

GROUP MEASUREMENT OF PALMAR PERSPIRATION
AS AN INDEX OF TENSION

A Thesis

Presented to

The Faculty of the Department of Psychology
The University of Houston

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In Partial Fulfillment
of the Requirements for the Degree
Master of Arts in Psychology

by

Richard R. Rudie

August 1954

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ABSTRACT

This study was concerned with changes in palmar perspiration level due to a stress-producing situation. The relationship of this measure to manifest anxiety and the personality scales on the Minnesota Multiphasic Personality Inventory was also investigated, as well as the effect of tension on ability to recall non-stressful and stress-producing memories.

It has been known for quite some time that body perspiration is controlled by the parasympathetic and sympathetic branches of the autonomic nervous system. Recent research of Kuno¹ and others, indicates that sweat glands on the palmar surface of the hand are minimally sensitive to thermal changes, and extremely sensitive to stimulation by the sympathetic nervous system as influenced by psychic factors, such as tension or stress.

The subjects used in this study were a class of forty-one female student nurses at the same level of training. These subjects were given an oral examination in which they were asked to define twenty terms, ten easy and ten difficult. During the examination a palmar perspiration index was obtained from each subject. At the next class period, the Minnesota Multiphasic Personality Inventory was administered, from which the Taylor Manifest Anxiety Scale could also be scored. The baseline or relief perspiration index, along with the students' rating of "difficult" or "easy" for each term, was also taken at this time.

A colorimetric technique was used in recording the perspiration indices, and average readings were then determined with a densiometer.

¹ A. Kuno: cited by O. H. Mowrer et al, Psychotherapy: A Symposium on Theory and Research, (New York: Ronald Press, 1953), pp. 227-228.

The following results were obtained:

1. A significant difference between the tension and relief perspiration indices. The critical ratio of 4.94 was reliable beyond the .01 level of confidence. Thirty-four of the forty-one subjects had a higher tension index.
2. A significant difference between the recall of "easy" and "difficult" terms. The critical ratio of 6.89 was reliable beyond the .01 level of confidence. Thirty-eight of the forty-one subjects remembered more "easy" terms than "difficult" ones.
3. The Taylor Scale of Manifest Anxiety correlated .39 with tension indices and .22 with relief indices.
4. There were no reliable differences between a high "perspiration index" group and a low "perspiration index" group on the M.M.P.I. scales.

From the results of this and previous studies, the perspiration index would appear to be a reliable measure of tension as produced by stressful situations. It also appears to have some relationship to manifest anxiety as measured by the Taylor Scale on the M.M.P.I.

The stress situation in the present study produced significantly greater recall on "easy" terms as compared with "difficult" ones, which is further evidence for a concept of defensive forgetting.

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CHAPTER I

STATEMENT OF THE PROBLEM

It has been known for quite some time that body perspiration is controlled by the parasympathetic and sympathetic branches of the autonomic nervous system. This system is, in turn, controlled by the hypothalamus and other parts of the brain.¹ Recent research of Kuno², and others, indicates that the sweat glands on the palmar surface of the hand are minimally sensitive to thermal changes, and extremely sensitive to stimulation by the sympathetic nervous system as influenced by psychic factors, such as tension or stress. The purpose of the present study is to investigate further the sensitivity of the palmar perspiration technique as a measure of tension.

More specifically, the present study was concerned with: (1) changes in the palmar perspiration level due to tension or stress; (2) the relationship between the palmar perspiration level and a measure of manifest anxiety; (3) the effect of tension on ability to recall non-stressful and stress producing memories; and (4) the relationship between perspiration index and personality scales on the Minnesota Multiphasic Personality Inventory³.

Importance of the Study. A great deal of research has been done in experi-

¹ C. Morgan and E. Stellar, Physiological Psychology, (New York: McGraw-Hill Book Company, Inc., 1950), pp. 340-356.

² A. Kuno; cited by O. H. Mowrer et al, Psychotherapy: A symposium on Theory and Research, (New York: Ronald Press, 1953), pp. 227-228.

³ S. R. Hathaway and J. C. McKinley, The Minnesota Multiphasic Personality Inventory and Manual, (The Psychological Corp.: New York, 1947).

mental psychology to obtain physiological measures applicable to the study of psychological problems of all types. At the present time, there seems to be an increasing concern with problems centering around the effects of stress and anxiety on the traditional areas of perception and learning. An independent measure of tension would be useful, particularly if such a measure could be shown to be reliable not only for groups, but also for individuals. In this study an effort was made to investigate further one such technique of obtaining an independent measure of tension.

