THE GALVANIC SKIN RESPONSE AS AN INDICATOR OF
SELECTIVE ATTENTION

by
Glenn D. Shean

A Thesis Submitted to the Faculty of the
DEPARTMENT OF PSYCHOLOGY
In Partial Fulfillment of the Requirements
For the Degree of
MASTER OF ARTS
In the Graduate College
THE UNIVERSITY OF ARIZONA

1964
STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in their judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED:  

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Jack Capehart
Assistant Professor of Psychology

Date
Acknowledgments

The author wishes to express his appreciation to Dr. Randall Martin for his invaluable participation, cooperation and supervision of this research.

Thanks are also due to Drs. Martha Bernal, Jack Capehart and Robert Lansing for their helpful comments and criticisms during the preparation of this manuscript.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>GSR AS A CRITERION OF EMOTIONAL RESPONSIVITY</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>STATEMENT OF PROBLEM</td>
<td>23</td>
</tr>
<tr>
<td>4</td>
<td>METHOD</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>RESULTS</td>
<td>34</td>
</tr>
<tr>
<td>6</td>
<td>DISCUSSION</td>
<td>58</td>
</tr>
<tr>
<td>7</td>
<td>SUMMARY</td>
<td>67</td>
</tr>
</tbody>
</table>

Appendix

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>RECOGNITION TASK, PROCEDURE 3</td>
<td>68</td>
</tr>
<tr>
<td>B</td>
<td>SHOCKS RECEIVED BY ALL SUBJECTS, PROCEDURE 2 (BOTH CONDITIONS)</td>
<td>69</td>
</tr>
<tr>
<td>C</td>
<td>INTERVIEW DATA, PROCEDURE 2 (SIGNAL)</td>
<td>70</td>
</tr>
</tbody>
</table>

REFERENCES                                                                                   | 74   |
<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CORRELATION BETWEEN GSR AND EXPERIENCED INTENSITY OF STIMULATION.</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>ANALYSIS OF VARIANCE FOR DIFFERENCES IN CONDUCTANCE CHANGE TO ELICITING AND INHIBITORY STIMULI, PROCEDURE 1.</td>
<td>37</td>
</tr>
<tr>
<td>3</td>
<td>ANALYSIS OF VARIANCE FOR DIFFERENCES IN CONDUCTANCE CHANGE TO ELICITING AND INHIBITORY STIMULI, PROCEDURE 2 (DISCRIMINATION).</td>
<td>41</td>
</tr>
<tr>
<td>4</td>
<td>ANALYSIS OF VARIANCE FOR DIFFERENCES IN CONDUCTANCE CHANGE TO ELICITING AND INHIBITORY STIMULI, PROCEDURE 2 (SIGNAL).</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>BETWEEN SUBJECTS CORRELATIONS FOR PRESTIMULUS RESISTANCE LEVEL AND CONDUCTANCE CHANGE, PROCEDURE 2 (SIGNAL).</td>
<td>55</td>
</tr>
<tr>
<td>6</td>
<td>WITHIN SUBJECTS CORRELATIONS FOR PRESTIMULUS RESISTANCE LEVEL AND CONDUCTANCE CHANGE, PROCEDURE 2 (SIGNAL).</td>
<td>56</td>
</tr>
</tbody>
</table>
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conductance Change as a Function of Trials and Eliciting and Inhibitory Conditions, Procedure 1</td>
<td>39</td>
</tr>
<tr>
<td>2</td>
<td>Conductance Change as a Function of Trials and Eliciting and Inhibitory Conditions, Procedure 2 (Discrimination)</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>Conductance Change as a Function of Trials and Eliciting and Inhibitory Conditions, Procedure 2 (Signal)</td>
<td>47</td>
</tr>
<tr>
<td>4</td>
<td>Sample GSR Record of Subject 1, Procedure 2 (Signal)</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>Sample GSR Record of Subject 2, Procedure 2 (Signal)</td>
<td>51</td>
</tr>
<tr>
<td>6</td>
<td>Sample GSR Record of Subject 3, Procedure 2 (Signal)</td>
<td>53</td>
</tr>
</tbody>
</table>
ABSTRACT

An experiment was designed to test the relative effectiveness of two hypotheses to account for the instrumental elicitation and inhibition of the galvanic skin response (GSR) to a discriminatory stimulus for painful shock. The hypotheses were: 1.) Attention diversion is one mechanism by which the mechanism of "repression" can be effected (Solley and Murphy, 1960). 2.) Punishment of an autonomic response will result in augmentation, rather than inhibition of that response (Mowrer, 1960).

