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IN DEFENSE OF THE ELECTRODERMAL RESPONSE AND CARDIAC AMPLITUDE AS MEASURES OF DECEPTION.

Reginald D. Mac Nitt†

No attempt will be made in this article to review the research already carried out in the field of "truth testing." The readers should be very familiar with this background, since many articles have already appeared in this and other journals setting forth such research. We have profited greatly from the scientific work of Jung, Darrow, Keeler, Inbau, Summers, Marston, Larson, and many others.

Since blood pressure changes have been investigated more frequently than most other measures, we carefully reviewed the research in this field. Here we found that some authorities are not as optimistic as many psychologists concerning the relationship of blood pressure changes to deception. Among these we found the following statement, by Sherman:

"Blood pressure changes are due to many factors, such as blood volume, arterial resistance, and variation in vascular elasticity. Although sympathetic nervous system stimulation is an important factor in changing arterial resistance and heart rate, the variations in the susceptibility of individuals to stimulation is an important factor which must be taken into account in evaluating blood pressure changes as a criterion of emotionality. The vascular system is extremely adaptable, and in many cases in which strong emotions are present relatively little blood pressure change may take place."¹

On this same subject, Lund states:

"As a means of forcing confession, it (blood pressure) might, indeed, prove very effective. Its use in any other way would, of course, be quite indefensible, since, the presence of given bodily changes, while indicative of some emotion or excitement, can tell us nothing about its cause."²

While it is true that theoretical discussions concerning the dangers of using blood pressure changes as measures of deception do not agree with the laboratory experience of many researchers in this field, the accumulative evidence produced by other laboratory technicians seems to indicate that these theoretical discussions must be heeded.

Our review of the research carried on by Marston led us to doubt the validity of his basic theory of lie detecting.

"One theory is to put the person being tested in a corner, make lying so hard for him that he will stumble mentally and feel trapped A person who tried to lie but knew he was not getting away with it would feel far more fear

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¹ Sherman, Mandel, *Basic Problems of Behavior* (1941) 51-52.

² Lund, Frederick H., *Emotions* (1939) 112.

than a liar who was confident of success. . . . The second theory is precisely the opposite. . . . Instead of testing for emotions of defeat, we proposed to test for emotions which make lying successful."³

Apparently, Marston fails to realize that all unpleasant emotions such as fear, pain, anger, and so forth are associated with sympathetic nervous activity such as an increase in blood pressure and pulse rate. We must constantly keep in mind the antagonistic effects of the main divisions of the autonomic nervous system. A liar confident of success would experience a pleasant emotional state, and this would involve changes of the cranial autonomic rather than the sympathetic autonomic. "The general effect of innervation over the four pairs of cranial nerves is to slow the heart, constrict the pupil, increase the flow of salivary and digestive fluids and increase the action of the stomach and intestines."⁴ We call attention to our reasons for doubting Marston's theory of lie detection primarily because he uses it to support blood pressure changes as a measure of deception and to discredit the use of the electrodermal response as a reliable and valid measure. It is our studied opinion that the physiology of the nervous system does not support either his theory of successful deception or his criticism of the electrodermal response. We also regret that Marston should come to the conclusion "that there is only one recognized or reliable deception test."⁵

We agree with other authorities that blood pressure changes may be a valid measure in approximately 75% of the cases examined. Since it is generally agreed that blood pressure changes are regulated primarily by the strength of the heart beat, we developed a circuit which records cardiac rate and amplitude directly through the use of an electrical stethoscope. Some of the physiological conditions reducing the accuracy of blood pressure changes as a measure of deception are thereby eliminated, and serious organic heart conditions are the only sources of error. This last statement has been verified by several physicians who have observed the operation of our instrument. They all agree that errors due to arterial resistance, vascular elasticity, blood volume, and so forth are eliminated. This is especially true when these conditions are caused by organic diseases. These same physicians, observing the operation of the "electric eye" of our electrical stethoscope, agree that all serious organic and functional diseases of the heart can be detected at once. This is in sharp contrast to the elaborate and extensive examinations that would have to be given by a physician to isolate the organic conditions which might cause inaccuracies in blood pressure changes when used as a measure of deception.

