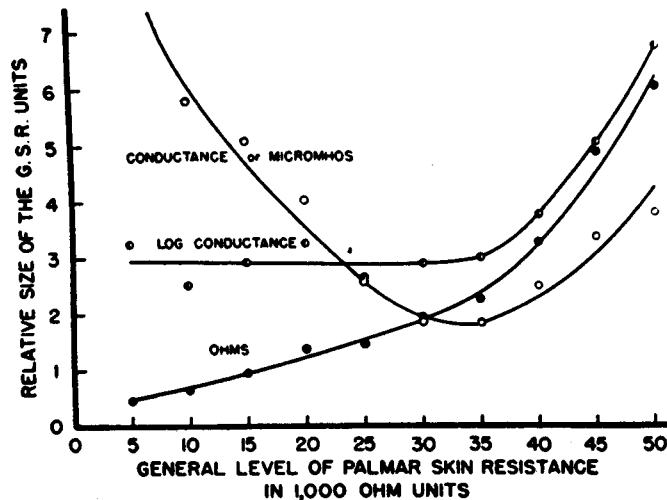


FIG. 1. A comparison of the relative size of the ohms, the conductance, and the log. conductance GSRs to 32 verbal stimuli in relation to the general level of resistance. ($N = 675$, with 48 Ss.)

In his research Haggard ⁴ studies the relation between the log of ohms drop and basic resistance for the range of basics between about 5000 and 50,000 ohms. Here the scale units are of approximately equal size. On the basis of the data reported in his paper, the log conductance measure is an adequate translation for about three-fourths of the drops, or for those falling at or below the 35,000 basic ohm level.

The question arose, whether it were possible to derive a method of quantification which will be satisfactory over the entire range? Haggard attacked the problem in this manner: he plotted the average GSR for all basic resistances within a range of 5000 ohms steps, and found a curve which was

³ Haggard, "Experimental Studies in Effective Processes II," *J. Exp. Psychol.*, XXXV, 46-56

⁴ Ibid

bent upwards for high resistances, which curve obviously resembled a logarithmic curve. (See Fig. 1)

He then took the log of each average GSR and plotted these scores against the basic resistance of his subjects at each 5000 ohm step and found this curve approximated a straight line. Since this straight line did not

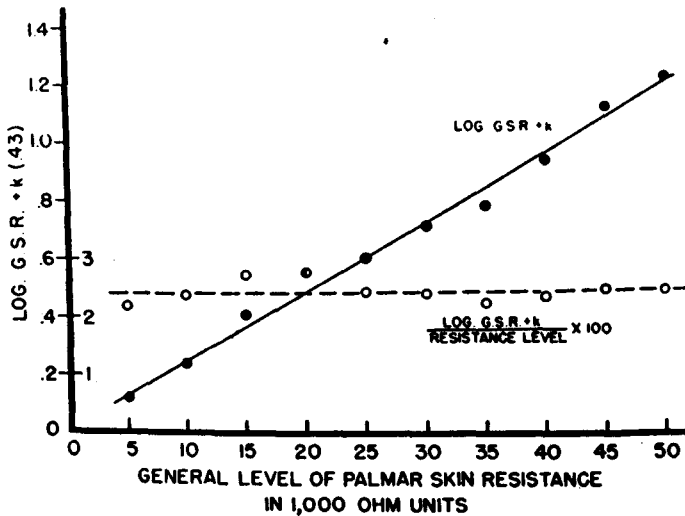


FIG. 2. The size of the log. (ohms) GSR + k units and $\frac{\log. (\text{ohms}) \text{GSR} + k}{\text{resistance level}} \times 100$ units to 32 verbal stimuli in relation to the general level of resistance. ($N = 675$, with 48 Ss.)

intersect the Y axis at the zero point, he knew that a certain constant could be added to each log GSR in order to make the line cross the Y axis at zero. (See Fig. 2) Furthermore, he found that where shock stimuli were used instead of 'neutral' ⁵ words, the data could be treated in the same manner with the same results, except that a different constant had to be added to the log GSR values found and that both curves for log GSR had practically the same slope.