Thirty seven students were run in a series of studies designed to investigate the effects of the two instrumental avoidance contingencies on the GSR.

The results were interpreted as supporting the view that "repression" can be effected through the mechanism of selective attention. The second hypothesis was not supported by the GSR data; introspective reports from the subject's however, were generally in support of Mowrer's paradigm.
INTRODUCTION

Throughout the history of the investigation of the learning process, the role of punishment has remained a point of controversy. Among current theorists Mowrer (1960), in his exposition of revised two-factor theory, recognizes punishment as being fundamental to fear conditioning, and postulates that it achieves its action by causing fears to become conditioned to stimuli associated with the occurrence of the punished response. In this theory, the role of punishment, as an incremental reinforcer (fear inducing) is crucial to the explanation of avoidance conditioning.

It is the purpose of the present study to investigate the effects of punishment, as an incremental reinforcer, under conditions of instrumental elicitation and inhibition of the galvanic skin response (GSR).

Traditionally learning theory has neglected the role of the emotions in learning, treating the effects of punishment on the emotions in a manner similar to its effect on skeletal responses. Thorndike (1911), originally held the position that learning is a reversible process, reward strengthening and punishment weakening it. He had little to say about the emotions, postulating hypothetical bonds between stimulus and response,
supposedly established by reward and destroyed by punishment. Thus, early Thorndikean learning theory could account for punishment, but could give no explanation for avoidance learning. Thorndike (1931), later came to the conclusion that his original position had been in error and that, while reward does indeed facilitate learning, punishment does not weaken it.

Pavlov (1927), also neglected to integrate the emotions into an understanding of the effects of punishment; as he attempted to found a science of behavior which was based entirely on unconditioned and conditioned reflexes. He accounted for the effects of punishment by postulating a cortical state of inhibition, supposedly generated by punishment (negative reinforcement) and which functioned to inhibit skeletal responses. Pavlov attempted to account for inhibition and its opposite, excitation, in purely cortical terms, neglecting the autonomic responses so important to modern theory.

Mowrer (1960), with his revised two factor learning theory, has taken the position that the emotions play a central role in those changes in behavior described as learning. For Mowrer, the emotions are important because, essentially, they are what is learned. Fear, hope, relief and disappointment - These are assumed to be the reactions which are most readily and importantly
conditionable; and once conditioned, to either environmental and/or response produced stimuli, they then guide and control performance in a general sensitive, adaptive manner. Emotional responses are held to be involuntary, conditionable and not subject to control through reward and punishment, in the same way as are overt - behavioral responses. Mowrer states:

A movement of some part of the body controlled by skeletal muscles can be inhibited by punishment; if the movement occurs and produces certain characteristic response correlated stimuli, these stimuli, if followed by drive increment, acquire the capacity to arouse fear and thus inhibit the response on future occasions. But let us consider a fear response called out by some objective danger signal, if punished, the effect would be to augment the response, not inhibit it, since danger signal followed by drive increment would be the very condition that brought the fear-to-signal response into existence in the first place (1960, p. 418).

From Mowrer's theory, one would predict that, to the extent to which a particular autonomic response is a valid index of emotion, punishment of this response will have the effect of augmenting the response and reward would have the reverse effect.

Gwinn (1949), has reported one of the few investigations of the way in which emotions and skeletal responses are affected by reward and punishment. This study dealt with fear motivated acts rather than fear itself, but results were consistent with Mowrer's hypothesis in that the effect of punishment was to facilitate a fear motivated act rather than inhibit it.
White and Schlosberg (1952), however, report results which appear to contradict this hypothesis. In a study on classical conditioning of the GSR in which the CS (light) – US (shock) interval was varied, they found a depression in the GSR when the interval was two seconds. Since the latency of the GSR is approximately two seconds, the experimenters speculated that this interval might result in punishment and thus a decrement of the response.

A number of studies indicate that responses previously considered to be involuntary (e.g. autonomic responses) can readily be brought under voluntary control. While these studies have no direct bearing upon Mowrer's current theory, they do appear to contradict his assumption that predictions based on his paradigm are directly observable in various autonomic responses, such as the GSR, or heart rate (Mowrer 1960, pp. 402, 421).

