THE USE OF SKIN RESISTANCE AS A MEASURE OF COGNITIVE DISSONANCE

by

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CHAPTER I

INTRODUCTION

Two lines of research inspired this paper. One line involves over 80 years of research and verification; the other has less than 20 years of testing amid controversy. Skin resistance has been used since 1890 as an effective indicator of autonomic arousal, anxiety, and stress.[1,2] Cognitive dissonance has been tested and attacked since it was introduced in 1957 by Leon Festinger.[3,4,5] The major problem with cognitive dissonance has been the inability of most researchers to use an independent variable representative of dissonance.[6] Cronkhite complained of this very problem in his doctoral dissertation. Nonetheless, his use of heart rate change provided a foundation for the use of other psychophysiological variables.[7] Skin resistance seemed like the next most reasonable choice after reviewing the previous research.

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[1] Stephen Rothman, Physiology and Biochemistry of the Skin, (Chicago: Univ. of Chicago Press, 1954), pp. 17-20.

[2] A. J. Silverman, S. I. Cohen, B. M. Shmavonian, "Investigations of Psychophysiologic Relationships with Skin Resistance Measures," Journal of Psychosomatic Research, 4 (1959), pp. 65-87.

[3] Leon Festinger, A Theory of Cognitive Dissonance, (Stanford: Stanford University Press, 1957).

[4] N. P. Chapanis and A. Chapanis, "Cognitive Dissonance: Five Years Later," Psychological Bulletin, 61 (1964), pp. 1-22.

[5] Gary Cronkhite, Persuasion: Speech and Behavioral Change, (Indianapolis: Bobbs-Merrill Co., Inc., 1969), pp. 56-60.

[6] C. H. Zastrow, "The Theory of Cognitive Dissonance," Psychological Record, 19 (1969), pp. 391-399.

[7] Heart rate did not significantly correlate with the experimentally induced dissonance. Gary Cronkhite, "Autonomic Correlates of Attitude Change," (Ph.D. dissertation, State University of Iowa, 1965).

There is much propensity to link skin resistance with cognitive dissonance. Festinger, in his book on cognitive, lists some attributes of cognitive dissonance, For example, he says, "The existence of dissonance is psychologically uncomfortable."[8] He continues by saying, "The presence of dissonance gives rise to pressures to reduce or change the dissonance...(and) dissonance acts in the same way as... tension."[9] Skin resistance is, by previous literature, also related to stimuli that are "psychologically uncomfortable" and resultive of tension. Already, skin resistance correlates with measures of fear,[10] anxiety,[11] prejudice,[12] stress,[13] and disturbing or contradictory information.[14] In the preceding research, no overt mention is made of cognitive dissonance, but common ground can still be found in the commonality of stimuli in dissonance and skin resistance studies. Two such stimuli that come to mind are anxiety as measured by the Taylor

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[8]Festinger, A Theory of Cognitive Dissonance, p.3.

[9]Ibid., p.3.

[10]James H. Geer, "Fear and Autonomic Arousal," Journal of Psychosomatic Research, 7 (1964), pp. 283-294.

[11]Lorna Wing, "Physiological Effects of Performing a Difficult Task in Patients with Anxiety States," Journal of Psychosomatic Research, 7 (1964), pp. 283-294.

[12]J. B. Cooper and H. E. Siegel, "The Galvanic Skin Response as a Measure of Emotion in Prejudice," Journal of Psychology, 42 (1956), pp. 149-155.

[13]J. C. Speisman, J. Osborn, and R. S. Lazarus, "Cluster Analyses of Skin Resistance and Heart Rate at Rest and Under Stress," Psychosomatic Medicine, 23 (1961), pp. 323-343.

[14]F. R. Westie and M. L. DeFleur, "Autonomic Responses and Their Relationship to Racial Attitudes," Journal of Abnormal and Social Psychology, 58 (1959), pp. 340-347.

Manifest Anxiety Scale and the use of affectively loaded words.[15,16] Further, circumstantial proof of a link between skin resistance and dissonance can be found in a number of studies that assumed that such a link exists.[17,18,19] Proof of this connection can wait till Chapter II but, the small matter of definitions should be dealt with first.

Some of the more frequently used terms are listed below. The main determiner for their inclusion is their use in the studies used in Chapter II. These will also be the definitions used in this paper.

> Galvanic Skin Response - The frequency and/or the amplitude of the deflection of the needle on the ammeter when measuring the electrical flow through the skin. This includes both conductance and resistance measures.[20]
>
> Skin Resistance Measures - Direct or representative measurement of the resistance that the skin provides to the electrical flow.

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[15] Taylor Manifest Anxiety Scales were used in R. N. Suinn's "Anxiety and Cognitive Dissonance" (Journal of General Psychology, 73 (1965), pp. 113-116) and E. S. Katkin's "Relationship between Manifest Anxiety and 2 Indices of Autonomic Response to Stress," (Journal of Personal and Social Psychology, 66 (1963), pp. 30-36). Both showed significant correlation between GSR and dissonance.

[16] Affectively loaded words were used in H. W. Dickson and E. McGinnies' "Affectivity in the Arousal of Attitudes as Measured by the Galvanic Skin Response" (American Journal of Psychology, 79 (1966), pp. 584-589) and N. T. Feather's "Cognitive Dissonance, Sensitivity, and Evaluation" (Journal of Abnormal and Social Psychology, 66 (1963), pp. 157-163). Both showed significant correlation between GSR and dissonance.

[17] D. E. Berlyne, Conflict, Arousal, and Curiousity, (New York: McGraw-Hill Book Co., Inc., 1960), pp. 283, 295-303.

[18] R. G. Gallimore, "Reduction Styles and Dissonance-Associated Autonomic Activity" (Ph.D. dissertation, Northwestern University, 1964).

[19] J. L. Dawson, R. E. Whitney, and T. R. Lau, "Attitude Conflict, GSR, and Traditional-Modern Attitude Change Among Hong Kong Chineses," Journal of Social Psychology, 88 (1972), pp. 163-176.

[20] A very common definition that has been accepted since the phenomena was discovered around the turn of the century.

Skin Conductance Measures - Direct or representative measurement of the ability of the skin to allow electrical flow. This can be arrived at by direct measurement or by converting skin resistance to its inverse by use of Ohm's Law.[21]

Ohm's Law - An electrical relationship expressed by the formula $E=I/R$ where E is voltage, I is current, and R is resistance. Briefly, if E is kept constant, then I is the inverse of R.

Cognitive Dissonance - For this study, dissonance is the difference in the scores on the attitude test given before and after the experimental stimuli. This follows previous patterns of "measuring" dissonance. In this case, pre- and post-testing hypothetically measures dissonance since the only difference will be the experimentally manipulated contradictory information provided the subjects.[22,23]

One final concern should be reviewed before concluding this introduction: the statement of hypothesis and variables. The research hypothesis is that cognitive dissonance, as defined by Festinger, produces physiological change, as measured by the galvanic skin response. The dependent variable is the GSR; the independent variable is presence (or absence) of the experimental dissonance. The null hypothesis to be tested is that there will be no GSR when the dissonance is present.

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[21] Chester Darrow, "The Significance of Skin Resistance in the Light of its Relation to the Amount of Perspiration," Journal of General Psychology, 11 (1934), pp. 451-452.

[22] Pre- and post-testing of attitudes is a common method of checking attitude change due to supposed dissonance. Suinn ("Anxiety and Cognitive Dissonance," Journal of General Psychology, 73 (1965), p. 114) and Feather ("Cognitive Dissonance, Sensitivity, and Evaluation," Journal of Abnormal and Social Psychology, 66 (1963), p.158) used this method. Of course, Festinger used this method also (p.124).

[23] Festinger's statement of dissonance is, "...(T)wo elements are in a dissonant relation if, considering these two alone, the obverse of one element would follow from the other" (p.13).