CHAPTER II

REVIEW OF THE LITERATURE

The earliest extensive study of human perspiration was done by Kuno, a physiologist. After careful and detailed study, he concluded that there are two distinct neurological centers for controlling body perspiration. This conclusion was strongly substantiated by what he termed "thermal" sweating and "emotional" sweating. "Thermal" sweating, which is concerned with body heat regulation, is evidenced over the entire body in general, but not on the palms of the hands or feet. "Emotional" sweating occurs on the palms of the hands and feet, and also in the armpits of sexually mature human beings.

"Emotional" sweating appears little affected by, and completely independent of, thermal changes to an optimum point. That point appears when the individual is in an environment of intense heat and realizes its danger. Palmar perspiration is then initiated which serves to aid the individual in his attempt to leave the threatening environment. Moistening the surface of the palm of the hands and feet has two effects which facilitate muscular work. The first is that moisture increases the friction of the hands and feet with objects they contact. The second is that the sense of touch becomes more acute as the friction increases. The expression, "spitting on the hands", is found in several different languages and has undoubtedly developed because of the effects of moisture as described above.

"Emotional" sweating occurs when the individual is involved with mental problems such as mental work, conflict, tension, frustration, anxiety, etc.

It also occurs in times of danger, whether real or anticipated. Kuno found wide individual differences in the activity of the sweat glands of the palms of both hands and feet. He noted that some individual's palms were usually dry, where others were extremely moist. Those individuals who had dry palms appeared to sweat only small amounts when stimulated, whereas, the other group would perspire profusely. He devised a crude and not too successful technique to measure this perspiration. After developing this technique, he noticed that the distribution and amount of perspiration would vary on different areas of the hand and also from one hand to the other¹.

The next important advancement in the study of palmar perspiration was made by Silverman and Powell². They developed further the "colorimetric" technique of measurement and tried it on a group of hospitalized psychoneurotic patients. For a control group they used members of the hospital staff. In order to compare their results, they quantified the obtained data on a four-point scale. This scale was established for different amounts of perspiration from a small amount to an extreme amount. They then compared results and found that the neurotic group had a characteristically heavier or larger amount of perspiration under normal hospital conditions.

Wright and Witzell³ compared a group of neurotics with a group of psychopaths on the palmar perspiration method introduced by Silverman and Powell. The neurotics showed more perspiration than the psychopaths.

¹ A. Kuno: cited by O. H. Mowrer et al, Psychotherapy: A Symposium on Theory and Research (New York: Ronald Press, 1953), pp. 227-228.

² J. J. Silverman and V. E. Powell, "Studies on palmar sweating", American Journal of Medical Sciences, 208: pp. 297-305, 1944.

³ E. Wright and L. Witzell, cited by O. H. Mowrer et al, op. cit., p. 230.

Their investigation provided further confirmation that palmar perspiration was a correlate of anxiety. Their study was conducted at a U. S. Naval convalescence hospital.

Gladstone⁴ made some interesting extensions and refinements of the Silverman and Powell technique. He modified the technique so that it could be applied to a group situation, and also introduced a photometric method for measuring the perspiration prints, instead of comparing them to a standard, as Silverman and Powell had done. He employed the colorimetric technique to measure the general level of palmar perspiration in classrooms of school children under different or varying circumstances. By modifying the technique and giving careful verbal instructions, his subjects were able to apply the test to themselves. According to his findings, the increase in palmar sweating occurs under conditions of pain, sensory stimulation, intense heat applied to a local area, mental arithmetic, conation, physical labor, mental and physical malfunction, general alertness, expectation of difficulty, and attempted deception. Physical exhaustion, poor physical condition, and feelings of well-being tended to decrease palmar sweat.

Recently, Mowrer⁵ has used palmar perspiration measures experimentally to indicate resistance by patients during therapy. He found a high degree of relationship between patient's self-ratings of tension changes and their perspiration index during therapy. The perspiration index of the therapist

⁴ R. Gladstone, "A group test of palmar sweat", Journal of General Psychology, 48: pp. 29-49, 1953.

⁵ Mowrer et al, op. cit., pp. 231-241.

was also taken, and in many cases the therapist's perspiration index was higher, but more stable, than that of the patient. The perspiration index offers a promising technique for the measure of tension in therapy sessions.