In 1901, Bair published a report of some experiments in which subjects were taught to exercise voluntary control over their previously undifferentiated ear movements. Twitmeyer in 1902, discovered a principle of conditioning independently of Pavlov and observed that voluntary sets on the part of his subjects facilitated the amplitudes of their conditioned responses. Cason in 1922, demonstrated that involuntary processes in human subjects (pupillary dilation and constriction)
could be conditioned. Hudgins (1933) established higher order conditioning of pupillary responses to subvocally produced auto-commands; demonstrating that an involuntary response could be conditioned to a self-initiated stimulus under voluntary control. Kotliarevsky (1936) has reported successful conditioning of pulse retardation to verbal stimuli consisting of self-instructions administered by the subjects themselves. Bersh (1956) has found that a light signal given when a cardiac response is given enables the subject to develop discriminative control over the cardiac conditioned response in an avoidance situation. Bykov (1957) reports conditioning of heart rate by pairing a neutral stimulus with a pharmacological agent.

The most widely used procedure in the acquisition of control of involuntary responses has been, to first classically condition the involuntary response (e.g. GSR) to voluntary response produced stimuli (e.g. a spoken word) and then to observe on test trials, the elicitation of that response by the voluntary response and by a generalized form of the voluntary response (e.g. the subject thinks the word). Although conceptualization of the above findings as indicating voluntary control leads to certain difficulties, as others have pointed out (Kimble, 1961), these studies suggested the mechanism for the instrumental eliciting procedures used in this experiment.
Recent experimenters have focused attention on the influence of the subject's cognitive, or verbalizable expectancies upon the conditioning and extinction of autonomic responses. Mowrer (1938), found that when shock electrodes were left unattached, the GSR to the first presentation of a conditioned stimulus was either very small or entirely absent. Mowrer speculates:

It seems that the unconditioned response and the conditioned response which could be elicited after the light had actually been paired with the shock were largely dependent upon the subject's state of expectancy. A buzzer signal indicated to the subject when the light might be followed by shock and when it would not be, and it was found that the conditioned response (GSR) to the light could be either suddenly extinguished or suddenly disinhibited, merely by changing the subject's internal state of readiness (1938, p. 72).

Staudt and Kubis (1948), observed that the GSR, seemed to be influenced by the amount of attention which the subject could effectively direct toward the stimulus. Razran (1935), reports that when subjects are instructed not to form any associations between the conditioned and conditioning stimuli, no conditioning takes place; the conditioned stimulus showing a strong tendency toward becoming an inhibitor or reverser of the response to be conditioned. He reports a Soviet study where vasodilation (rather than vasoconstriction) was the predominant reaction to shock when this response was made instrumental in shock termination. When subjects were allowed to watch
plethysmographic records of their response to the shock, they were able to control vasodilation and shut off the shock. Razran concludes that autonomic reactions can be modified by subsequent reinforcement and that such reinforcement is effective only when cognition is present. Danko (1962) has recently reported the establishment of "cortical switch-over and cortical switch-off," of autonomic responses in man using both visual and auditory signals.

Notterman, Schoenfeld and Bersh (1952), informed one group of subjects that there would be no further shocks and found extinction of the conditioned heart rate response to be much quicker than in an uninformed group undergoing the same extinction procedure. Branca (1957), undertook intensive questioning of his subjects and related their expectations of shock as well as their verbalizations as to whether the shock was painful or not to the frequency and occurrence of conditioned GSRs. He concluded that expectation of shock as a painful or fearful experience was necessary and sufficient to produce responses to the experimental and generalization stimuli and that such expectancy was the result of awareness of the existing relationships between the experimental stimuli and experience with the unconditioned stimulus.
Chatterjee and Erikson (1962), manipulated the cognitive expectancies of their subjects in three groups by means of different instructions prior to conditioning. Group 1 was told that shock would follow a particular word only. Group 2 was told that shock would follow one particular word only and each remaining word would be followed by one shock sometime during the experiment. Group 3 was told that a certain number of shocks would be administered at certain points during the experiment, but that the experimenter could not tell beforehand when. Conditioning was evident in Groups 1 and 2 but here all subjects had verbalizable expectancies concerning the relationship between stimulus and shock. Group 3 showed no evidence of having conditioned heart rate responses. Group 1 subjects were told following conditioning trial 7 that there would be no further shocks. This information resulted in almost complete extinction of the conditioned heart rate on the first extinction trial. Group 2 subjects were not informed of the termination of conditioning trials and there was no evidence of extinction in this group.

Grings, Carlin and Appley (1962), have demonstrated with human subjects that a tendency to anticipate stimulation (response set) can be manipulated in a situation analogous to classical conditioning. A set
or tendency to anticipate that stimulation would follow a verbal cue (suggesting such stimulation) was inferred from the magnitude of the GSR to the cue.

Coppock (1956), has observed that the amplitude of GSR's to standard stimulation varies in some subjects with their stated intention, or set, to "feel fear" or to "feel no fear".