CHAPTER II

PRIOR RESEARCH

Electrodermal Research

Electrodermal research is, generally, divided into skin potential (abbreviated as S.P.) and skin response (abbreviated as S.R.) measures of electrical flow. For this paper, we will only be concerned with skin response measures. This limitation is not an arbitrary one. A review of the literature demonstrates two characteristics concerning skin potential: S.P. requires more sensitive equipment than S.R.; and S.P. correlates with S.R.[1,2] So, in the face of S.P.'s difficulty of measurement and S.P.'s redundancy with S.R., a review of prior S.P. research is excluded from this paper. What will concern us are the two principal skin response measures: skin resistance response and skin conductance response (abbreviated respectively S.R.R. and S.C.R.). In discussing the background research of S.R., the following format will be used:

1) Physiological definition;

2) Psychological explanation;

3) Factors affecting measurement;

4) Factors related to S.R.

Speculation on the mechanisms of skin response has a long history.

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[1]Skin potential is an endodermal measure of natural body electricity while skin response is an exodermal measure of artificially supplied electricity through the skin. S.P. is generally 10^{-3} less in strength.

[2]R. C. Wilcott, "Correlation of Skin Resistance and Potential," Journal of Comparative and Physiological Psychology, 51 (1958), pp. 691-696.

From 1888, the year that it was discovered, S.R. has had several theories offered as possible explanations for the phenomena.[3] From the 1930's on, the most accepted view has centered on the eccrine sweat glands and the layers of skin as the main mechanisms. Several studies have connected these mechanisms to S.R.

The hypothetical construct of sweat glands and skin layers has been formulated by several authors.[4] Basically, the skin has been viewed by researchers as having two layers: (1) a top, highly absorptive and conductive layer; and (2) a highly resistive barrier to water and chemical ions, with a piercing of both layers by the sweat glands. From a logical standpoint, this can be viewed as a structure designed to meet the thermoregulatory and chemical needs of the body. The barrier limits the loss of water and necessary chemical ions. The sweat glands allow a pathway for the dispersal of water and chemical ions. The outer layer absorbs and spreads the water and chemical ions for more efficient elimination and cooling.

There are two main groups of studies that prove the existence of an analogue of this construct. The first group correlates sweat gland activity with S.R. This relation was suggested by the observation that S.C.R. frequently was greatest where sweat glands were the densest - i.e. the palms of the hands.[5] More direct proof was provided by direct control of the sweat glands. In one study, loss of nervous control of

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[3] R. A. McCleary, "The Nature of the Galvanic Skin Response," Psychological Bulletin, 47 (1950), pp. 99-104.

[4] R. Edelberg, "Electrical Activity of the Skin," Handbook of Psychophysiology, eds. N. S. Greenfield and R. A. Sternbach, (New York: Holt, Rinehart, and Winston, Inc., 1972), pp. 384-392.

[5] I. Martin and P. H. Venables, "Mechanisms of Palmar Skin Resistance and Skin Potential," Psychological Bulletin, 66 (1966), pp. 481-484.

sweat glands was studied in hospital patients with peripheral nerve sections or sympathetic ganglionectomy. These operations eliminated S.R. completely.[6] Similarly, patients suffering from congenital absence of sweat glands showed no S.R. (or S.P.).[7] A further study used normal subjects. These subjects were given an application of atropine, a chemical blocking agent that inhibited excitation of the sweat glands. This chemical application eliminated S.R.[8] This line of research provided proof that sweat gland activity was related to electrical flow in the skin. The view of the sweat glands as electrical pathways is related to the next group of studies.

The proof of an analogue of the barrier is harder to gain from the previous research. The proof of its existence is without doubt. Its exact location, though, is without solid data. Three studies are indicative of the existence of this barrier. The first and the oldest study examined S.R.R. before and after pinpricks to the skin under the electrode. After the injury, S.R.R. decreased.[9] (Comparably, a skin physiology textbook warned the fledgling researcher of possible error in measurement if the slightest cut existed in the skin around the electrode.[10]

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[6] C. P. Richter and B. G. Woodruff, "Changes Produced by Sympathectomy in the Electrical Resistance of the Skin," Surgery, 10 (1941), pp. 957-970.

[7] H. N. Wagner, "Electrical Skin Resistance Studies in Two Persons with Congenital Absence of Sweat Glands," Archives of Dermatology and Syphilology, 65 (1952), pp. 543-548.

[8] M. H. Lader and J. D. Montagu, "The Psycho-galvanic Reflex: A Pharmacological Study of the Peripheral Mechanisms," Journal of Neurology, Neurosurgery, and Psychiatry, 25 (1962), pp. 126-133.

[9] C. P. Richter, "Physiological Factors Involved in the Electrical Resistance of the Skin," American Journal of Physiology, 88 (1929), pp. 596-615.

[10] S. Rothman, Physiology and Biochemistry of the Skin, (Chicago: University of Chicago Press, 1954), pp. 16-17 and pp. 21-22.

In the second experiment, researchers stripped away thin layers of skin in successive steps. In between each step, the researchers measured the rate of water loss through the skin. Generally, the rate remained constant till the tenth layer. This placed a water barrier at the botton of the stratum corneum.[11,12] The third experiment examined the ion barrier characteristics of the skin. One experimenter hypothesized that the corneum would absorb a photographic solute down to the barrier, but not below the barrier. An application of silver nitrate was used on the skin. The skin was exposed to the solute for thirty minutes, exposed to light, and reduced by a photographic developing solution. Histological examination showed the corneum to be permeated with the reduced silver. The lower boundary of this darkened area was just above the stratum granulosum.[13] Similarly, another experimenter has used successive skin stripping to find a chemical barrier at the granular level.[14] Unfortunately, these experiments cannot be considered definitive since another ion barrier has been found using radioactive tracers in the dermo-epidermal junction.[15]

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[11] I. H. Blank, "Further Observations on Factors Which Influence the Water Content of the Stratum Corneum," Journal of Investigative Dermatology, 21 (1953), pp. 259-271.

[12] The top three layers of the skin, in descending order, are stratum corneum, stratum granulosum, and stratum Malpighii. These three layers are the epidermis. The fourth and last layer is the dermis.

[13] R. Edelberg, "Development of an Electrode for Long Term Application in Biological Recording," NASA Manned Spacecraft Center, Contract Report NAS 9-445, (Sept. 1963), pp. 9-17.

[14] I. H. Blank and E. Gould, "Penetration of Anionic Sur-Surfactants (surface active agents) into the Skin: 1. Penetration of Sodium Laurate and Sodium dodecyl Sulfate into Excised Human Skin," Journal of Investigative Dermatology, 33 (1959), pp. 327-336.

[15] V. H. Witten, M. S. Ross, E. Oshry, and A. B. Hyman, "Studies of Thorium X Applied to Human Skin: 1. Routes and Degree of Penetration and Sites of Deposition of Thorium X in Selected Vehicles," Journal of Investigative Dermatology, 17 (1951), pp. 311-322.

One other phenomena should be examined in this review since it, specifically, applies to the palms, and generally, to the skin: the absorption phenomena. Basically, researchers have defined this phenomena as a bi-directional flow of water in the epidermis. This bi-directional flow was shown in a vapor pressure experiment in 1959. A vapor pressure chamber was attached to the skin to control the level of humidity of the air in contact with the skin. Weight changes were measured as vapor pressure was varied. The change in flow was observed around 86% relative humidity. Essentially, water diffused from the skin up to 86%; water was absorbed into the skin after 86%.[16] A further set of experiments showed that this phenomena had reflex properties. A device, able to measure hydration of the skin, was used in conjunction with vapor pressure equipment. A simultaneous recording of hydration, vapor pressure, and S.C. was also used. The results indicated that while vapor pressure indicated an outflow from the skin, hydration of the skin declined. (S.C. increased and decreased with water vapor.) This would be reasonable as simple evaporation from the skin, but the hydration device was designed to prevent evaporation. The studies concluded that permeability of the skin increased during electrodermal responses. To insure reliability, two other devices for measuring hydration were used in these studies. The results still indicated a reflexive water absorption related to S.R.[17] Several researchers have

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[16] K. J. K. Buettner, "Diffusion of Water Vapor through Small Areas of Human Skin in Normal Environment," Journal of Applied Physiology, 14 (1959), pp. 269-275.