Castle⁶, in a study on palmar perspiration and its relationship to personality factors, correlated the palmar perspiration indices of thirty subjects with their scores on the Taylor Anxiety Scale before, during, and after stress. She found a correlation of .24 before stress, .49 during stress, and .56 after stress. She concluded that the palmar perspiration index is a reliable measure of emotional tension upon exposure to a stress situation. She divided her subjects into an upper and lower group on the basis of their perspiration indices, and found that the high group had significantly higher scores than the low group on the Schizophrenic, Social Interest, Depression, Psychasthenia, Psychopathic Deviate, and Paranoia scales of the Minnesota Multiphasic Personality Inventory. No significant differences were found on the remaining scales of the M.M.P.I.

The Taylor Scale of Manifest Anxiety is composed of fifty selected items from the M.M.P.I. This scale has been used to discriminate between anxious and non-anxious subjects⁷. In their recent study, Bitterman and Kniffin⁸ successfully used the Taylor Anxiety Scale to select low and high anxiety subjects. Subjects with Taylor scores between one and eight comprised the low anxiety group and those with scores from twenty-six to forty-four,

⁶ M. M. B. Castle, "Palmar Perspiration as an Index of Tension and its Relationship to Personality Factors", An unpublished Master's Thesis, University of Houston.

⁷ J. Taylor and K. Spence, "Relationship of anxiety level to performance in serial learning", Journal of Experimental Psychology, 44: pp. 61-64, 1952.

⁸ M. E. Bitterman and C. V. Kniffin, "Manifest anxiety and perceptual defense", Journal of Abnormal and Social Psychology, 48, 2, pp. 248-252, 1953.

the high anxiety group.

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Another aspect of the present study is concerned with the effect of stress or tension on memory. From the time of Ebbinghaus⁹, memory studies have been of great interest to psychologists. Of pertinent interest is the study by Zeigarnik¹⁰ which was concerned with the effect of completed and uncompleted tasks on memory. She administered several tasks to the subjects and they were permitted to complete some of them and were interrupted on others. She later asked the subjects to recall as many of the tasks as they could. In general, the subjects remembered more of the unfinished tasks in comparison to the completed ones. Her interpretation was that tension is continued until a means for its reduction is available. The relationship of memory for uncompleted tasks, as compared to completed tasks, became known as the "Zeigarnik effect" and has stimulated a great deal of work in this area.

Many recent studies have involved memory, problem solving, and forgetting under conditions of frustration or tension in ego-involved and non ego-involved situations. Rosensweig¹¹ did a study using puzzles on two groups, one of which was told that the properties of the puzzles were being studied, and the other group was told that they were being subjected to an intelligence test. At the conclusion of the experiment the subjects were asked to recall the puzzles they had attempted. The subjects in the non

⁹ G. Murphy, *Historical Introduction to Modern Psychology*, (New York: Harcourt, Brace, and Company, 1951), pp. 174-181, 1951.

¹⁰ *Ibid.*, p. 301.

¹¹ S. Rosensweig, "Need-persistent and ego-defensive reactions to frustration as demonstrated by an experiment on repression", *Psychological Review*, 48, pp. 347-349, 1941.

ego-involved group remembered more incompleated puzzles, and the ego-involved group remembered more completed puzzles. The interpretation drawn by Rosenzweig was that the non ego-involved group is under little or no tension and that their interest was centered mainly on the task. The ego-involved group felt threatened after every failure and forgetting came into play as an ego defense mechanism. The greater the amount of ego involvement, the greater the amount of defensive forgetting.

Rosenzweig¹², in a later study, found that in formal situations, as opposed to informal situations, subjects recalled completed tasks or problems more than incompleated, due to ego defensiveness.

Alper¹³ did a study on memory for completed and incompleated tasks as a function of personality. Her conclusions are as follows: "Selective recall is not an isolated process, but is instead subject to certain basic laws which function in the service of self-esteem needs of the personality as a whole. It is the subject's personality, and not the experimenter's Aufgabe, which determines the context for the subject." Two patterns of selective recall were isolated: (1) recall of failures or incompleated tasks indicates that the individual has a strong ego, and (2) recall of completed tasks indicates the individual's self-esteem is threatened and that he has

¹² S. Rosenzweig, "An experimental study of "repression" with special reference to need-persistent and ego-defensive reactions to frustration", Journal of Experimental Psychology, 32, pp. 67-74, 1943.