Mowrer speculates on these findings:

Whether this observation could be confirmed by more systematic experimentation is uncertain; but it is at least suggestive of the phenomenon of "repression." In clinical literature it is not uncommon to read that a given individual "repressed his fear" (of this or that); and the inference might follow that such an inhibition of fear was achieved through a traumatic (punishing) experience of some kind. Despite many conjectures as to how (and if) such repression actually occurs, it is still not well understood (1960, p. 422).

While this description of the mechanism of repression is consistent with current clinical application of the term, it is not consistent with Mowrer's paradigm for emotional learning. According to this paradigm the effect of a punishing stimulus would be to augment an emotional response, not inhibit, or repress it. In any case, the phenomenon which Coppock has described would appear to be most accurately identified as an example of the mechanism of "denial" or "suppression" rather than "repression".
Freud describes these mechanisms as follows:

Consider a mental process seeking to convert itself into action: we know that it can suffer rejection, by virtue of what we call "repudiation" or "condemnation"; whereupon the energy at its disposal is withdrawn, it becomes powerless, but it can continue to exist as a memory. The whole process of decision on the point takes place with the full cognizance of the ego. It is very different when we imagine the same impulse subject to repression: it would then retain its energy and no memory of it would be left behind; the process of repression, too would be accomplished without the cognizance of the ego (1924, p. 304).

O'Kelley and Muckler conceptualize this mechanism as follows: "In repression the individual unconsciously rejects from his awareness those aspects of his past experience that have either immediate or remote potentialities for causing him pain" (1959, p. 50).

White states:

Repression is ordinarily reserved for a particular kind of denial: the forgetting, or ejection from consciousness, of memories of threat, and especially the ejection from awareness of impulses in oneself that might have objectional consequences. Repression thus refers to that in oneself. Denial is applied directly to external dangers (1954, p. 230).

While the distinction between these mechanisms is relatively unambiguously defined in textbooks, a few moments observation of a group of clinicians will soon convince one that the terms "repression" and "suppression" cannot be so readily distinguished in practical experience.
Solley and Murphy (1960), suggest that it is not a sufficient analysis of the problem to say that subjects repress the unpleasantness of a stimulus. Repression is a useful descriptive term, but, even clinically, this term is analyzed into more dynamic components. The authors suggest a number of behavioral mechanisms by which repression can be effected.

1.) The subject may reinterpret the meaning of a punishing event.
2.) Another mechanism which might lead to repression could be the bracing effect we all experience when we know we are going to be hurt unavoidably. We raise our physiological defenses both musically and autonomically.
3.) Another useful mechanism might be the diverting of attention. By actively thinking about something entirely different we can partially avoid the pain (1960, p. 122).

Admittedly, the above conceptualization of the dynamics of repression may not account for all phenomena so labelled, but it does provide a useful basis for experimentation. The "inhibition of fear" or "repression" as suggested by Mowrer might be conceptualized as a diversion of attention. By thinking about something entirely different, when in a threatening situation, it appears that one can partially avoid the pain.

Stern describes vividly how the mechanism of attention diversion may operate:

The dynamic structure of attention must be completed by the ever present counterpart of concentration: dynamic inhibition of the other areas of personal activity.
Since the person's supply of energy is limited at all times, concentration upon one area is obtained at the cost of withdrawing energy from others. The sharper the focus directed upon the specified performance, the duller the background into which all the rest of personal existence is thrown (1938, pp. 475 - 476).

Indeed we would live in a very chaotic perceptual world if we could not "turn off" or at least regulate extraneous sensory stimulation while we pay attention to other stimuli.

Until recently we had no clear conceptualization of how the process which Stern describes could occur. However, several recent studies have demonstrated how this mechanism of selective attention may operate.

Hernandez - Peon, et al. (1956) have demonstrated sensory inhibition to occur in the auditory pathway, during attentive behavior to visual and olfactory stimuli. When auditory signals become irrelevant to the animals they are suppressed almost before they get started up toward the cortex. The authors speculate:

The present observations suggest that the blocking of afferent impulses in the lower portions of a sensory path may be a mechanism whereby sensory stimuli out of the scope of attention can be markedly reduced while they are still in their trajectory toward higher levels of the central nervous system. This central inhibitory mechanism may, therefore, play an important role in selective exclusion of sensory messages along their passage toward mechanisms of perception and consciousness (1956, p. 332).
Hernandez-Peon, et al. (1956) obtained similar results for transmission of photically induced potentials when auditory and olfactory stimuli were attended to. Thus we find this mechanism to operate quite effectively at both a visual and auditory level.