[17] R. Edelberg, "Skin Potential and Skin Conductance: An Attempt at Integration," Presidential Address presented at the 6th Annual Meeting of the Society for Psychophysiological Research, Denver, Colorado, October, 1966. Further research with different hydration devices is found in later research by Edelberg reported in "The Information Content of the Recovery Limb of Electrodermal Response," Psychophysiology, 6 (1970), pp. 527-539.

attempted an explanation but, no conclusive work has resulted. Generally, it is agreed that some method has evolved in the skin to control the level of hydration of the corneum and water absorption thru the water barrier. In short, a water gate has evolved.

The importance of the previously discussed physiological components can be seen in the various models proposed by researchers.[18] A review of the basic points of the various models would help provide a firm foundation for venturing into the psychological aspects of S.R. Most models use the sweat glands, the barrier level, and the absorption capability. The models hypothesize that electrical current can flow through the corneum, if hydrated, through the sweat ducts, if full, and through the dermis, if a pathway exists. Resistance would, then measure the relative completeness of these conditions. For example, as the sweat ducts filled, conductance and potential would increase. As the corneum becomes hydrated, the conductance and potential would slowly increase since a new pathway of low resistance has been formed. As the sweat is diffused and evaporated, conductance and potential would decline. At this point, the model can only explain a relatively slow rise and fall in the conductance. (This is charted as a negative wave.) However, if the sweat ducts stayed full, and the corneum constant in hydration, there should be no response changes, if we stop here. Yet, there are response changes under such conditions. Thus, the absorption capability is concluded to produce the responses by rapidly altering the hydration level of the corneum. This particular series of events explains the measuring of base levels and response

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[18] Edelberg, Handbook of Psycho-physiology, pp. 384-392.

levels. Base level is relative to the fullness of the sweat ducts; Response level is relative to the absorption membrane capability. Of course, this generality is subject to the provisio that measurements are valid only at the time of measurement since base level and response level can change over time.

The overriding question, at this point, is why do these changes in skin's electrical behavior take place. One author summarizes the possible reasons for the S.R. as follows:

1) "Thermoregulation to compensate for vasoconstriction"
2) "Thermal preparation for a heat load of muscular origin"
3) "The adjustment of physical properties to favor manipulative contact"
4) "The adjustment of physical properties as a defense against abrasion"
5) "The enhancement of tactual acuity either mechanically or neurochemically"
6) "The secretion of a characteristic odoriferous substance that facilitates tracking by other members of the species"[19]

Previous research provides explanations for these six points.

A series of experiments into thermoregulation show two processes taking place. When startle and tension producing stimuli affect the

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[19] Edelberg, Handbook of Psycho-physiology, pp. 402-404. "The selection of the appropriate interpretation must await experiments designed to allow identification of the nature of the biological adaptation."

subjects, cutaneous vasoconstriction takes place. This is a biological adaptation to redirect blood flow away from the skin to lessen the loss of blood through surface injuries and to increase blood pressure for better perfusion of the muscles.[20] By redirecting blood flow, the blood is not able to carry as much heat to the skin surface for radiation. An alternate system of heat loss, sweating, is called into operation.[21] In brief, sweating compensates for vasoconstriction and prepares the body for possible metabolic activity.

Another group of studies have shown the adaptive ability of the skin. One experimenter has interpreted the hydration of the corneum as aiding in grasping and manipulating objects.[22] A previous researcher presents evidence that moist skin is more sensitive than dry skin.[23] In fact, hydration of the corneum increases the skin's resistance to tearing and abrasion while increasing tactual acuity. In microsurgery, it is almost impossible to cut a piece of epidermal material from a profusely sweating individual because of its rubbery, slippery texture.[24] However, these studies also indicate an inverted U-shape function in the measurements of tactual sensitivity and facility. This is seen in

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[20] D. T. Graham, "Cutaneous Vascular Reactions in Raynaud's Disease in States of Hostility, Anxiety, and Depression," Psychosomatic Medicine, 17 (1955), pp. 200-207.

[21] C. W. Darrow, "The Galvanic Skin-Reflex and Finger Volume Changes," American Journal of Physiology, 88 (1929), pp. 219-229.

[22] C. W. Darrow, "The Galvanic Skin Reflex (sweating) and Blood Pressure as Prepatory and Facilitative Functions," Psychological Bulletin, 33 (1936), pp. 73-94.

[23] D. Katz, Der Aufbau der Tastwelt, (Berlin: Barth, 1925), pp. 176-178, cited by C. W. Darrow, Psychological Bulletin, 1936.

[24] R. Edelberg, "Microelectrode Study of the Galvanic Skin Response," Federation Proceedings, 20 (1961), p.326.

the decline of sensitivity and friction after intermediate levels of hydration are reached.[25] Thus, it is necessary for the body to develop a "fine tune" control of hydration. The logical choice is the absorption membrane. A further control of tactual acuity is the lowering of touch receptor thresholds by neural impulses. While this is not as dominant as the sweating process, neural control of tactual thresholds is positively correlated with S.C.R.[26]

One last explanation for electrodermal activity is based on a carry-over from species protection in the far past. Quite simply, when man had a much more sensitive nose, man could identify his species and individuals in the species by the smell of their sweat. Sweat is composed of not only NaCl, but also a complex mixture of organic compounds. Indeed, some researchers have hypothesized that sweat during emotional stimuli may contain a chemical equivalent of a cry for help.[27]

A brief discussion of physical factors affecting measurement would be appropriate right now. Basically, S.R. is measured by running a flow of electricity through a "balanced" system. This "balanced" system usually consists of several resistance units with known values and a resistance unit of unknown value through the skin. The system is balanced by altering one of the known resistors until an attached meter shows no deflection. Then, since all the known

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[25]T. Adams and W. S. Hunter, "Modification of Skin Mechanical Properties by Eccrine Sweat Gland Activity," Journal of Applied Physiology, 26 (1969), pp. 417-419.

[26]H. Kaye and L. P. Lippsitt, "Relation of Electrotactual Threshold to Basal Skin Conductance," Child Development, 35 (1964), pp. 1307-1312.

[27]Rothman, Skin, Chapter 7.

resistors can't change, any change in the skin's resistance will unbalance the system and cause a deflection in the meter. So, anything that affects the resistance of the skin becomes important. By far, the factor most in need of control is air temperature during the experiment. Generally, resistance increases (conductance decreases) as temperature decreases in a ratio of 3% /°C.[28] Another factor is humidity. Humidity needs to be controlled since it affects evaporative water loss. However, humidity is determined by location of electrodes. For instance, one might expect a high humidity rate to inhibit evaporation causing sweating to increase to carry the heat load. This would raise skin conductance. Negative correlations, though, have been found between palmar S.C. and relative humidity. This would suggest the strong activity of the absorption membrane in the palmar surfaces.[29] A further control needs to be exercised on the electrode and electrode contact paste used in the experiments. The wrong paste can elevate the response beyond actual values while the wrong electrode metal can produce artifacts and polarization potentials masking true values. The most common system of electrodes is Ag-AgCl electrodes and .05 M NaCl paste. However, copper or solder may be substituted for the electrodes.[30] One final factor needs to be mentioned - the factor of

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[28] R. L. Maulsby and R. Edelberg, "The Interrelationship between the Galvanic Skin Response, Basal Resistance, and Temperature," Journal of Comparative and Physiological Psychology, 53 (1960), pp. 475-479.

[29] P. H. Venables, "The Relationship between PGR Scores and Temperature and Humidity," Quarterly Journal of Experimental Psychology, 7 (1955), pp. 12-18.