¹³ T. C. Alper, "Memory for completed and incompleated tasks as a function of personality; correlation between experimental and personality data", Journal of Personality, 17, pp. 104-137, 1948.

a weak ego.

In his studies on repression using the interruption technique, Glixman¹⁴ found evidence to support his first hypothesis, that "as stress increases, the recall of incompleting activities decreases". His second hypothesis, "as stress increases, the recall of completed activities increases," was not substantiated by his findings.

In their study on the conditions of self-defensive forgetting, Sanford and Rissen¹⁵ found evidence to support the following proposition: "Other things being equal, self defensive forgetting is most likely when the need to regain self-respect is maximal and when the possibilities of accomplishing this by constructive striving are minimal".

The results of the studies cited tend to indicate that the palmar perspiration technique of measuring emotional tension is a very useful and workable method of measurement. A general theme or trend is evident in the various studies previously discussed regarding memory for completed and incompleting tasks. This trend indicates that memory or recall is a function of the amount of tension and anxiety created within the subject in particular situations.

¹⁴ A. F. Glixman, "Recall of completed and incompleting activities under varying degrees of stress", Journal of Experimental Psychology, 39, pp. 281-295, 1949.

¹⁵ R. M. Sanford and J. Rissen, "What are the conditions of self-defensive forgetting", Journal of Personality, 17, pp. 244-260, 1948.

CHAPTER III

METHODS AND PROCEDURES

I. SUBJECTS

The subjects for this investigation were a class of forty-one female student nurses. They were all at approximately the same level of training, and taking their introductory course in general psychology. No attempt was made to control age limits or intelligence.

II. MATERIAL AND APPARATUS

Perspiration Index. The method used for obtaining the perspiration index was Gladstone's¹ modification of the Silverman and Powell² technique. The sensitised paper used in the measurement of the palmar perspiration was prepared in the following manner. A five per cent solution of tannic acid was prepared and filtered. It is advisable to use the acid solution within a few days after preparation because it will not remain stable for a long period of time. This acid solution was poured into a glass container larger than the size of the paper to be treated. A high grade paper (Dietagen number 198M) of fairly uniform translucence was immersed in the solution. Several sheets of paper can be treated at the same time if caution is observed so that the solution is evenly distributed over the paper with no dry spots due to paper sticking together or to air bubbles. The paper is permitted to remain in the acid solution for five minutes after the last sheet is added. The papers are then carefully pinned by a corner to some string that has been put up in a fashion similar to a clothesline. Each paper is hung so

¹ Gladstone, op. cit.

² Silverman and Powell, op. cit.

that it avoids contact with other papers while drying. When dry, the papers may be stacked and kept in an envelope until used. The paper may be cut to the desired size (2" X 4") before or after tannic acid treatment.

A salt solution of anhydrous ferric chloride and reagent grade acetone was prepared by mixing thirteen grams of anhydrous ferric chloride with 400 ml of acetone. Three drops of reagent grade hydrochloric acid (H Cl) was added to stabilize the solution. Gladstone substituted chemically pure acetone, which is quick drying, for the slow drying solvent used by Silverman and Powell. Light³ found that by adding three drops of H Cl to the anhydrous ferric chloride in acetone he could stabilize the solution so that it could be used and kept almost indefinitely in a brown, well-stoppered bottle to protect the solution from light and evaporation. This solution is a great improvement over the one used by Silverman and Powell, and it has about the same concentration as the original solution.

Individual wooden scales were made and standardized to a constant weight of 500 grams, which is slightly over the ideal weight of one pound found by Light⁴. Each subject used a scale while palmar perspiration indices of tension and relief were being obtained.

The instrument used to measure the amount of perspiration on the sensitized paper is called a densiometer⁵. It measures the amount of light coming from a constant source that passes through the paper and darkest part of the print, and through a constant-sized opening onto a photoelectric cell. This cell is activated and the current passes through an attached micro-

³ Light, cited by Mowrer et al, op. cit., p. 230.

⁴ Light, ibid. p. 230.

⁵ Gladstone, op. cit.

ammeter, and then deflects the needle giving a reading in microammeter units. Readings are obtained for each of the three fingers and an average reading is calculated for each individual.