⁵ Haggard, "Experimental Studies in Affective Processes II," J. Exp. Psychol., XXXV., XXXV, 46-56

When the constant was added, in either case, the ratio obtained between log GSR plus K, and the respective Basic Resistances, was constant. This value remained the same throughout all levels of basic resistances. (Fig. 2) Hence he obtained a scale value or unity which fulfilled the requirement number four mentioned before.

Haggard,⁶ had made a supplementary study to the one just mentioned, whose purpose was to ascertain the effect of adding more responses to the 675 responses of the first study in order to learn whether the log ratio would remain constant. He concluded that the increase in number of responses up to 1950 did not notably change the shape or slope of the curve.

He also had another purpose in doing this supplementary study, ⁷ on his proposed measure. He wanted to test the practicability of his measure, and the theory that the relative variability of the GSR scores was independent of the general level of skin resistance. If his suggested formula could meet these requirements it could be put to general use and show the inadequacies of the previously mentioned measures.

Haggard's second study ⁸ showed that his measure was practical after a conversion table was constructed and constants derived, for neutral and electric shock stimuli. He asks then whether the relative magnitude of the derived GSR scores is independent of the general level of skin resistance.

⁶ Haggard, "Experimental Studies in Affective Processes II," J. Exp. Psychol., XXXV, 46-56

⁷ Ibid

⁸ Ibid

The study shows quite clearly that the means of the derived scores, when grouped according to the level of skin resistance, are independent of the general level. Then he asks whether the relative variability of the derived GSR scores is independent of the general level of resistance? The study showed that when the derived GSR measure was used, the standard deviations of the means were not related in any particular manner to the general level of skin resistance, indicating that all the measures are from the same population.

Since Haggard's proposed measure fulfills the requirements mentioned on our pages 4 and 5, whereas the previously mentioned measures fulfill the demands for only part of the range of possible scores, his measures are in one sense to be preferred to the others. That is, for Haggard's instruments and subjects at least, Haggard's proposed measure can be applied over the entire range of GSR scores and general levels of skin resistances and have units of equal size. Since the curves for raw scores and conductance scores are straight for only a part of the GSR range, we would not have units of equal size throughout the entire range.

CHAPTER III

DESCRIPTION OF INSTRUMENTS, SUBJECTS, AND PROCEDURES

A. Instruments

The Psychogalvanometer used in this experiment employed as the balancing instrument a G. M. Laboratories Inc. Mirror type D'Arsonval Galvanometer, manufactured at 4300 North Knox Avenue, Chicago 41, Illinois. It is described in their Supplementary Catalogue P. G-1 and P. G-2 as Type 570-500, with a zero center. The mounting and housing were done by the present experimenter, and the whole mechanism was designed for rugged use. The sensitivity per mm. scale division at eight inches is .06 microamperes. The internal resistance was listed in the catalogue at 90 ohms but was actually 100 ohms. This was critically damped with the ohm resistance in the bridge circuit. The bridge itself was designed for psychogalvanometric use after the model of Woodworth's¹ with a possible range of measurements from 500 to 55,000 ohms with 500 ohm steps. The subject, in this set-up, is in series with the X arm, and hence the total current flowing through the bridge circuit when the galvanometer is at zero is constant, regardless of what the basic resistance of the subject might be. The error of the bridge as a whole was .3 percent.

1 R. S. Woodworth, Experimental Psychology, 1938, 278

A check was made in order to satisfy ourselves that the excursion of the galvanometer swings progressed linearly throughout its range as the resistance change in the X arm progressed. Aside from the difficulty of extreme deflections, the record of successive increases of resistance change showed that linearity of measurement had been attained. Actually a drop of 1500 ohms should give a 50 mm. deflection whereas it gives 51 mm.

The battery potential used was nine volts. This relatively high voltage was necessary to get reasonable sensitivity for all subjects. The potential across the subject's electrodes varied with the subject's resistance. Our voltage across the subject varied from 1.5 volts at 10,000 ohms to 5.5 volts at 40,000 ohms.