[30] R. Edelberg and N. Burch, "Skin Resistance and Galvanic Skin Response: Influence of Surface Variables and Methodological Implications," Archives of General Psychiatry, 7 (1962), pp. 163-169.

current density. Current density is the measure of current per unit of area. The importance of current density is in its linearity of current to voltage. When current is linearly related to voltage, a true ohmic relationship exists and no outside electrical influences are affecting experimental measurement. This range of linear values represents the optimum range for measurement since there is no inherent skin reactivity to the electrical flow above and beyond the stimuli. The optimum range is 8-12 x $10^{-6a}/cm^2$. An added advantage of low current density is that low current density and a good electrode/electrolyte system controls the polarization error.[31]

The last area of discussion on electrodermal research concerns S.R.'s relation to a variety of variables. Researchers have argued the question, "What does S.R. measure?," long enough that a number of theories with the appropriate number of believers exist. In fact, a cataloguing, of the various indices S.R. is supposed to measure, provides a good review of the theories. The list is:

1) Indices of level of arousal
2) Level of alertness or attentiveness
3) Stimulus specificity by type and magnitude of body reaction
4) Body adaptation to stimuli
5) Discernment of orienting reflex from defensive reflex
6) Measure of individual differences in responsiveness, conditioning, stress, and anxiety.

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[31] R. Edelberg and N. Burch, Archives of General Psychiatry, 7 (1962), pp. 163-169.
W. W. Grings, Bioelectric Recording, pp. 276 and 280.

7) Measure of differences among psycho- and physio-diagnostic groups.[32]

In general, though, most theories use S.R. as a dependent variable measuring body reaction to enervating stimuli. (For lack of a better word, this will be referred to as "arousal" from now on).

Arousal, as a heading, includes emotion, attention or orienting reflexes, anxiety, mental effort, psychological discomfort, etc. Unfortunately, it is used to cover almost too much ground. A series of experiments might help bring arousal more into focus. The idea that attention requires the body to be enervated receives fairly conclusive evidence. One researcher used photographs that were rated for attention and for emotion. Later, he showed these photographs to subjects wired to S.C.R. devices. His conclusions showed a +.64 correlation between S.C.R. magnitude and the attention rating and only a +.32 between S.C.R. magnitude and emotion rating.[33] An experiment on task difficulty used attention as the differentiating medium. Subjects were told to listen for stimulus words in long series of words. They used four experimental task conditions: press a foot pedal to stimulus; mentally note occurrence of stimulus; count the number of times the stimulus occurs; or merely listen. The magnitude of S.C.R. was related, in high to low order, to motor response, implicit association, counting, and listening. The researchers concluded that

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[32] D. C. Raskin, "Attention and Arousal," Electrodermal Activity in Psychological Research, eds. W. F. Prokasy and D. C. Raskin, (New York: Academic Press, 1973), pp. 125-155.

[33] J. Flanagan, "Galvanic Skin Response: Emotion or Attention?," Proceedings, 75th Annual Convention, American Psychiatric Association, 1967.

the greater the task requirement the greater the attention required.[34] A further experiment was conducted in a series of three studies. In the first experiment, subjects were asked to either respond or not respond verbally to stimuli. To measure response separate from the stimulus, subjects were told to wait 10 seconds before responding. In this case, subjects told to respond had higher S.C.R. magnitudes. In the second experiment, the experimental subjects were given finger movements to perform in relation to stimuli. The experimental manipulation was to vary the number of finger movements. The results showed that S.C.R. increased directly with the number of finger movements. The last experiment gave an option of response. The experimental subject had to choose which of the several proper responses he would use. Again, S.C.R. increased directly with the number of alternatives.[35]

While attention provides a method for viewing arousal, it has limitations. Most of the attention experiments suffer from the assumption that attention is necessary for arousal. This is not true. One researcher used classical conditioning (shock/stimuli) to establish a S.R. pattern in subjects. He, then, assigned these subjects to attention experiments involving different sound channels into each ear. The instructions were to attend to only one channel. He, then, inserted the previously conditioned stimuli into the unattended ear

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[34] I. Maltzman and D. C. Raskin, "Effects of Individual Differences in the Orienting Reflex on Conditioning and Complex Processes," Journal of Experimental Research Into Personality, 1 (1965), pp. 1-16.

[35] J. Germana, "Response Characteristics and the Orienting Reflex," Journal of Experimental Psychology, 78 (1968), pp. 610-616.

channel. S.R.R. showed significant "arousal" when the stimuli was presented.[36] Even more impressive data has been shown in subception of stimuli. In this study, experimental conditions were manipulated so that subjects could make no conscious determination that the stimuli has been presented. By using a classic conditioning system, subjects were given reaction patterns to stimuli. They were, then, exposed to the stimuli by means of a tachistoscope set for levels beyond conscious discrimination. Subjects were further asked to try to discriminate when stimuli was presented. The scores between correct, conscious, discriminations and S.R.R. scores of arousal to conditioned stimuli and unconditioned stimuli were used. The researcher defined the "subception effect" as the difference between the mean wrong guesses of the conditioned stimuli and the mean wrong guesses of the unconditioned stimuli. Results for subception were significant. While subjects could not discriminate consciously, they could subconsciously and have a significant S.R.R. "arousal" score.[37]

Perhaps the best statement one can make in defining arousal is that arousal is a general body enervation directly influenced by the needs of the surrounding environment. In all the previous studies, the subjects reacted to their environment whether it involved attention, task difficulty or conditioning. This can be seen in three studies involving fear, test anxiety, and psychological discomfort. All have

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[36] R. S. Corteen and B. Wood, "Autonomic Responses to Shock Associated Words in an Unattended Channel," Journal of Experimental Psychology, 94 (1972), pp. 308-313.

[37] R. S. Lazarus and R. A. McCleary, "Autonomic Discrimination Without Awareness: A Study of Subception," Psychological Review, 58 (1951), pp. 113-122.

the same quality - body reaction to the experimentally controlled environment.

The first study used two experimental groups differentiated by their fear of spiders. Both the high- and low-fear experimental groups and controls were exposed to a series of slides of animals and insects. The orienting reflex was reduced by slides of previously determined neutral animals. The experimental and control groups both saw a series of ten slides. The difference between the two groups was that the stimulus slides were different. The experimental group viewed spiders in slides 8, 9, and 10. The control group viewed snakes in 8, 9, and 10. This way, actual fear of some thing could be measured more easily. Each slide was controlled for equal viewing time by subjects. S.R. was measured during each slide and averaged for each slide. On the first stimulus slide, the high fear experimental group was significantly different on S.R. from the low fear and the high fear and low fear control groups. On the last two slides, high fear experimental was significantly greater than both controls and significantly different on the second slide and almost significant on the last slide ($p < .08$) from the low fear experimental group.[38]

Another example of environmental effects on arousal is test anxiety. This study tested and grouped subjects into high and low test anxiety groups. They were given 30 minutes of instruction in test taking with a successful example by all subjects in answering test questions. S.R. base readings were the averages for this 30 minutes. They were, then, given an unsolvable test problem. The

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[38]James H. Geer, "Fear and Autonomic Arousal," Journal of Abnormal Psychology, 71 (1966), pp. 253-255.

S.R. scores for the high and low groups showed significant differences.

One other factor can be related to arousal - psychological discomfort. In this study, the researcher used a stressor film called Subincision. This film showed the ritual surgery used by male aborigines to mark their genital organs. The subjects were asked to provide psychological self-evaluations of three measures: pleasantness, excitement, and tension. Continuous measurement of S.C.R. was graphed during the film. Both measures paralleled the content of the movie with peaks occuring during the surgery scenes and troughs in the more mundane scenes.[39]

The correlation of S.R. and arousal has a long history. In 1950, one researcher reviewed previous literature for studies showing correlations between self-reported levels of magnitude to a variety of experiences and S.R. In the 19 studies reviewed, correlations ranged from +.45 to +1.00 with a median value of +.75.[40] Most of these studies tested responses to attitude- or emotion-loaded words. Another review of the literature in 1959 prompted a researcher to test loaded words and S.R. specifically. In three separate tests, correlations reported were +.89, +.87, and +.94. The conclusion stated, "...(W)e are certainly willing to entertain the suggestion that the differential magnitude of the galvanometric deflections to words is one of the most reliable phenomena in psychology today!"[41] With this base, it was a short jump into attitude studies.

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[39] A. M. Mordkoff, "The Relations between Physiological and Phenomenological Indices of Arousal," (Ph.D. dissertation, University of California, Berkely, 1963).