Minnesota Multiphasic Personality Inventory. The M.M.P.I.⁶ was administered according to the standardized instructions for administration as listed in the manual. The nine M.M.P.I. scales used were considered in regard to their inferences about normal people, and shall be described from that standpoint.

1. Hypochondriasis scale (Hs). The hypochondriacal individual is the type who develops vague pains and complains of body malfunction in stressful or unpleasant situations. His pain and discomfort is difficult to identify and not usually based on organic causes. He adjusts in the above manner to obtain sympathy from others and to relieve the unpleasant, stressful situation.

2. Depression scale (D). A high D score indicates poor morale of the emotional type characterized by introversion, lack of self-confidence, a tendency to worry, and narrowness of interest in stressful situations.

3. Hysteria scale (Hy). The person who scores high on the hysteria scale is the type that develops actual physical symptoms when confronted with emotional problems. Typical complaints are gastrointestinal, cardiac, writer's cramp, fainting, etc.

4. Psychopathic Deviate scale (Pd). Among normal individuals, a high Pd score indicates a partial absence or disregard of proper attitudes toward social mores. The deviate usually becomes depressed when he dis-

⁶ S. R. Hathaway and J. C. McKinley, The Minnesota Multiphasic Personality Inventory and Manual, (The Psychological Corp.: New York, 1947).

covers he has been guilty of some asocial behavior.

5. Interest scale (Mf). This scale indicates the tendency toward masculinity or femininity of interest pattern. There are separate scales for males and females. A high score in either case indicates a deviation of the basic interest pattern in the direction of the opposite sex.

6. Paranoia scale (Pa). A paranoid individual is characterized by oversensitivity, suspiciousness, and is very easily threatened.

7. Psychasthenia scale (Pt). This scale detects the individual troubled with phobias, obsessions, and compulsions. Usually the psychasthenic individual is in a state of mild depression, chronic excessive worry, lack of self-confidence, and has difficulty concentrating.

8. Schizophrenia scale (Sc). The schizophrenic type of individual tends to be the chronic "daydreamer". When faced with stress or conflict, this individual tends to withdraw, become apathetic, and to deny or escape reality.

9. Hypomania scale (Ma). This type of individual usually gets into trouble for undertaking too many things. He is enthusiastic in stirring up projects and then may lose interest before their completion. At times he may even become depressed, which is an idea contrary to popular opinion. This depression is usually concealed.

Taylor Scale of Manifest Anxiety⁷. Taylor originally constructed the anxiety scale for use in a study of eyelid conditioning. The scale was constructed from approximately two hundred items from the M.M.P.I., which were submitted

⁷ J. Taylor, "A personality scale of manifest anxiety", Journal of Abnormal and Social Psychology, 48, 2, pp. 285-290, 1953.

to five clinicians along with a definition of manifest anxiety that followed Cameron's⁸ description of chronic anxiety reactions. The clinicians were asked to designate the items indicative of manifest anxiety according to the definition. Sixty-five items were selected on the basis of eighty percent agreement, or better. The scale was later modified several times and, at present, consists of fifty of the original sixty-five items.

Memory List. An examination list of twenty terms to be defined was prepared for use as the announced test. This list of terms was constructed so that one-half of the items were difficult to define, and one-half were easy to define. This test was given to the subjects in an effort to ascertain how their recall would be affected by a tension or stress situation.

III PROCEDURE

The procedure was divided into the following four parts: 1. Notify the class of a forthcoming test. 2. Obtain from each subject palmar perspiration index of tension and list of recalled terms from test. 3. Administer M.M.P.I. to all subjects and obtain scores of each. 4. Obtain from each subject palmar perspiration index of relief and a rating of "difficult" or "easy" for each test item.

In part one of the procedure the instructor notified the class of an important examination to be given during the next class period. He advised them to make good use of their time over the week end. They were also admonished that they, as a class, had not done too well on the previous examination, and that the forthcoming examination would count heavily on

⁸ N. Cameron, The Psychology of Behavior Disorders: A Biosocial Interpretation, (New York: Houghton Mifflin Company), 1947.

their semester grade.

In part two, the class instructor made the following announcement: "Today Dr. Sheer is with us to help evaluate your training in psychology. Dr. Sheer and I have prepared a list of terms that you should be able to define. These terms are your examination. I will write the terms on the board and you will be given about five minutes to organize your thought, after which, you will be called upon to rise and define some term, or terms, orally." The necessary materials to obtain the perspiration index had been placed at each student's seat before class. The class was again reminded to organize their thoughts, and told that the examination was to be oral and it would begin in five minutes.