Time was recorded in seconds indicated by a flashing light whose interruptions were produced by a mercury switch operated by a synchronous motor. This light produced a fine row of dots along the record, parallel to its edge. The galvanometer light is on continuously, as is the usual arrangement.

Onset of stimuli was indicated by another signal lamp which was operated by hand and allowed for the measurement of the reaction time.

The subject was connected to the bridge via two finger cups which contained brass electrodes submerged in .1 normal saline solution. The excursions of the galvanometer were recorded by a camera of simple design, carrying high speed bromide paper at a uniform rate of 2.4 inches per minute.

B. Subjects

Two groups of subjects were used in this study. One group consisting of twenty-three was tested with the twenty emotional words, and another group

consisting of thirteen was tested with the thirty-two unemotional words. An occasional response was lost due to its extreme size or other disturbing stimuli, so that the total N for emotional R's was 238 and for unemotional was 347. All of the subjects were male, undergraduate college students, and had a major or minor in psychology. And, for the sake of cooperation and rapport we used only those students who expressed a desire to participate in the project.

C. Testing Materials

The material used in this project consisted of two lists of words, one list of emotional words and one list of unemotional words.

The emotional words list contained the following words; sick, high, love, afraid, sin, closed, hospital, ashamed, sex, open, pain, God, sweetheart, trouble, church, breast, medicine, dark, evil, and worry. The unemotional word list contained the words; city, pasture, taxi, hay, country, farm, easy, horse, library, barn, stores, soft, pavement, cafe, meadow, weak, carrot, traffic, subway, tender, sidewalk, corn, quiet, boulevard, harvest, office, poultry, theater, cow, kind, streetcar, and plow.

The list of emotional words was compiled at Loyola University of Chicago, and the list of unemotional words was the same list used by Haggard in his study.

D. Procedure

The subject was placed in the bridge, and allowed to become comfortable and adjust to the situation for approximately five minutes. After the five minutes were up the experimenter balanced the bridge to the subjects' resistance. When the subject was balanced into the instrument and became

adapted, the stimulus words, emotional or unemotional, were read to the subject in an even tone of voice one word at a time, allowing ample time for recovery before the next word was presented. Stimuli were never presented if the subject was falling or rising in resistance. The task was of the simple free word association type test, and all the responses by the the subject were recorded along side each of the stimulus words on the data sheet, along with the basic resistance of the subject as indicated by the instrument and adjustment before each of the stimuli words.

When the list of stimuli words was completed, the subject was removed from the instrument, and the record of the PGR's as recorded by the camera was developed. Each response was measured in mm. and converted to ohms by means of a specially constructed conversion table calibrated for the machine used.

CHAPTER IV

RESULTS AND CONCLUSIONS

After all the records had been obtained from the two experimental groups, and all the ohm drops measured, the next step was to determine the exact basic resistance of the subject at each of the responses. The actual basic resistance at the moment of any given PGR was computed by measuring the distance that the basic deviated from the neutral points of the galvanometer just before the PGR, and making the necessary correction. This distance was measured in mm. and then converted to ohms and, added to or subtracted from ohms resistance of the neutral setting of the galvanometer.

This correction took care of the rises or drops in resistance, between the given bridge steps, that the subject may have had during the experiment, that is, between the various stimulus words.

When each PGR and its basic resistance had been computed, each pair, a PGR and its basic resistance, were recorded on a card. When all the cards containing one PGR and its basic resistance, were collected, the cards were arranged in ascending order according to the basic resistance on each card. The cards were then divided into 5000 ohms step groups according to the basic resistances. All the cards in each of the groups were then assigned the basic resistance of the midpoint of the step in which they were, i.e. 12,500 ohms, 17,500 ohms, 22,500 ohms, 27,500 ohms, and 32,500 ohms.

After each group was assembled, the PGR's within the group were then added together and an average PGR was obtained for each of the basic resistance groups or steps. It was a simple matter then to make a graph using basic resistances as the abscissae in steps of 5000 ohms and average PGR's for the respective groups of basic resistances as the ordinates.