³ Marston, William Moulton, *The Lie Detector Test* (1938) 34.

⁴ *Op. cit. supra* note 2 at p. 40.

⁵ *Op. cit. supra* note 3 at p. 51.

A careful review of the electrodermal response research plus our own experience in this field, led us to believe that the principal sources of error in this measure could be eliminated or controlled far more readily than those concerned with blood pressure changes and respiration. We also came to the very obvious conclusion that the electrodermal responses could be subjected to statistical treatment far more accurately than any other of the commonly used measures.

It might be stated at this point that we never seriously considered respiration as a measure of deception. Successful measures of deception must be concerned with involuntary responses. We fully realize that the lines of demarcation among involuntary, semi-voluntary, and voluntary responses are not clearly defined. It is a fact that a few individuals can control blood pressure, cardiac rate and amplitude, and electrodermal responses. However, the number of persons who can successfully control respiration is far greater than it is for the commonly classified involuntary responses. We have had only two persons who successfully controlled the electrodermal response for a limited time and none who were able to control cardiac amplitude. Summers has stated: "In this country the respiratory technique has not been seriously considered in any jurisdiction."⁶ Other experts in the field have made similar statements. Our decision on this matter is not meant to discount in any way the laboratory experiences of others who have found respiration recordings *useful* criteria for determining deception.

While it is unfortunately true that the exact nature of the electrodermal response is not known, we firmly believe that the action of the sweat glands has less influence upon the response than was formerly believed. This is especially true if the electrodes are placed on other areas than the palmar surfaces. The success record of our *Psychointegroammeter* has been in no small measure due to the fact that our electrodes are applied to both wrists and not the palm or back of the hand.

"Secretions of the skin arise from the sweat glands and the sebaceous glands. The former are found in large numbers on the palms of the hands, the soles of the feet, and in the axilla. . . . The sebaceous glands are distributed over the entire cutaneous surface."⁷ On the palmar surfaces, resistance is reduced by anxiety, mental stress and anticipation of what is to come. Since these emotions are not always directly related to the revealing of deception, and since the sweat glands are known to be particularly active on these surfaces, errors may arise. We believe that on the wrists and other surfaces, reduction of resistance "is most noticeable dur-

⁶ Summers, Rev. Walter G., "Science Can Get the Confession," *Fordham Law Review*, 334 (November, 1939).

⁷ *Op. cit. supra* note 2 at p. 181.

ing periods of increased metabolism and increased heat production indicating that the secretory changes on these surfaces are thermo-regulatory in function."⁸ The pilomotor fibers of the skin are also known to contract under strong emotion creating pressure upon the sebaceous glands.

Lund further states that

"the parallelism which exists between local skin temperature and galvanic reactivity has been the object of some interest. It has led certain investigators to believe that the vasomotor changes upon which skin temperature depends, may have something to do with the galvanic response. . . . Wiersma and Wells . . . found the response more definitely linked with vasoconstriction."⁹

We know that vasoconstrictor fibers are distributed mainly to the skin and to organs of the abdominal and pelvic regions. We also know that vasoconstrictor fibers are of sympathetic origin. Referring again to our measure of cardiac rate and amplitude, we know that changes in rate and amplitude of the heart are produced by the outflow over vagus and sympathetic nerves. We have reason to believe that the motor fibers of the vagus nerve decrease the action of the heart while those of the sympathetic system increase the heart action. Finally, we know that the acceleration fibers of the sympathetic system issue from the spinal cord. We therefore come to the conclusion that our two measures of cardiac rate and amplitude and electrodermal response are correlated to a high degree.

Trovillo, in his article "A History of Lie Detection,"¹⁰ seems to feel that embarrassing situations may arise through the use of the electrodermal response in criminal detection due to old complexes concerning other crimes. If this is true for the electrodermal response, it is equally true for blood pressure changes or cardiac rate and amplitude. Such a criticism cannot be leveled at the electrodermal response alone. An understanding of the physiological and psychological factors involved will not permit isolation of the electrodermal response for such criticism.¹¹ Marston, over and over again, makes the same vital error only to contradict himself on another page of his own book or articles.