After five minutes, the experimenter obtained a palmar perspiration index of tension for each student, using the colorimetric technique devised by Silverman and Powell⁹, including revisions of Gladstone¹⁰ and Light¹¹. Because this technique is not widely known, the following specific directions are included.

1. Everyone take the little piece of specially treated paper on your chair and write your name across the bottom on the narrow end.
(Illustrate on blackboard.)
2. Now gently blot the finger tips of your right hand on your handkerchief or uniform.
3. Everyone ready? Now carefully remove the cover from the little brown applicator bottle and paint the solution on the middle three

⁹ Silverman and Powell, op. cit.

¹⁰ Gladstone, op. cit.

¹¹ Light, cited by Mowrer et al, op. cit., p. 230.

fingertips of your right hand down to the first joint. Paint the solution on evenly so that the fingertips will be well-coated but not excessively coated.

4. Do not touch anything with the fingertips of your right hand.
Carefully replace cover of applicator bottle with your left hand.
Wave your hand so the solution will dry. (Illustrate.)
5. Now notice a rubber band wound around the shaft of your crude scale.
(Illustrate on blackboard.) In a few minutes when I give you the signal, place the specially treated paper on the platform of the scale with the long side of the paper parallel to the long side of the platform. Now, with your left hand, carefully place the special paper on the platform.
6. Everyone ready? In a few minutes, when I give you the signal, I want you to place the three middle fingers, that you painted with the solution, on the special paper with just enough pressure to push and keep the rubber band, that you looked at a moment ago, down to the block of wood. Don't press harder and don't press lighter. Keep the rubber band just down to the block. Assume a comfortable position, this will last for three minutes. Are your painted fingertips dry? (Wait until all are dry.) Put your three painted fingertips on the special paper. Keep the pressure even or steady for the full three minutes until you are told to remove them. (Time for three minutes.)
7. Time! Remove your fingers from the paper. Be careful not to smudge the prints, or blots, on the special paper.

8. Take a piece of paper and write down as many of the terms, that your instructor wrote on the board, as you can remember. Put your name on your paper. You will be given five minutes for recall.

(Materials were collected.)

In part three of the procedure, the group form of the M.M.P.I. was administered to the subjects according to the standardized method of administration.

In the fourth and last part of the procedure, a palmar perspiration index of relief was obtained using the technique as outlined in part two of the procedure. The terms to be defined in the examination were again presented in the same order and each subject was asked to rate, on paper, each term as to whether she thought the term to be difficult or easy.

CHAPTER IV

RESULTS

In analyzing the results of this study we will consider in turn: (1) differences on the perspiration index during and after stress; (2) differences in recall on non-stressful and stress producing memories; (3) relationship between the perspiration indices and Taylor's Manifest Anxiety Scale; and (4) relationship between the perspiration index and the M.M.P.I. scales.

For our first analysis, Table I shows that the mean of the tension perspiration indices was 4.39, with a standard deviation of 2.29. The mean of the relief perspiration indices was 2.65, with a standard deviation of 2.02. The coefficient of correlation between the tension and relief perspiration indices was .47. The standard error of the difference between correlated means was .352. The critical ratio was then computed to determine if there was a significant difference between the means of the tension and relief perspiration indices. The critical ratio obtained was 4.94, which is significant well beyond the one percent level of confidence.

A chi-square was computed to determine if there was a significant difference between the obtained and expected frequencies of the tension and relief perspiration indices. Table II shows that thirty-four of the subjects had a higher tension perspiration index, and that seven subjects had a higher relief perspiration index. Chi-square was computed taking into consideration Yates'¹ correction for low expected frequencies. The value of the chi-square obtained was 16.48, which is significant well beyond the one percent level

¹ H. Garrett, Statistics in Psychology and Education, (New York: Longmans, Green and Co., Inc.), pp. 258-259, 1953.

TABLE I

MEANS, STANDARD DEVIATIONS, AND CRITICAL RATIO BETWEEN
THE TENSION AND RELIEF
"PERSPIRATION INDICES"

	N	Mean	S.D.	C.R.
Tension	41	4.39	2.296	4.943 *
Relief	41	2.65	2.028	

* Significant beyond the .01 level of confidence

TABLE II
 FREQUENCY AND CHI-SQUARE BETWEEN
 THE TENSION AND RELIEF
 "PERSPIRATION INDICES"

N=11

	Frequency	Chi-square
Tension Higher	34	16.48 *
Relief Higher	7	

* Significant beyond the .01 level of confidence

of confidence and, therefore, would occur less than one percent of the time by chance.