[40] H. G. McCurdy, "Consciousness and the Galvanometer," Psychological Review, 57 (1950), pp. 322-327.

[41] J. I. Lacey, "Psychophysiological Approaches to the Evaluation of Psychotherapeutic Process and Outcome," Research in Psychotherapy, eds. E. A. Rubinstein and M. B. Parloff, (Washington, D.C.: American Psychological Association, 1959), pp. 160-208.

In a series of studies by Cooper and various junior authors, the studies justified the use of S.R. to measure prejudice because S.R. would measure the subjects' reactions to tension,[42] emotional,[43] meaningful,[44] and conflicting[45] stimuli. The basic design of these experiments was comparable. Subjects rated and ranked 20 ethnic and national groups according to their preferences. Then, derogatory and complimentary statements were made. The experimenters insulted the subjects' most liked group and complimented the subjects' most disliked group. Neutral groups received both complimentary and derogatory statements. Generally, significant S.R.R.'s were shown when there was conflicting attitude and statements ($p < .005$). One of the studies reversed procedure and tried to use S.R.R. to predict prejudicial rankings. A rank order correlation of .82 was reported.[46]

In a study on attitudes about organized religion, S.R.R. was used to measure subjects' reactions to three groups of statements: pro-church; neutral-church; and anti-church. Previous attitude questionnaires were used to select three experimental groups of pro-, anti-, and neutral-church groups. Specific instructions directed

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[42] R. S. Woodworth and H. Schlosberg, Experimental Psychology, (New York: Holt, Rinehart & Winston, 1954),

[43] E. McGinnies, "Emotionality and Perceptual Defense," Psychological Review, 56 (1949), pp. 244-251.

[44] W. E. Bingham, Jr., "A Study of the Relations Which the GSR and Sensory Reference Bears to Judgments of Meaningfulness, Significance, and Importance of 72 Words," Journal of Psychology, 16 (1943), pp. 21-34.

[45] L. H. Lanier, "An Experimental Study of Affective Conflict," Journal of Psychology, 11 (1941), pp. 199-217.

[46] J. B. Cooper and H. E. Siegel, "The GSR as a Measure of Emotion in Prejudice," Journal of Psychology, 42 (1956), pp. 149-155.

the subjects' attention to the affective component of their attitudes. All three groups were presented an equal number of pro-church; neutral, and anti-church statements. The results indicated no significant differences in S.R.R. scores among the groups, but significant differences were found in S.R.R. scores to contradictory statements.[47]

In summary, it would appear that S.R. is an effective measure of a body's reaction to a variety of stimuli. The stimuli can best be generalized into stimuli that activate the body into a higher energy state. Whether this higher energy state is due to one particular biological reflex or several is open to question, but it is proven that S.R. can measure reactions to mental stimuli that affect cognition. This is particularly significant when affectively loaded words and phrases are used. Other factors that affect S.R. include task complexity, attention, anxiety, emotion, and psychological discomfort. As a result, S.R. is able to measure a body's reflexive action to stimuli as it decodes, comprehends, and encodes a response.

Cognitive Dissonance

This section will not be as extensive as the previous section. The reason for this limitation is lack of proper definition of cognitive dissonance. Previous studies have not properly defined cognitive dissonance. They either conclude that their experimental manipulation will cause cognitive dissonance or state that cognitive dissonance exists and their experiment controls it.[48] Neither

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[47] H. W. Dickson and E. McGinnies, "Affectivity in the Arousal of Attitudes as Measured by GSR," American Journal of Psychology, 79 (1966), pp. 584-589.

[48] G. L. Cronkhite, Persuasion, (Indianapolis: Bobbs-Merrill Co., Inc., 1969), p.60.

situation provides an objective (or even semi-objective) measure of cognitive dissonance itself. They all purport to measure the effects of cognitive dissonance. As a result, this author will not use previous studies, but will rely on the original theoretical statement defining cognitive dissonance.

The formulator of cognitive dissonance defines cognitive dissonance as, "These two elements are in a dissonant relation if, considering these two alone, the obverse of one element would follow from the other."[49] Further, the existence of cognitive dissonance is psychologically uncomfortable and tension producing.[50] So, the basic elements, as related to this paper, are the existence of cognitive dissonance and the measurement of that dissonance. (For the sake of clarity, these two components will be called dissonant situations and dissonance produced arousal.[51]) Since previous studies do not adequately prove the existence of cognitive dissonance, this author will use the original statement of definition of dissonant situations by the formulator. This author will, then, use S.R. to measure the physiological effect of the theorized dissonant situation. A pre- and post-stimuli questionnaire will check for an attitude change.

Cognitive Dissonance and Physiological Arousal

Three studies will be used in this section. Essentially, they will show that a connection between cognitive dissonance and psycho-physiological measures has been hypothesized by these researchers.

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[49] L. Festinger, A Theory of Cognitive Dissonance, (Stanford: Stanford University Press, 1957), p.13.

[50] L. Festinger, Cognitive Dissonance, p.3.

[51] G. Cronkhite, Persuasion, p.60.

The first study used the basic dissonance hypothesis that dissonance causes arousal. The specific measure of arousal was heart rate. The subjects initially completed an attitude questionnaire on John Glenn and the admission of Red China into the United Nations. Those who favored Glenn and disfavored Red China's admission were considered dissonant; those who favored both were consonant. All subjects, then, heard a 96 second speech purported to be by Glenn on allowing Red China's admission. Heart rate was measured continuously from 30 seconds prior to speech to 4 minutes after the speech. A post-speech questionnaire on attitudes were administered after the speech. The experimenter sought to correlate the dissonance reported with the change in arousal. Unfortunately, the correlation was not significant. (In fact, none of the hypotheses of cognitive dissonance were validated.)[52] Potential reasons for failure included wrong use of measure, improper stimulus, and improper measure. The researcher did find validation for improper and wrongful use of the arousal measure. Previous physiological studies showed that cardiac deceleration accompanied external attention processes while cardiac acceleration accompanied mental task demands. Such a variation could affect arousal scores. Further, the two-part control of the elements might have allowed other variables to affect the dissonant relationship.

The second study focused on dissonance-produced arousal and specific dissonance reduction patterns. This researcher used S.R. and respiration as the arousal measures. The dissonant stimuli involved the subject's popularity with peers. Experimental control was allowed

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[52] G. L. Cronkhite, "Autonomic Correlates of Attitude Change," (Ph.D. dissertation: State University of Iowa, 1965).

by previous personality scales for all subjects. The stimuli was, then, tailored to produce dissonant or consonant effects. Subjects were, also, asked to select one of four reduction tasks. Again, no meaningful results occurred, but the researcher admitted that a test of arousal-dissonance hypothesis might prove significant if a larger N were used (N = 22).[53]

The third study tried to measure dissonance by physiological arousal and attitude change. The specific arousal measure was S.R. The stimuli was a high-authority information feedback that was dissonant or consonant with subjects' attitudes. The subjects were neuropsychiatric patients. (They were selected by choosing 16 subjects from each major group of treatment - schizophrenia, psychoneurosis, and personality disorder.) All subjects were enough advanced in their treatment to be considered improved. A pre-test questionnaire established the prior attitudes. Several days later, the subjects came back and retook the questionnaire. The difference was that an expert's opinion of the proper answer was noted on the questionnaire. There were a series of dummy questions before the test questions to zero-in the arousal measures. S.R. was measured continuously throughout the test. Comparisons were made between attitude tests' absolute differences and base S.R. and test S.R. (Test S.R. was mean S.R. score sampled every 4 seconds during stimuli questions.) The results indicated a significant attitude change ($p < .01$) and a trend towards significance for S.R. ($p < .10$). (Only the neurotics reached significance, but they had more trouble understanding the questions.) Some problems biased

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[53] R. G. Gallimore, "Reduction Style and Dissonance-Associated Autonomic Activity," (Ph.D. dissertation: Northwestern University, 1964).

