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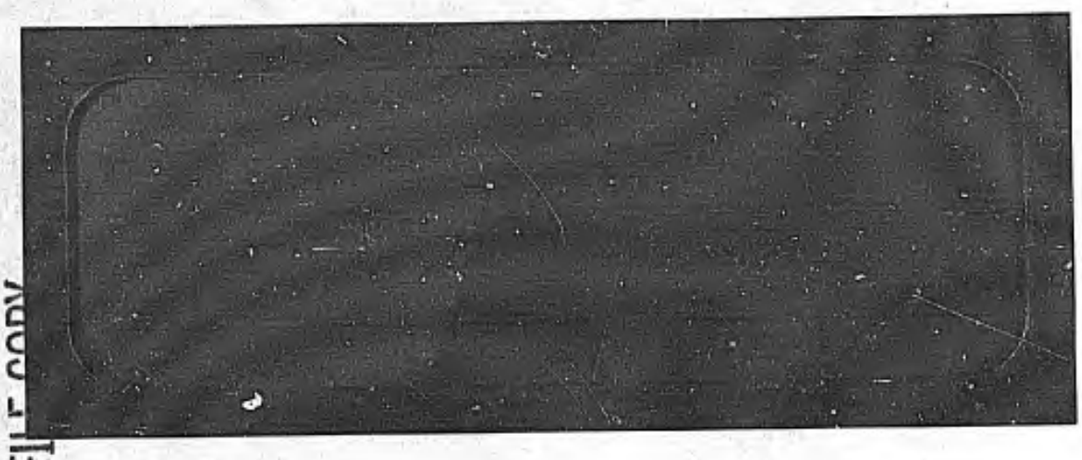

MOTIVATION, MORALE, AND LEADERSHIP DIVISION

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
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(6) AN INVESTIGATION OF TWO MEASURES OF PALMAR SWEAT UNDER FIELD CONDITIONS.

~~by~~

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INTRODUCTION:

The reactions of troops participating in maneuvers which involved atomic weapons have been studied by HumRRO on three different occasions. Each time one focus of the study has been on the measurement of emotional stress in such a situation. In the first study, done in the Fall of 1951 at Exercise DESERT ROCK I, verbal measures of emotional stress were obtained through attitude questionnaires. For the second, done at Exercise DESERT ROCK IV in the Spring of 1952, in addition to the attitude questionnaire; two measures of physiological reaction were developed for use in the field. Both of these measures utilized palmar sweating as an indicator of emotional stress. One of these measures, the Gladstone Finger Clamp technique, was then used more comprehensively in the third study, done at Exercise DESERT ROCK V in the Spring of 1953. This report is based, for the most part, on the findings of the third study (DR-V).

In the second study (DR-IV), two different techniques were used to measure palmar sweating. Both of these techniques were designed to be used with large groups of men under field conditions:

1. The Manual Perspiration Tube Technique.[1/] This technique was developed by Dr. Robert McCleary of the School of Aviation Medicine, Randolph Field, Texas. It requires that the subject hold in his hand for a specified period a small bag containing crystals of anhydrous cobalt chloride. The color of these crystals shifts as they absorb moisture. The amount of moisture absorbed can be assessed by comparing the crystals with a set of standards. This gives a direct measure of the amount of palmar sweating.

2. The Finger Clamp Technique.[2/] This technique was developed by Dr. Roy Gladstone of Oklahoma A & M, Stillwater, Oklahoma. It requires that the subject first wet his finger with an acetone solution of ferric chloride (provided in a small capsule embedded in a piece of sponge), then, when it has dried, clamp over it for a specified period, a strip of paper that has been treated with tannic acid. When sweat carries the ferric chloride into the paper, a dark precipitate of

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1/ "Palmar Sweat As An Index of Anxiety: A Field Method Suitable for Large Groups" by Robert A. McCleary, 1st Lt. USAF (MC). Report Number 21-1207-0004 Report Number 1, Air University, USAF School of Aviation Medicine, Randolph Field, Texas, May 1953.

2/ "An Investigation of Certain Variables Affecting the Results of a Group Test of Palmar Sweating" by Dr. Roy Gladstone. Final Report Subcontract No. HumRRO 650-005, 1 March 1954.

ferric tannate is formed. Since the amount of precipitate depends upon the amount of moisture present, a measure of the translucency of the paper is an inverse measure of the amount of palmar (or finger) sweating.

DESERT ROCK IV STUDY:

The troops participating in the DESERT ROCK IV study were from the 701st Armored Infantry Battalion, 1st Armored Division, Fort Hood, Texas. Six groups of men were selected from this battalion for the administration of the attitude questionnaire. Four of these groups (approximately 250 men) were also tested with the McCleary technique, while some 90 of the remainder were tested with the Gladstone technique. The physiological tests were administered to both groups at the same time. Each group was instructed in the mechanics of taking its particular test and a trial run was made on each group on the day preceding the shot -- during the dry run for the maneuver. The groups were then tested at the time of the shot (experimental test) and again on the day following the blast (control test).