(See Fig. 3)

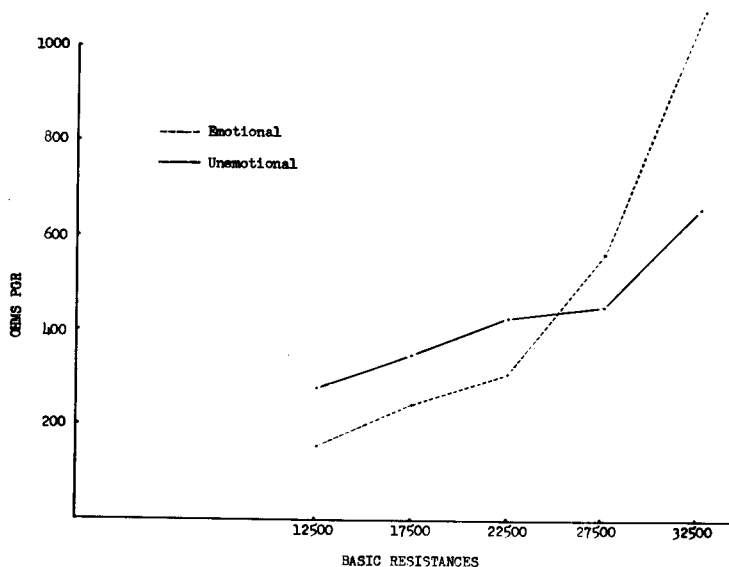
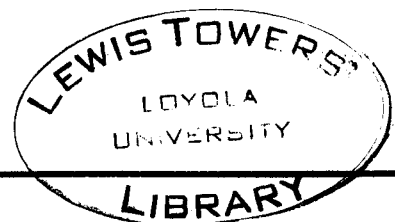


Fig.3. Showing relationship between PGR's and basics, for emotional and unemotional stimuli.

For convenience in comparing our data with that of Haggard, we used the same scale as Haggard, both for the abscissae and ordinates. (See Fig. 1 and 2)¹

It is noted in the graphs for the raw scores of the emotional and unemotional words, that the emotional words have higher average PGR's in the

¹ See pages 6 and 7



upper basic resistance ranges. (See Fig. 4)

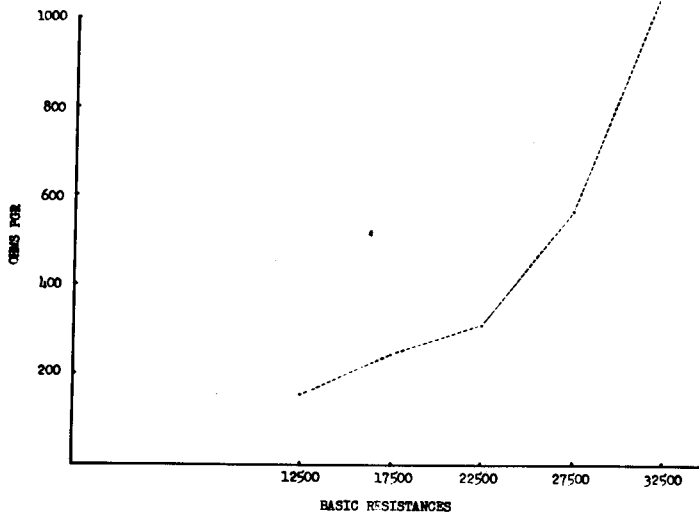


Fig. 4. Showing relationship between PGR's and basics, for emotional stimuli.

The unemotional words have higher average PGR's in the lower basic resistance ranges. (See Fig. 5)