However, the point raised by Trovillo is one that must be taken into consideration. We recently had a case that illustrates this point. A radio and electric refrigerator service man was suspected of making service charges on refrigerators and radios still covered by guarantee. The employer had some evidence that he was charging the customer and turning in a "no charge" sales slip. He was also suspected of stealing radio parts for his own use. While test-

⁸ *Op. cit. supra* note 2 at p. 207.

⁹ *Op. cit. supra* note 2 at p. 188.

¹⁰ Trovillo, Paul V., "A History of Lie Detection," *J. Crim. Law & Criminol. (Police Sci. Sec.)* 29 (6): 107 (May-June, 1939).

¹¹ At least, with our circuit, we have not found this true for the electrodermal response alone.

ing to determine the amount of money and goods stolen, we obtained significant heart and electrodermal reactions whenever the sum of \$5,000 was mentioned. While the total amount stolen over a three and one-half year period of employment with this concern could have been \$5,000, the isolated nature of the responses indicated clearly that this was not the amount. Our carefully worded questions and checks indicated that the total amount stolen was between \$1750 and \$2000. We easily discovered later that the response to the sum \$5,000 referred to a home situation. This man's mother had recently been ill, and his father at that time transferred some property valued at \$5,000. We have found that stealing from other places than the one in question, mentioned by Trovillo, is easily handled by repeating the name of the place in question each time a question is asked, thus keeping the mind of the suspect on the present crime.

The various criticisms and failures of some workers with the electrodermal response raises another vital point. The success of any technique of lie detection depends upon three factors. First, one must have an instrument accurately measuring two or more involuntary or semi-voluntary responses commonly associated with deception. These may include blood pressure changes, respiration, electrodermal response, cardiac rate and amplitude, and others. Second, the operator must not only be skilled in the actual operation of the instrument and control of environmental conditions necessary for the test, but must have a workable knowledge of psychology and physiology in order that he may adequately interpret the results after they are recorded by the instrument. Third, an expert interrogator must take charge of all questioning before, during, and after the test has been given. It is our opinion that this third factor has been neglected more than the others. Many a test has failed primarily because all the necessary details of the case were not obtained and the questions not carefully worked out before the test was given.

At this point, we should like to check our findings with those of the Chicago Police Scientific Crime Detection Laboratory concerning the electrodermal response. Trovillo¹² reports several different patterns of response. We have found "relatively larger magnitude of response during deception than on non-significant questions" or significant questions answered truthfully. We have found "greater area of response in deception than on non-significant questions" or significant questions answered truthfully. Our research supports the third pattern mentioned by Trovillo—"a gradual ascending electrodermal response, as an accompaniment of prolonged nervous excitation (in contrast to a gradually descending response accompanying relief of tension)." We have found that it is not difficult

¹² *Op. cit. supra* note 10 at pp. 110-111.

to adjust our instrument to these ascending and descending responses.

Trovillo¹³ also quotes Benswanger to the effect that certain patterns in the electrodermal curves can be identified as typical of the individual. Phlegmatic subjects are supposed to produce different curves than hysterically disposed persons. While we have not worked with abnormal subjects, we do know that, in normal subjects, different curves are found in the same individual at different times. A subject's curve at one testing may show sudden ascent and rapid descents while at another time the same subject may produce a curve without these complex waves. It is our opinion that it would be dangerous to generalize concerning the identification of curves as typical of certain individuals.

In 194 experimental cases, 17 laboratory tests of imaginary crimes, and 59 actual embezzlement cases in the State of Ohio, the electrodermal response has provided interpretations 99% accurate. The only inaccuracy of the electrodermal response has come through the much used card demonstration of lying, commonly used by Keeler and others. On 36 card tests, our results were only 75% accurate.

The special investigator working with the writer provided several types of situations:

1. We tested employees whose honesty and integrity were above reproach.
2. We tested employees who had already confessed to stealing goods and money, but who were told to lie about their stealing.
3. We tested employees about whom much evidence was already in the possession of the authorities.
4. We tested employees about whom little or nothing was known as to their possible dishonesty.