the results, though. Some of the questions were hard for the subjects to understand. The researchers also believed that Type I error affected their group interaction scores on their ANOVA. Nevertheless, the researchers felt that dissonance does produce attitude change and S.R. is a sensitive measure of dissonance arousal. They concluded that a "cautious interpretation" might provide support for dissonance produced arousal.[54]

Application of Previous Research

The review of previous research shows two facts: first, S.R. can measure psychological stimuli such as conflicting attitudes, psychologically uncomfortable stimuli, and stressful stimuli; second, dissonant situations, in theory, result from conflicting stimuli and cause psychological discomfort and tension. It is hypothesized that if an experimental condition is established where a subject's attitude on some topic is brought into conflict with information unknown to the subject, this is a theoretically dissonant situation. Further, if S.R. measurements are made during the presentation of the stimuli, we can measure the effect of the dissonant situation. In this experiment, the subjects' attitudes on the safety and desirability of beer and potato chips are brought into dissonance by a persuasive speech, that "proves" that beer and potato chips are dangerous and undesirable. This is dissonant because most subjects accept these food items, while the new information shows that the food items should not be accepted. By also using pre- and post-stimuli questionnaires, we can check the

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[54] W. W. Ward and W. A. Carlson, "Cognitive Dissonance, Opinion Change, and Physiological Arousal," Journal of General Psychology, 71 1964, pp. 115-124.

effects of the stimuli by previously used techniques. If there is a significant G.R. reaction and a significant attitude change, we might be able to suggest a correlation of dissonant situations with a physiological measure as proof of a measure of dissonant-produced arousal.

CHAPTER III

PROCEDURE

Pre-Experiment Procedure

The pre-experiment phase consisted of questionnaire validation and equipment standardization. The validation process examined the questionnaire's ability to significantly differentiate between high and low responses to stimuli. The standardization process examined the equipment's operation levels for conformity with optimum values.

The questionnaire was tested by A. L. Edwards' suggested procedure.[1] A pilot sample of 28 subjects took the questionnaire. The questionnaire consisted of 24 statements with five-division Likert scale responses. Only 21 of the statements were tested in actuality. Three nonsensical statements were used to produce random breaks in the questionnaire. Statements were worded positively and negatively to avoid pattern answers. Positive statements received a value of 4 for high agreement and 0 for high disagreement; Negative statements received a value of 4 for high disagreement and 0 for high agreement. Using t-tests, 19 of the 21 statements significantly differentiated between the top fourth and the bottom fourth of the pilot sample. (The two questionnaires are shown in Appendix A.)

The S.R. equipment used a schematic reported in a journal article.[2] In the previous chapter, the important equipment variables mentioned

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[1] A. L. Edwards, Techniques of Attitude Scale Construction, (New York: Appleton-Century-Crofts, 1957).

[2] E. Zolik and C. Reinhard, "A Transistor Psychogalvanometer," Journal of General Psychology, 59 (1958), pp. 299-300.

were current density, electrode metal, and electrode paste. With the present equipment, current density was 11.18×10^{-6} amps/cm^2. The electrode was copper. The electrode paste was a .05M NaCl solution suspended in a corn starch paste.[3] All variables fell within the optimum criteria for S.R. measurement.

Experimental Procedure

An initial sample of 128 subjects took the questionnaire. From this sample, two experimental groups were formed. Both groups heard an oral stimulus before re-taking the questionnaire. The main differences between the groups were the use of S.R. equipment with one group and the size of the two groups.

The non-equipment group used 61 subjects. They consisted of Oral Communications I students. (M = 39; F = 22) The subjects took the questionnaire one week before the stimulus was presented. The stimulus was a taped persuasive speech from a high credibility source warning about the use of carcinogenic food additives in potato chips and beer. However, the speech was actually written by the experimenter and by a speech student. (See speech in Appendix B.) The subjects were re-tested immediately after hearing the speech. A t-test measured significance in the pre- and post-stimulus questionnaire results.

The equipment group used 35 subjects. They consisted of Oral Communications I students, also. (M = 16; F = 19) They received the pre-stimulus questionnaire one to two weeks before the speech. The

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[3] R. Edelberg and N. R. Burch, "Skin Resistance and Galvanic Skin Response," Archives of General Psychiatry, 7 (1962), p. 168.

subjects were allowed to examine the equipment while the experimenter explained the equipment generally. The explanation consisted of the experimenter stating that the equipment measured "emotional reactivity" to various stimuli. The experimenter down-played the importance of the equipment by claiming that the experiment was primarily a speech evaluation problem. This also helped center the subjects' attention on the speech. The experimenter attached the equipment to the fingers of the non-dominant hand of the subjects. After a five minute stabilization period, the experimenter asked if all subjects were relaxed and prepared to listen. When all said "Yes," the baseline was noted and the speech started on the tape recorder. The specific S.R. measures used were the lar-deflection on the S.R. meter and the S.R. value at the end of the speech. Once the electrodes were removed, the subjects completed the questionnaire again. T-tests checked the significance of the differences between pre- and post-stimuli results, between baseline S.R. and highest S.R., and between baseline S.R. and end S.R.

Post-Experimental Procedure

The main post-experimental procedure involved debriefing the subjects. Both groups (equipment and non-equipment) received the speech debriefing. The equipment group received additional information on the S.R. In debriefing the speech, the experimenter informed the subjects that the speech was false and was written solely for the experiment. The equipment debriefing involved a more detailed explanation of the measuring process and its effectiveness in measuring reactions to speeches. The experimenter also asked the subjects if they had read any

recent articles on the subject and if they had ever eaten any potato chips or drank any beer.[4]

A dissemination control was also used in the debriefing process. This seemed necessary to protect the reactions of future subjects. The experimenter did two things to control the release of debriefing information. First, he asked for the silence of the subjects at the end of the debriefing. Second, he tested all members of the same class in one session.

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[4]An article on carcinogenic food additives appeared in the student newspaper two weeks before the majority of the testing. This article minimized the danger of the additives while the stimuli sought to increase the apprehension of danger from the additives. Luckily, most of the subjects reported in the debriefing that they had not read the article.

CHAPTER IV

RESULTS AND CONCLUSIONS

Experimental results consist of four measures. They are questionnaire results on pre- and post-stimuli for both experimental groups, the difference in baseline S.R. and end S.R., and the difference in baseline S.R. and highest S.R. The results are summarized in the charts below. All four differences were dignificant.

Questionnaire Results

	Equipment (N=35)	Non-Equip. (N=61)
Pre-Stimuli $\bar{X}$	47.83	49.62
Post-Stimuli $\bar{X}$	53.80	54.18
S^2 Pre-Stim.	36.01	36.59
S^2 Post-Stim.	16.10	11.67
t-score	4.82 ($p < .01$)	3.46 ($p < .01$)

Equipment Results
(Baseline=.1)

	High S.R. (N=35)	End S.R. (N=35)
$\bar{X}$	.272	.201
S^2	.028	.022
t-score	5.963 ($p < .01$)	3.917 ($p < .01$)

Taking the non-equipment group first, the questionnaire was designed to measure the group's attitude to carcinogenic food additives. Their attitude change due to the stimuli can be measured from the difference in pre- and post-stimuli responses. As can be seen from the charts above, the difference was significant. The equipment group also showed a significant difference in their questionnaire results. This seemed particularly auspicious since this group had the added distraction of being attached to the S.R. equipment. It should also

be noted that the stimuli tended to change both groups' attitude in the same direction. (For the equipment group, X changed from 47.828571 to 53.8; for the non-equipment group, X changed from 49.622951 to 54.180328.)

The S.R. results represent the difference between the baseline and the high and end S.R. The baseline was set at a standard level by the experimenter. The experimenter also chose to use both S.R. measures. This seemed to be a good insulation against potential subject's reaction to the equipment. This was almost borne out in the results. While the two S.R. measures were significant when compared to the baseline, they were almost significant when compared to each other (.1 p .05). This seemed to indicate a potential reaction to the equipment (or experimenter) that would affect the high S.R. measure. Thus, the end S.R. served as a good check on the high S.R. measure and as a more accurate measure of the S.R. measure.