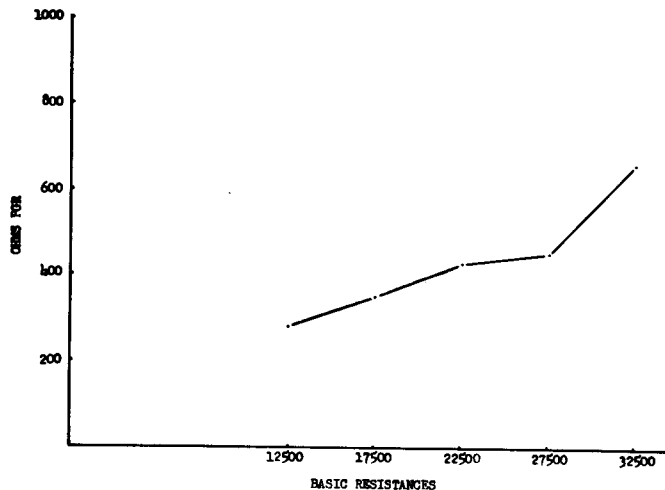


Fig. 5. Showing relationship between PGR's and basics, for unemotional stimuli.

The figure of the average FGR's for emotional words shows a fast rising curve as the basic resistance groups increase in ohm size. The figure for unemotional words shows a gradual but steadily rising curve as the basic resistance groups increase in ohms size. Actually two S's contributed in large measure to the high average FGR's in the 12,500 and in the 17,500 basic groups.

It is apparent from the inspection of the curves, that as the basic resistance increases the FGR drops also increase, but not proportionately, otherwise each curve would be a straight line.

Many learned authorities have noticed this point before, but have interpreted the fact differently. One can change this upward tending curve into a straight line, simply by changing the average ohms drop into the log of the average ohms drop. Accordingly, we have made the necessary transformations for the average FGR's corresponding to the several respective groups of basics, both for the emotional and unemotional stimuli by taking the logs to base ten of each mean ohms drop, and we have drawn the curves showing their relationships to their respective basics. (See Figs. 6 and 7)

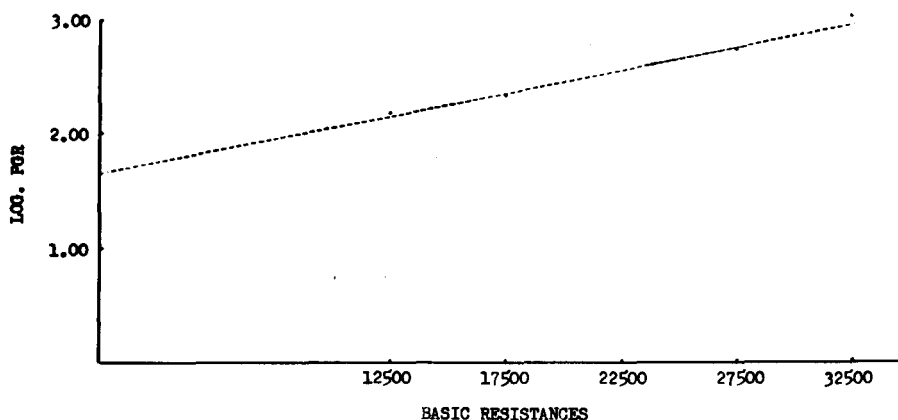


Fig.6. Showing relationship between log mean ohms drop and basics for emotional words.

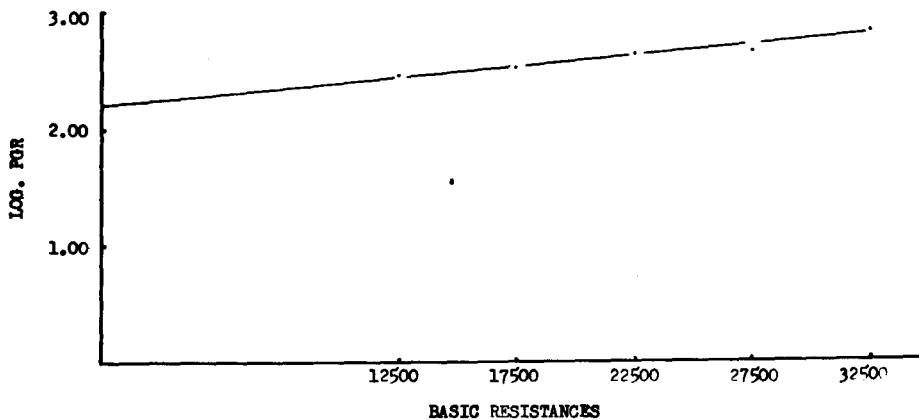


Fig. 7. Showing relationship between log mean ohms drop and basics for unemotional words.