In many of these cases, the operator (writer) was not told any of the vital details of the case by the special investigator. The operator in some cases did not even know where they were employed, how long they had been employed, sources of stealing, whether or not they had already confessed, or whether or not they were innocent of any crime. The honest employees were easily picked out, the confessed embezzlers were quickly identified, and in all cases of embezzlement, the approximate amount stolen, year stealing started, stealing while employed by others, and other pertinent information was correctly reported by the operator and checked by confessions or the verifiable records of the employees—the operator's report failing only on a few minor details. In all of these 59 cases, the electrodermal response was the more accurate of the two employed.

A few actual case histories will indicate the type of case most frequently handled recently.¹⁴

¹³ *Op. cit. supra* note 10 at p. 107.

¹⁴ All of these cases and many others will be verified by the Ohio Merchants' Audit Bureau of Columbus, Ohio, who provided the subjects for this research.

Case No. 6078 Tested February 19, 1942 at Findlay, Ohio:

This lady's confession before taking the *Psychointegroammeter* "truth test" was for \$4.00. After taking the test, she was definitely convinced that she stole from her sales from 10c to \$1.00 at a time. During a period of 2 years and 11 months, she stole at least \$918. She signed a confession for this amount.

Case No. 6079 Tested February 19, 1942 at Findlay, Ohio:

This man said that he had occasionally taken money from the cash drawer to buy cigarettes, but had later put it back. The *Psychointegroammeter* "truth test" indicated quite a different story—that he had been stealing by ringing his sales short an average of \$2.00 a day for more than three years, and that the total amount stolen was between \$1500 and \$2000. When he confessed, his own figures were that he stole at least \$1718.

Case No. 6038 Tested October 17, 1941 at Defiance, Ohio:

This man, claiming to be a sanctified Christian, when first confronted about his stealing, threatened violence. He finally agreed to take a *Psychointegroammeter* "truth test," hoping to lie his way out. When the results were shown to him, he admitted he had been stealing for about 4 years and during that time, just working as an extra employee, had stolen at least \$1000 for which amount he signed a confession.

Case No. 6068 Tested February 13, 1942 at Bellefontaine, Ohio:

This man, 62 years old, working for the same store about 22 years, when first confronted about ringing his sales short, admitted ringing from 5c to 10c short on a sale, but insisted that the total amount was not over \$5.00. He later stated that he stole this money to buy tools with which to work. The *Psychointegroammeter* "truth test" indicated that he stole during the years he had been employed at this store at least \$15,000. After being confronted several times with the results of the "truth test", he and his wife both signed a confession that it was undoubtedly true that that much money had been taken from his employer, and that they had no written record to disprove our facts. He, knowing that he had been spending considerable money for liquor, and she, knowing that she had been a very extravagant wife, both agreed that the "truth test" was undoubtedly correct. Figure 1 shows a part of the record responsible for breaking down this embezzler.

THE PSYCHOINTEGROAMMETER

The part of this instrument measuring electrodermal response is an ultra-sensitive vacuum-tube ohmmeter. A steady current is supplied to two electrodes, constructed of copper screening about 2 x 3 inches in size especially formed to fit the wrists and applied with elastic bands under air pressure to the wrists of the subject. Any change in body resistance or nerve potential alters the voltage drop between these electrodes. This slight change in voltage is amplified many times and recorded on a graph. At the same time, an electrical stethoscope is placed over the heart, and cardiac rate and amplitude are picked up, amplified hundreds of times, and recorded.

This instrument was designed and assembled by Louis Kelsey.¹⁵ The graphs are recorded on a modified Esterline-Angus Model A W Ammeter, a circuit which in our opinion is easier to adjust than the old Wheatstone Bridge. The scale for the electrodermal re-

¹⁵ Mr. Kelsey is now electrical design engineer with the R.C.A. Manufacturing Co., Indianapolis, Ind.