With the McCleary technique it appeared that the men sweated significantly <u>less</u> during the shot than on the next day. With the Gladstone technique this finding was reversed; the men appeared to sweat <u>more</u> during the shot than on the next day.

The apparent contradiction between the results obtained with the two techniques may have been related to the difference in the time span and the timing of test administration. The Manual Perspiration Tube technique was administered during the period H-hour minus 15 minutes through H-hour plus 20 seconds, the Finger-Clamp technique during H-hour minus three minutes through H-hour plus 20 seconds. The greater chilling experienced by the men on D-day, as compared with the following day, may also have been a factor. These conditions may have influenced the results in these ways:

(1) If the rate of sweating actually rose sharply just before and during the moment of detonation, the Finger-Clamp technique was conducted during a time of higher average sweating rate than was the other measure. This rate of sweating may have been high enough to more than compensate for the greater chilling of the men on D-day; if so, more perspiration would be shown on D-day with this technique than on the following day (even though the men were then less chilled).

(2) If the Manual Perspiration Tube technique was indeed applied during a period of lower average sweating rate, the greater chilling being assumed for D-day might have resulted in a showing of a lower perspiration level at that time by this technique (even though more sweat might have been shown on D-day had chilling been constant on the two days.

Other possible factors that could account for the apparent contradiction in the results obtained from the two measures are:

(1) Difference in Sampling:

The McCleary results were obtained from a large group of men (N=248) without eliminating any subjects due to defective protocols. On the other hand, the Gladstone results were based on a relatively small group of men (N=90) of whom half were eliminated due to defective protocols (final N=45).

(2) Differences in the Techniques:

One major difference between the two techniques was the palmar area from which sweat was measured. The Gladstone technique measures sweat from the finger while the McCleary technique measures sweat from the entire palmar area.

In addition, there are, of course, differences in the technique by which the amount of sweat was physically measured.

In the hope of gaining more insight into the contradictory results with the two techniques a controlled experiment was conducted by applying the two techniques to groups of men in stress and non-stress situations of a constant ambient temperature over three ranges of temperature 40°, 70° and 100°. However the results of this study did not serve to clarify the situation. McCleary reported that palmar sweat as measured by the Manual Perspiration technique increased monotonically as a function of increasing temperature. McCleary also reported significant increases in palmar sweat due to stress for all three temperature levels. On the other hand, Gladstone reported that palmar sweat as measured by the Finger-Clamp technique increased as a function of temperature from 40° to 70° but decreased slightly

from 70° to 100°. Gladstone also reported that the differences between the stress and non-stress measurements were significant at the 5% level or better for 40° and 70° temperatures but were not significant at the 100° temperature.

DESERT ROCK V STUDY:

A. Introduction

Since Dr. Gladstone was undertaking a rather extensive program of laboratory research on his test, it was decided to use the Finger Clamp technique in the third study (DR-V). For this study a larger group of men was used and the measurements were repeated several times in the course of the study. Attempts were made to improve the technique itself by correcting the final measures of the opacity of the paper strips for the density of the paper itself. On the assumption that sweating would be affected by body temperature, finger tip temperatures were taken on many of the subjects at the time of each test and used to correct the final measures of palmar sweating. Further, an attempt was made to relate the sweat scores to the verbal measures of emotional stress in the attitude questionnaires.

B. Test Administrations

Companies B and C of the 505th regiment, 82nd Airborne Division, Fort Bragg, North Carolina participated in the DESERT ROCK V study. The study covered a period of about two weeks during which approximately 200 men from the above companies were given the sweat test ten times using the Gladstone Finger Clamp technique. The testing schedule and the relation between the tests and the time of the shot are as follows:

Test	Date	Place	Relation to D-Day and H-Hour
1	April 27	Fort Bragg	D-11
2	April 28	Fort Bragg	D-10
3	April 29	Fort Bragg	D-9
4	May 4	Desert Rock	D-4
5	May 5	Frenchman's Flats	D-3
6	May 6	Desert Rock	D-2
7	May 8	Frenchman's Flats	H-20 minutes
8	May 8	Frenchman's Flats	H-Hour
9	May 8	Frenchman's Flats	H+15 minutes
10	May 8	Desert Rock	H+10 hours

After tests 2, 5, and 9 an attitude and information questionnaire was administered to the troops. Finger tip temperatures were obtained at every test administration except 8 (during the shot); however, the small number of thermometers available limited this measurement to the men from one company (approximately half of the sample).

Immediately after Test 4, a four hour atomic information indoctrination was given the troops by the DESERT ROCK staff. Test 5 was administered during the dry run.

The relative darkening of the strips of paper used in these tests was measured in terms of light transmission. These values, corrected for paper density, constituted the sweat scores for each man on each test. It should be noted that when there was little sweat, little ferric tannate was precipitated, the paper was only

slightly darkened and the relative light transmission, hence the sweat score, was high. When there was a lot of sweat, the final score was, of course, low.