Before examining the conclusions of this experiment, some of the factors that affect measurement should be examined. In the attitude measurement section of the experiment, experimental blinding and subject's prior attitudes posed particular problems. Since the experimenter worked alone, a reaction to the experimenter was possible. This was controlled by two means. First, the experimenter tested the stimuli on complete classes. The instructor of the class was present at all times. Further, the class was not forced to subdivide into smaller test groups, so the subjects were insulated from an interpersonal relation with the experimenter. This hopefully kept the experimenter-subjects relation closer to the teacher-student relation that the subjects would be used to. The other area of concern was subject's

prior opinions on the topic. Of particular concern to the experimenter was the possibility of subjects having a close relative who has or had cancer. This was examined in the pilot study for the questionnaire validation. The pilot questionnaire specifically asked if the subjects had a personal or close relation with another person with cancer. There were nine subjects out of 28 subjects who had a personal relation with cancer. Only five subjects were in the bottom half of the pilot sample. A further attempt to control the prior attitudes was made in the debriefing after the actual experiment. There the experimenter asked the subjects if they had or had had a personal relation with cancer. In this case, none were reported.

The S.R. equipment was primarily checked by environmental controls. In a prior chapter, temperature, humidity, electrode, and electrode paste were noted as the significant areas of possible error in measurement. During the equipment experiments, each was checked. The temperature remained constant for all but one of the testing sessions. In that one session, temperature varied by +5 F. Since only two subjects were tested, they were not included in the group. Humidity was also measured during the testing. Humidity remained around 40% for all sessions. To counter electrode impurities, they were washed and cleaned by steel wool before each session. The electrode paste was standardized by having all of the paste mixed at once and, then, stored in an air-tight container for molarity protection.

The conclusions of the study can be summarized in three points. First, a stimulus constructed along dissonance theory guidelines can cause significant attitude change. Second, S.R. measured during the dissonant stimulus was significantly greater than base S.R. Third,

S.R. can measure the effect of a dissonant stimulus. The first two conclusions are shown in the experimental results. The stimulus produced not only significant attitude changes, but also, significant S.R. differences. Since the S.R. was measured during the stimulus, the S.R. seems to be able to measure a dissonant stimulus. This conclusion follows prior research in validating a connection between physiological measures and psychological phenomena similar to Festinger's cognitive dissonance. However, this conclusion must be limited. This study only tested the general concept of cognitive dissonance. While this closely follows results in the area of physiological psychology, it does not extend as far as the physiological studies. Prior research has expanded the scope of research to include individually identifiable psychological effects such as anger, fear, anxiety, etc. Cognitive dissonance tries to include all of these traits. (In fact, it was this close similarity between dissonant effects and other studies that prompted this researcher to examine this area.) At best, one can only say that S.R. can measure the general stress reaction that cognitive dissonance produces. Further research is needed before one can say exactly what cognitive dissonance causes. This should be a particularly fruitful area of research since biomedical monitoring is now capable of differentiating various psychological effects. It is hoped that this study may provide a base for future research.

APPENDIX

APPENDIX A

CANCER SURVEY

AGE_____

DO YOU HAVE A LIVING RELATIVE IN YOUR IMMEDIATE FAMILY WHO HAS CANCER?_____

HAVE YOU HAD A RELATIVE IN YOUR IMMEDIATE FAMILY DIE OF CANCER?_____

The following is an opinion survey on certain aspects of cancer. After reading each statement, circle the degree of agreement you feel about the statement. Thank you for your time.

1. The Federal Government is not protecting the public adequately from cancer-producing agents.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

2. There needs to be better testing of food additives for carcinogens.

   SA A U D SD

3. Supposed cancer producing agents have not been adequately proven to cause cancer.

   SA A U D SD

4. Cancer is psychomatic in origin.

   SA A U D SD

5. All people are susceptible to cancer.

   SA A U D SD

6. Cigarettes are the worst thing you can smoke.

   SA A U D SD

7. Cancer is not a national problem.

   SA A U D SD

8. Cancer cures will be found shortly.

   SA A U D SD

9. Diet is important in preventing cancer.

   SA A U D SD

10. Cancer researching scientists do not deal with the real world.

    SA A U D SD

11. There needs to be more testing for other cancer producing agents.

    SA A U D SD

12. Suspected cancer producing agents should be banned from use.

    SA A U D SD

13. Food additives are dangerous because they cause cancer.

    SA A U D SD

14. Cancer warnings are effective in providing public awareness of signs of cancer.

SA A U D SD

15. Cancer cures could be found if there were more money available for research.

SA A U D SD

16. There is more cancer on the East Coast than in the Midwest.

SA A U D SD

17. Manufacturers should not be forced to follow a governmental ban on suspected cancer-producing agents.

SA A U D SD

18. Cancer warnings are unsubstantiated fear tactics.

SA A U D SD

19. Smog causes cancer.

SA A U D SD

20. Pipesmoking does not cause cancer.

SA A U D SD

21. People who work in heavily industrialized areas will get cancer.

SA A U D SD

22. We should support cancer research irregardless of the cost.

SA A U D SD

23. We should stop buying products containing suspected carcinogens.

SA A U D SD

24. Cancer is a disease of the working class.

SA A U D SD

CANCER SURVEY

The following is an opinion survey on certain aspects of cancer. After reading each statement, circle the degree of agreement you feel about the statement. Thank you for your time.

1. The Federal Government is not protecting the public adequately from cancer-producing agents.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

2. There needs to be better testing of food additives for carcinogens.

   SA A U D SD

3. Supposed cancer producing agents have not been adequately proven to cause cancer.

   SA A U D SD

4. Cancer is psychosomatic in origin.

   SA A U D SD

5. All people are susceptible to cancer.

   SA A U D SD

6. Cigarettes are the worst things you can smoke.

   SA A U D SD

7. Cancer is not a national problem.

   SA A U D SD

8. Cancer cures will be found shortly.

   SA A U D SD

9. Diet is important in preventing cancer.

   SA A U D SD

10. Cancer researching scientists do not deal with the real world.

    SA A U D SD

11. There needs to be more testing for other cancer producing agents.

    SA A U D SD

12. Suspected cancer producing agents should be banned from use.

    SA A U D SD

13. Food additives are dangerous because they cause cancer.

    SA A U D SD

14. Cancer cures could be found if there were more money available for research.

    SA A U D SD

15. There is more cancer on the East Coast than on the Great Plains.

    SA A U D SD

16. Manufacturers should not be forced to follow a governmental ban on suspected cancer-producing agents.

SA A U D SD

17. Cancer warnings are unsubstantiated fear tactics.

SA A U D SD

18. Smog causes cancer.

SA A U D SD

19. People who work in heavily industrialized areas will get cancer.

SA A U D SD

20. We should support cancer research irregardless of the cost.

SA A U D SD

21. We should stop buying products containing suspected carcinogens.

SA A U D SD

22. Cancer is a disease of the working class.

SA A U D SD

APPENDIX B

STIMULUS SPEECH

There is, at present, a problem that neither the federal government nor private industry has handled properly. I call this problem CHEMICAL IGNORANCE. Simply put, chemical ignorance is the use of chemicals WITHOUT full knowledge of their effects. Two RECENT examples illustrate this problem very well.

The first involves the use of chemical preservatives in the manufacturing of potato chips. MOST of you are aware of the two STANDARD preservatives that are used in foods; BHT, otherwise known as BI-HYDRO-THI-AX-INE; and BHA, BI-APH-RE-NINE. BHT and BHA are used with GREAT regularity in the food processing industry and have been extensively tested alone. There is ALSO a chemical preservative used in grease to help maintain stability during storage. TRI-OX-C-NI-AC-THINE is particularly useful in limiting rancid deterioration of food grease. ALL THREE preservatives have been tested by the Food and Drug Administration during standard consumer safety experiments. However, what was not tested was the compound that results from their combination under certain conditions. For instance, ONE national brand of potato chips heats the grease (and preservatives) in a large vat. They then pass their chips through this vat on a conveyor tray. After passing through the vat, they enter a "wind chamber" where fans blow on salt, seasoning, the BHA AND the BHT. These fans ALSO dry the potato chips. The important point of this process that you should note is the addition of BHA and BHT to the hot grease BEFORE it is cooled by the fans. The heat allows the preservatives to recombine to form BI-HYDRO-NI-AC-THINE. This compound has only been found in one-fourth of the

chips tested. However, this compound is a sure carcinogen when it reaches a certain trigger level quantity. In common terms, you would need to eat 15 pounds of potato chips to reach this quantity. The problem is still serious, though, because BI-HYDRO-NI-AC-THINE is not eliminated from the body. It remains in the body and is stored in the fatty tissue around the kidney. When it finally reaches the trigger level, it can cause cancer in the lower abdomen area. NOW you may ask, what is the normal quantity in a human in the United States? Nobody knows. It is something that should be investigated, but lack of money AND authority has STOPPED the Food and Drug Administration so far.