Figure 1

Part of a 25 foot record which resulted in a confession of thefts of goods and money totaling \$15,000 and extending over a period of 22 years. The cardiac rate and amplitude record is on the right of the chart; the electrodermal response in the main portion. Questions 119 to 125 were answered truthfully, and all other questions represent lies. Notice the increase in cardiac amplitude when lies are told.

Figure 2

THE PSYCHOINTEGROAMMETER

sponse is 0 to 5 milliamperes. The three chronograph pens record reaction time, electrodermal response, and cardiac rate and amplitude.

TEST PROCEDURE

Two types of questions are carefully prepared before the test is given. Such non-critical questions as "Are you married?", "Is it raining outside?", "Are you standing on your head?", "Is today Thursday?" are used to secure the individual standard for comparison with critical questions. Whenever possible, the critical questions concern as many different phases of the crime as possible so that the interpretation may be based on patterns of deception or non-deception. If a person is suspected of stealing goods and money from his place of employment, questions can be prepared concerning the average amount stolen each day or week, the total amount of goods stolen, the total amount of money stolen, and the total amount of goods and money stolen. The year stealing started is then established. These results should be consistent thruout. For example, in case No. 6068, the recordings indicated that this man had stolen about \$8,000 in cash over the counter, \$5,000 in goods for his own use at home, and \$2,000 on deliveries. When we ask questions concerning the total amount of goods and money stolen, our records indicated a sum of \$15,000. Thus our pattern of deception was consistent throughout.

We also employ the principle of repetition. In a recent case, we repeated the same question ten times in the course of the test. Nine out of ten of the responses indicated that he was lying. The critical and non-critical questions are prepared in cycles of 40 to 50 questions each. In most cases we use from 2 to 4 cycles or 80 to 200 questions with at least three responses for each question. It generally requires about 45 minutes for a cycle. We then have a rest period of ten to fifteen minutes before starting the next cycle of questions. The time interval between questions varies according to the response to the question. We wait until the needle of the ammeter has returned to a point between 0 and 1.

Figure 3 illustrates the high correlation which most generally exists between the electrodermal response and cardiac amplitude. The standard set for this individual was 33. The average emotion on non-critical questions in this case was 22. We always allow a margin of 50%. Tentatively, we may assume that any reaction over 33, accompanied by an increase in cardiac amplitude, indicates deception. If the reaction is below the standard, we assume that the subject is telling the truth. However, responses above or below the standard and increased or decreased heart action do not always differentiate between truth telling and lying. This is the reason for the repetition of questions and the approach of the case from

*Figure 3*RELATIONSHIP BETWEEN
ELECTRODERMAL RESPONSE
AND CARDIAC AMPLITUDE

This is part of a three cycle record of 150 questions. Questions 33 and 34 are non-critical questions. Questions 35-42 are worded as follows: "Did you steal as much as \$... from the 'X' store?" and each was answered "No." Notice the great increase in cardiac rate and amplitude on questions 37, 38, and 39. The amounts involved for each question are:

35	\$200
36	\$250
37	\$300
38	\$350
39	\$400
40	\$450
41	\$500
42	\$750

different angles. If two-thirds or more of the responses are below the standard and no increased action of the heart is recorded, we have a truthful record. Our many experimental cases have shown this to be true. On the other hand, if two-thirds or more of the responses are above the standard and increased cardiac amplitude is recorded, then we are relatively certain that we are recording deception. The high percentage of confessions we have obtained on embezzlement cases indicates that such interpretations are justified. Such interpretations have also been consistent with the actual facts in the case.

In conclusion, our research seems to indicate that the electrodermal response and cardiac rate and amplitude are reliable and valid measures of deception if the proper technique is used. Of course our criminal investigations have been mostly concerned with embezzlement of goods and money. For this reason, we make no claim as to what the instrument would bring forth if used with individuals committing more serious crimes than embezzlement. Perhaps some ex-convicts, murderers, and those of low intelligence would not respond to our technique, but this fact should not lessen the importance of its more extensive use in the business world.

We firmly believe that the electrodermal response and cardiac amplitude as measures of deception will find their place in actual criminal investigations—not as inferior measures, but equal to or better than other measures now commonly used.