The results of our second analysis are presented in Table III. The means, standard deviations, and a critical ratio were determined for the subject's memory of "easy" or "difficult" terms to define. The subject's concept of "easy" and "difficult" was used in Table III. The mean of the memory for the "easy" group was 6.80, with a standard deviation of 2.23. The mean of the memory for the "difficult" was 3.68, with a standard deviation of 1.81. The standard error of the difference between means was .453. The critical ratio was equal to 6.89, which is significant well beyond the one percent level of confidence.

A chi-square was then computed to determine if there was a significant difference between the expected and obtained frequencies in the recall of "easy" and "difficult" terms. In Table IV you will notice that thirty-eight subjects remembered more "easy" to define terms and that three subjects remembered more terms that were "difficult" to define. Yates' correction was again applied to the calculation of chi-square which was 28.18, significant well beyond the one percent level of confidence.

For our third analysis Table V shows the correlation between the Taylor Scale of Manifest Anxiety² and the palmar perspiration indices of tension and relief. The mean score for the subjects on the Taylor Anxiety Scale was 14.93. The correlation between the Taylor Anxiety Scale and the palmar perspiration index of tension is .39, significant at the .05 confidence level. This is a low but definite relationship. There was a .22 correlation

² Taylor, op. cit.

TABLE III

MEANS, STANDARD DEVIATIONS, AND CRITICAL RATIO BETWEEN
 THE "EASY" AND "DIFFICULT" MEMORIES
 USING SUBJECTS' CONCEPT OF "EASY" AND "DIFFICULT"

Memory List	N	Mean	S.D.	C.R.
Easy	41	6.804	2.23	
Difficult	41	3.683	1.81	6.89 *

* Significant beyond the .01 level of confidence

TABLE IV
FREQUENCY OF INDIVIDUALS (N=11) REMEMBERING
MORE "EASY" OR MORE "DIFFICULT" TERMS
TO BE DEFINED

Term	Frequency	Chi-square
"Easy"	38.0	28.18 *
"Difficult"	3.0	

* Significant beyond .01 level of confidence

between the Taylor Anxiety Scale and palmar perspiration index of relief, which is not statistically reliable.

In our fourth analysis the perspiration indices were related to the M.M.P.I. scales by dividing the subjects into two equal groups on the basis of the perspiration level of the relief indices. The upper group was composed of those subjects who had the highest perspiration indices, and the lower group was composed of those subjects who had the lowest perspiration indices. The results, presented in Table VI, indicated no significant difference between the means of the upper and lower perspiration groups on the M.M.P.I. scales.

TABLE V

TENSION AND RELIEF INDICES OF PALMAR PERSPIRATION
CORRELATED WITH THE
TAYLOR SCALE OF MANIFEST ANXIETY

Tension	$r = .39 *$
Relief	$r = .22$

* Significant at the .05 level of confidence

TABLE VI

RELIEF INDEX DISTRIBUTION DIVIDED INTO UPPER AND LOWER HALF
 SCORES ON M.M.P.I., BASED ON UPPER AND LOWER GROUP
 OF RELIEF INDEX

M.M.P.I. Scale	Mean Upper Group	Mean Lower Group	S.D. Upper Group	S.D. Lower Group	"t" ratio
Hypochondriasis	5.7	6.05	3.52	2.36	.359
Depression	13.67	19.25	4.203	3.534	.46
Hysteria	20.45	21.3	4.31	3.95	.634
Psychopathic Deviate	14.5	15.9	4.91	4.61	.91
Interest	36.85	36.95	3.64	3.80	.0823
Paranoid	9.15	9.95	2.89	2.09	.9780
Psychasthenia	12.05	13.2	7.57	6.51	.515
Schizophrenic	10.45	11.35	6.06	5.59	.467
Hypomania	17.8	17.65	4.925	4.596	.09

CHAPTER V

DISCUSSION

The significant difference between the tension and relief perspiration indices found in this study gives support to the hypothesis that the palmar perspiration technique is a dependable method for obtaining a quantitative measure of tension due to stress. Thirty-four of the forty-one subjects showed a higher perspiration index after exposure to the experimentally induced tension situation. Only seven subjects showed a higher relief index. Upon inspection of individual records, there was some evidence that several of the seven subjects did not apply an adequate amount of the anhydrous ferric chloride salt solution to their finger tips prior to the tension measurement. This possible error could have biased the perspiration indices in an unfavorable direction.