C. Results

For each test the mean and standard deviation of the scores was computed using only those 136 men who participated on all ten administrations of the test (Table 1).

The means in Table 1 show that the men sweated less during the tests closest to H Hour (Tests 7, 8, and 9) than they did at any other time. They did sweat slightly more during the shot than either immediately before or immediately afterward, but the difference is not statistically significant.

D. Results Corrected for Finger Tip Temperature

It is apparent from a comparison of the ambient temperature data and the mean palmar sweat scores that ambient temperature is related to the level of palmar sweating in this study. Since in the DR-IV study the control and experimental data were taken at approximately the same ambient temperatures, the sharply contrasting findings between the two studies (DR-IV and DR-V) may be possibly accounted for by the differences in ambient temperature occurring during the DR-V study.

A correction was worked out by Dr. Gladstone based on finger tip temperatures and applied to the individual sweat scores. This

Table 1

Means and Standard Deviations of Sweat Scores

(N = 136)

Test	Relation to D-Day and H Hour	Ambient[a/] Temperature	Mean	SD
1	D-11	68°	.78	.13
2	D-10	72°	.77	.14
3	D-9	83°	.67	.19
4	D-4	75°	.75	.16
5	D-3	71°	.91	.07
6	D-2	85°	.80	.13
7	H-20 minutes	66°	.94	.04
8	H	67°	.92	.06
9	H+15 minutes	68°	.95	.04
10	H+10 hours	75°	.89	.12

a/ Obtained from U.S. Weather Bureau (for Las Vegas) and from Pope Field (for Ft. Bragg).

correction factor is a curvilinear function of fingertip temperature.3/ That is, as fingertip temperature increases the correction factor decreases up to a point (fingertip temperature 93°) and then increases (from 93° to 97°) and finally decreases again. The correction factor is, of course, added to each man's sweat score so that theoretically each man's sweat score is corrected to a finger tip temperature of approximately 93°.

Means and standard deviations were computed for the corrected scores using only those 73 men who had sweat scores and finger tip temperatures for all administrations of the test. These data are presented in Table 2. It will be observed that when the correction factor is applied the means tend to flatten out and the mean sweat score for the experimental trial (Test 8) is lower than all control trials except for control trial 3.

The interpretation of these results presents something of a problem. Instead of one peak in palmar sweating at the experimental trial as was expected there are two peaks -- one at Test 8 and one at Test 3. Applying the sign test to changes in sweat between successive trials indicates that the differences between the experimental trial and the two adjacent control trials (Tests 7 and 9) are statistically significant at the 1 percent level. However, there are also statistically significant differences between adjacent control trials (Test 2 vs 3, Test 5 vs 6, and Test 6 vs 7). It appears that

3/ For a more complete description of the correction curve see chapter 13 of Dr. Gladstone's report.

Table 2

Means and Standard Deviations of Sweat Scores Corrected for Finger Tip Temperature

(N = 73)

Test	Relation to D-Day and H Hour	Mean	SD
1	D-11	.75	.14
2	D-10	.76	.13
3	D-9	.67	.20
4	D-4	.74	.16
5	D-3	.77	.08
6	D-2	.79	.13
7	H-20 minutes	.75	.04
8[a/]	H	.70	.07
9	H+15 minutes	.75	.03
10	H+10 hours	.75	.09

a/ On the assumption that the change in finger tip temperature was uniform throughout the short period of time between Test 7 and 9, corrections for the sweat scores of Test 8 were derived by interpolation.

the effect of observing the shot does tend to increase the level of palmar sweat. However, there are also other systematic variables that are influencing the level of palmar sweating from trial to trial.

E. Reliability of the Sweat Measures

Since the sweat scores were highly skewed, the scores of the 136 men who took all ten tests were transformed by taking the square root of the difference between each individual sweat score and 1,000. This transformation yielded distributions of scores that were usually symmetrical and presented better approximations to the normal distribution than did the original untransformed scores. Correlations were then computed using the transformed scores between scores on successive tests. These data are presented in Table 3.

It is clear from these correlations that the reliability of the measure is very low in the tests that were carried out under field conditions, and not entirely satisfactory under any of the testing conditions.

F. Conclusions

On the basis of the results presented in this report the following conclusions are drawn:

(1) Palmar sweat as measured by the Finger Clamp Technique is influenced by ambient temperature.

(2) The Finger Clamp Technique has a low test-retest reliability when administered under field conditions.

(3) The evidence suggests that observing the blast did increase the level of palmar sweating as measured by the Finger Clamp Technique.

Table 3

Correlations Between Successive Tests

(N = 136)

Tests Correlated	r
1 & 2	.54
2 & 3	.47
3 & 4	.25
4 & 5	.49
5 & 6	.17
6 & 7	.21
7 & 8	.12
8 & 9	.22
9 & 10	.14

4. The evidence suggests that uncontrolled variables other than ambient temperature were producing significant differences between the control trials.

5. It is concluded that in its present state of development the Finger Clamp Technique for measuring palmar sweat should not be used under field conditions except for purposes of further study of the technique itself.