The graph for the raw scores presents a curvi-linear relationship between ohms drop and basic body resistances, but the graphs for emotional words is not identical with the graph for unemotional words, either in slope or in slope-intercept.

On the assumption that the relationship is not linear, some transformation of the scores ought to produce a linear relationship, hence our next two graphs show the same relationship after the mean drops have been converted into logarithmic scores. They are both very nearly straight lines, thus confirming the hypothesis of Haggard, concerning the relationships between PGR and Basic Body Resistance.

But our question was to learn, whether or not the curve for responses to emotional stimuli had the same characteristics as that for responses to unemotional stimuli. Haggard found, when using the same instrumental settings that logs of electric shock responses produced a straight line relationship with the same slope as that from unemotional words. Our data does not conform

to those of Haggard's² study, either because of instrumental differences or because of the difference between our emotional stimuli and his electric shocks since we both used the same unemotional words. The slope of Haggard's curve for both kinds of stimuli (his K constant) was .024 times one hundred. The slope of our curve for unemotional words was .0188 times one hundred, and when the R's for the two S's mentioned on page 17 are eliminated, the slope becomes .022, a value somewhat closer to that of Haggard. The slope for our emotional words was .0395. (See Appendix I)

A second question arises in connection with our hypothesis, as to the possibility of comparing mean drops to emotional stimuli with mean drops to unemotional stimuli at a given level of basic resistance. Accordingly we have made the necessary groupings for the average PGR's, corresponding to the several respective groups of basics, both for the emotional and unemotional stimuli. We might wish to know whether responses to emotional and unemotional words are significantly different at any given level of basic resistance. In order to answer this question, we would first have to get the standard deviation for each mean PGR. According to Haggard's findings, the standard deviations for these groups increase in proportion to the size of the basic resistance. When this is the case, the more rigid tests for the significance of difference between means do not apply. We next computed the standard deviations for all groups of PGRs, with emotional and unemotional stimuli, and plotted them against their respective mean drops in resistances. (See Fig. 8 and 9)

² Haggard, "Experimental Studies in Affective Processes II," On the quantification and evaluation of 'measured' changes in skin resistance." J. Exp. Psychol., XXXV, 46-56

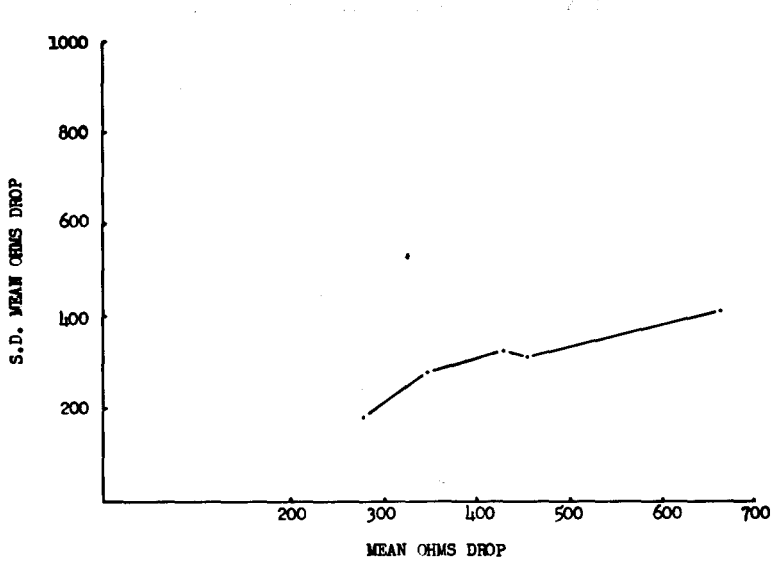


Fig. 8. Showing relationship between standard deviations of mean ohms drop and mean ohms drop for non-emotional words.