In Castle's study all but four of the thirty subjects showed an increase in perspiration level during and after tension or stress situation. All four of these subjects had anxiety scores below the mean, and three had very low scores on the M.M.P.I. scales. Thus these two studies, one with individual measures and the present study with group measures, indicate that the perspiration index is a dependable indicator of stress.

The palmar perspiration technique of obtaining a quantitative measure of emotional tension, like other psychological instruments, has several possible sources of error. Gladstone listed four logical sources of error. They are: "(1) smudging of the print by the subject may affect the final measure; (2) the amount of tannic acid varies from place to place on the

paper; (3) the light bulb may vary in efficiency during the period of measurement; (4) too much solution on the fingers may affect the results." Other possible sources of error could be (1) in photoelectric cell efficiency; (2) too little solution on the finger tips; (3) uneven translucency of the paper before and after treatment with the tannic acid solution; (4) fluctuation of electric current while obtaining densiometer readings of perspiration indices; (5) error in judgment of microammeter deflection. Even with all these sources of error, this technique appears to be a reliable method of obtaining a quantitative measure of emotional tension.

The subjects in this study rated most of the terms "easy", rather than "difficult", to define. Thirty-eight subjects remembered more terms that were "easy", and three remembered more that were "difficult", by their own judgment. The recall of "easy", rather than "difficult", terms suggests the operation of defensive forgetting. The tension indices indicate that the subjects were threatened by the examination.

In this study the tension perspiration indices correlated .39 with the Taylor Anxiety Scale. The relief perspiration indices correlated .22 with the same scale. This indicates a low correlation, a small but definite relationship between the perspiration index and the scale of manifest anxiety. Castle found a correlation of .24 before stress, .49 during stress, and .56 after stress, between the Taylor scale and the perspiration indices. There appears to be some relationship between the perspiration index and manifest anxiety as measured by the Taylor Scale.

Contrary to the results reported by Castle, there were no reliable

differences between the low and high "perspiration index" groups on the M.M.P.I. scales, although most of the differences were in the predicted direction. These conflicting results may be due to our group measurements, as compared with Castle's individual measurements, and also to the greater homogeneity of our group.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The present study was concerned with changes in the palmar perspiration level due to a stress-producing situation. The relationship of this measure to manifest anxiety and the personality scales on the M.M.P.I. was also investigated, as well as the effect of tension on ability to recall non-stressful and stress-producing memories.

The subjects used in the study were a class of forty-one female student nurses at the same level of training. These subjects were given an oral examination in which they were asked to define twenty terms, ten easy and ten difficult. During the examination a palmar perspiration index was obtained from each subject. At the next class period, the Minnesota Multiphasic Personality Inventory was administered, from which the Taylor Manifest Anxiety Scale could also be scored. The baseline or relief perspiration index, along with the students' rating of "difficult" or "easy" for each term, was also taken at this time.

A colorimetric technique was used in recording the perspiration indices, and average readings were then determined with a densiometer.

The following results were obtained:

1. A significant difference between the tension and relief perspiration indices. The critical ratio of 4.94 was reliable beyond the .01 level of confidence. Thirty-four of the forty-one subjects had a higher tension index.
2. A significant difference between the recall of "easy" and "difficult"

terms. The critical ratio of 6.89 was reliable beyond the .01 level of confidence. Thirty-eight of the forty-one subjects remembered more "easy" terms than "difficult" ones.

3. The Taylor Scale of Manifest Anxiety correlated .39 with tension indices and .22 with relief indices.
4. There were no reliable differences between a high "perspiration index" group and a low "perspiration index" group on the M.M.P.I. scales.

From the results of this and previous studies, the perspiration index would appear to be a reliable measure of tension as produced by stressful situations. It also appears to have some relationship to manifest anxiety as measured by the Taylor Scale on the M.M.P.I.

The stress situation in the present study produced significantly greater recall on "easy" terms as compared with "difficult" ones, which is further evidence for a concept of defensive forgetting.

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