I'll talk about that problem in a minute, but first let me provide a second example of chemical ignorance. This involves spring water and hops. This example deals with a popular regional beer in the Rocky Mountains and Great Plains areas. Here, AGAIN, all of the ingredients had been tested ALONE. However, when the hops was put through the fermentation and wash process to form the beer-base, it had a flavor enhancer added. (This enhancer had also been tested alone by the FDA.) When the base was added to the spring water, nobody realized that certain trace minerals, (silicate compounds primarily), would combine with the flavor enhancer to form a car-cin-o-gin. This compound has been tested on laboratory mice in quantities that are comparable to 40 twelve-ounce cans per 48 hours. While research has been done on this product, it is still unsafe to assume that it is not a threat. The reason: the research money only extended to checking car-ci-no-nic effect. It did not include research on trigger levels that could be transferred to humans. We really do not know what the minimum trigger level is and that is a question that should be answered.

Before going to possible ways to handle cancer research, let me make one final point about these examples. We were lucky to catch THESE TWO! The potato chip drying process has been changed: at our suggestion. Unfortunately, this was not done until March, 1975, (and it is still not an accepted practice in the industry). The beer company has started using a filtering system. Unfortunately, we did not complete the research until December, 1974 and the company did not install the filtering system until August, 1975. Yes, we caught these two cases, BUT, how many others do we not know anything about? THAT is the danger of chemical ignorance!

Given by: Dr. Edwin Kolich, Director, Dangerous Food Division, Food and Drug Administration before Senate Subcommittee on Food and Drugs December 19, 1975.

APPENDIX C

ELECTRONIC SCHEMATIC

The Journal of General Psychology, 1958, 59, 299-300.

A TRANSISTOR PSYCHOGALVANOMETER*

Department of Psychology, Marquette University

EDWIN ZOLIK AND CLYDE REINHARD

This paper describes an inexpensive, versatile galvanic skin response indicator which can be easily constructed. Basically the instrument is composed of a Wheatstone bridge, a transistor amplifier, and a 0-1 milliampere meter for response indication. Variable sensitivity has been provided so that the instrument can be employed under conditions of either mild or strong responsivity.

The circuit design is based on the conventional balanced bridge circuit which can be utilized by itself only if the output indicator is very sensitive, since the output current of this circuit is small. This stems from the fact that the bridge is balanced, and no output is obtained when $\frac{R_1}{R_2} = \frac{R_4}{R_4}$ (R = resistance). This means that if $R_1 = R_2$, and R_4 is the subject, then R_3 must be of the same magnitude of resistance as R_4 in order to balance the circuit. Then if a moderate voltage were supplied across the bridge in which these two legs (R_1 and R_2; R_3 and R_4) have high resistance values, a low output current could be expected with a change in the subject's resistance.

In our design (Figure 1), the small output current of the bridge is fed to a *DC* transistor amplifier. The setting of the subject's base resistance is accomplished by substituting a 50-ohm, 3-watt potentiometer for $R_1 - R_2$ of the bridge. With the subject connected in the electrical bridge circuit by means of external electrodes, the bridge is balanced by adjusting the slide arm on the potentiometer. Consequent changes in the subject's resistance will unbalance the circuit and result in a current output which is amplified by the DC transistor amplifier (CK 722PNP and 2N170NPN).

The variable sensitivity of the unit is accomplished by the variable resistance (R_5, 25,000-ohm, carbon control) in the emitter of the CK722 transistor. This resistance has a negative feedback effect on this amplification stage, decreasing the amplifier gain as more resistance is added to the emitter circuit. This makes it possible, by increasing the amplification, to obtain noticeable deflections in the milliammeter under conditions of ex-

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tremely weak responsivity. If responsivity is high, the sensitivity may be reduced to prevent excessive off-scale deflections. Although this original circuit employs a Raytheon CK 722PNP transistor cascaded with a GE 2N170NPN, other popular transistors could be used with equal success. R_3 is a 47,000-ohm, ½-watt resistor.

The power (3 volts) is supplied by two size *D* flashlight cells in series, which will give many hours of service before the sensitivity is noticeably decreased. The electrodes are constructed from ordinary test lead wire to which pennies were soldered. The contacts can be embedded in small

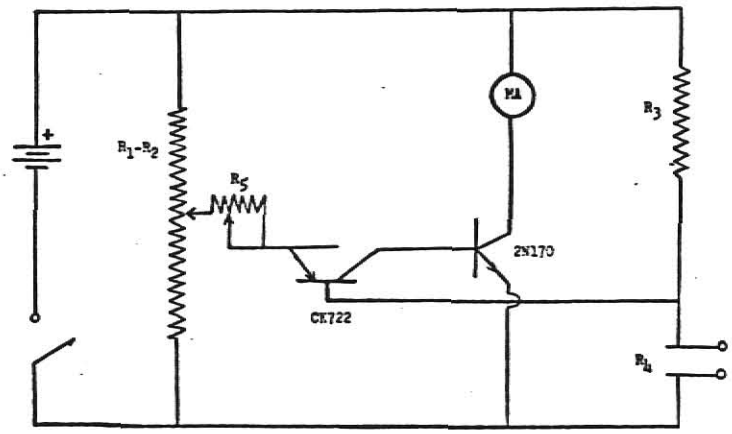

FIGURE 1
CIRCUIT DIAGRAM FOR TRANSISTOR PSYCHOGALVANOMETER

sponges which are dampened in saline solution when the instrument is in operation. For increased sensitivity, it is suggested that the skin be coated with electrode contact jelly and the electrode contacts be directly taped to the skin.

In actual operation it is suggested that the electrodes be placed on the subject first, and then plugged into the psychogalvanometer. This would prevent accidental shorting and possible consequent damage to the sensitive ammeter. After the electrodes have been placed on the subject and plugged into the instrument, the sensitivity is set at the desired point. Then the instrument is turned on and the Subject Base Resistance knob is adjusted to give an arbitrary base reading on the ammeter. Any *GSR* of the subject will now be reflected on the meter.

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THE USE OF SKIN RESISTANCE AS A MEASURE OF COGNITIVE DISSONANCE

by

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AN ABSTRACT OF A MASTER'S THESIS

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Leon Festinger's theory of cognitive dissonance hypothesizes an individual's possible reactions to dissonance among the individual's cognitive elements. While a theoretical definition of dissonance is presented in Festinger's theory, an experimental definition is not presented. Festinger suggests psychological tension as a potential measure. Other researchers have related dissonance with stress, anxiety, and emotional reactions with varying degrees of success. In most cases though, this correlation was not the major point of the studies. In fact, most of the researchers assumed the existence of dissonance. The purpose of this study is to explore the use of skin resistance as an experimental measure of dissonance.

The study used two experimental groups selected from a larger sampling universe. The universe was tested for their attitudes on cancer. The two experimental groups heard an oral stimulus constructed along hypothetical dissonance guidelines. A pre-stimulus and a post-stimulus attitude test measured the attitude change of both groups. One of the experimental groups was also connected to a skin resistance measuring device while they were listening to the stimulus. The highest skin resistance and the skin resistance at the end of the stimulus were recorded for the subjects.

The results showed a significant reaction to the stimulus on the attitude change and on the skin resistance measures. The author concluded that skin resistance was a valid measure of cognitive dissonance.