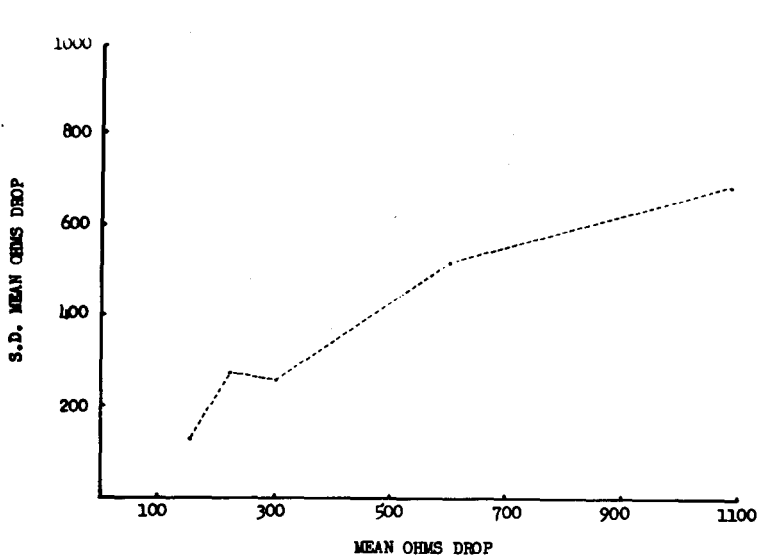


Fig. 9. Showing relationship between standard deviations of mean ohms drop and mean ohms drop for emotional words.

Inspection of these graphs shows that the S.D.s increase in proportion to the basics, and that there is no possibility of testing the significance of the difference since the variations are not independent of their means. Thus our data conforms to those of Haggard in this regard, namely that there is no independence of the means from their respective variances.

A simple comparison of the ratios in the last column of Table I of the Appendix, shows that the slopes for emotional and for unemotional R's are mutually exclusive.

Table I in the Appendix shows, for easy reference, basic body resistances, their corresponding mean ohms drop, standard deviations of these means, logs of ohms drop, corrected logs, and the ratios log ohms plus a constant K divided by basics for emotional and unemotional stimuli.

CHAPTER V

SUMMARY

PGR's were measured for emotional and unemotional stimuli. They were regrouped according to their respective basics. The resulting relationships were curvilinear, until drops were converted into log ohms. The slope of the line for emotional words was different from that for the unemotional words, contrary to what we would expect from Haggard's findings. Our results agree with Haggard's in proving the lack of independence between variances and means when raw score ohms was used. The lack of agreement with Haggard's work may possibly be due to the small number of subjects in the group receiving unemotional stimuli. Further experimentation will be needed in order to settle this issue.

Since many researchers have actually used t tests of significance with PGR data the findings of this and similar researches may have some influence on the work of future experiments.

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APPENDIX

UNEMOTIONAL						
BASICS	N	MEAN OHMS DROPS	S.D.	LOG OHMS	CORRECTED LOG	RATIO $\frac{\text{Log Ohms plus K}}{\text{Basic}}$
12,500	139	279	177	2.4456	0.2356	.0188
17,500	100	347	280	2.5403	0.3203	.0183
22,500	44	427	324	2.6304	0.4204	.0187
27,500	52	455	306	2.6580	0.4480	.0163
32,500	12	662	413	2.8209	0.6109	.0188
						MEAN .0188
EMOTIONAL						
12,500	67	153	126	2.1847	0.5147	.0412
17,500	70	226	273	2.3541	0.6841	.0390
22,500	52	301	251	2.4786	0.8086	.0359
27,500	43	565	513	2.7520	1.0820	.0393
32,500	6	1080	684	3.0334	1.3634	.0420
						MEAN .0395

TABLE I showing Basic Body Resistances, Their Corresponding Mean Ohms Drop, Standard Deviations of These Means, Logs of Ohms Drop, Corrected Logs, and the Ratio Log Ohms plus K/Basic for Emotional and Unemotional Stimuli

APPROVAL SHEET

The thesis submitted by Lee Francis Osborn, Jr. has been read and approved by three members of the Department of Psychology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

May 1, 1952
Date

Vincent V. Herr Jr.
Signature of Adviser