The effects of attention or set in electroencephalographic studies are summarized by Lindsley:

One of the earliest findings by Berger, many times confirmed by others, is the fact that in a relaxed state in the absence of special stimulation the dominant activity is a fairly rhythmic 10-per-second potential oscillation called the alpha rhythm. When light, sound, or other types of sensory stimulation are introduced, the alpha rhythm is blocked or markedly reduced. However this may be, an interesting aspect of sensory stimulation and its effect upon the alpha rhythm is that it seems to depend more upon attention or set under conditions of anticipation, or upon suddenness and unexpectedness, as in arousal by startle, than upon sensory stimulation per se (1951, p. 496).

White (1963), has found that central thought processes in human subjects serve to control sensory input. Subjects were instructed to imagine a beautiful scene and photically induced potentials, as recorded by the EEG, were found to be inhibited.

A study by Epstein and Fenz (1962) would appear to offer further insight into the mechanism of selective attention as a means of inhibiting fear to a punishing stimulus. Responses of novice parachutists to a word-association test were recorded on the day of the first jump and a control day. It was predicted that
parachutists would produce positive gradients of GSR and cognitive deficit as a function of an increasing dimension of stimulus relevance. Results indicated that the parachutists tended to give stories to the relevant cards which were extreme denials of fear of parachuting (calmness and relaxedness of hero). Subjects on the day of a jump denied fear in response to stimuli of high relevance for parachuting, and projected fear and hostility in response to stimuli unrelated to parachuting. The subjects who did not demonstrate such defenses produced steeper GSR gradients to cues of fear of parachuting than the subjects who did. In this study denial of fear was associated with a decrease in physiological (GSR) activation to cues associated with fear.

An analogous phenomenon was reported by Solley and Engel (1961), in a punishment - neutral condition, subjects began asking questions about the experimenter - who was he, what did he do, or where did he live; etc - and managed almost completely to avoid facing their loss of nickels as a punishment stimulus. By diverting their attention, or "leaving the field" so to speak, the children effectively repressed the unpleasantness of the punishment stimulus.

This analysis clearly does not exhaust the possibilities for conceptualizing the dynamics of
repression, but it does serve to illustrate one of the possibilities. The present study proposes to investigate the mechanism by which the subject selectively attends to non-threatening stimuli when faced with a discriminatory stimulus for shock. The GSR was selected as an indicator of emotional responsivity.
GSR AS A CRITERION OF EMOTIONAL RESPONSIVITY

PHYSIOLOGICAL BASIS OF THE GSR

Soon after the discovery of the GSR, usually credited to Fere in 1888, three alternative theories were suggested as to its origin. One, the vascular theory was first expressed by Fere. He thought that vasodilation was the physiological cause of the GSR. Krogh (1929), later demonstrated that there are a variety of vasomotor responses connected to a startle stimulus. Darrow (1927, 1929), gathered evidence against the vascular theory; demonstrating that there are variable vasomotor responses connected with the GSR. Darrow’s findings caused McDowall (1933), to suggest a dual theory of the vascular basis of the GSR. He pointed out that whole blood has a higher resistance than extracellular fluid, thus the diminished blood content of the layers of the skin that comes about through vasoconstriction could cause a fall in skin resistance. Densham and Wells (1927), had found that changes in the tension of the skin can cause electrical changes, and McDowall used this evidence to support the hypothesis that vasodilation might have mechanical effects which would cause a lowering of skin resistance.
Later studies by Darrow (1932, 1937), indicate that there is no causal relation between vascular responses and the GSR. Darrow indicates that blood pressure responses and the GSR, each have a different psychological significance, and suggests that increased blood pressure tends to occur after stimuli of disturbing ideational content, while GSR's occur more frequently in the face of pure sensory stimuli of a startling nature.

Sommer, in 1902, suggested that the GSR was a matter of involuntary muscular activity. A number of studies have cited the effect of muscular tension increase during performance of various tasks - squeezing a dynanometer, sitting up, etc., these tasks increase muscular tension and also decrease general skin resistance. After an extensive review of the literature McCleary (1950), concludes that there is actually only weak evidence to support the muscular theory of GSR origin.

Tarchanoff, in 1890, first suggested that the GSR is the result of some pre-secretory change in the sweat glands. This theory eventually came to rely on two mechanisms. One was that the decreased resistance of the GSR comes about because of the presence of sweat - an electrolyte that can lower skin resistance. The second was that the GSR depends on a change in the sweat glands that precedes actual secretion, such as increased permeability of the cell membrane. The use of fluid
electrodes to obtain the GSR rules out the first suggestion. Further evidence against this theory is demonstrated in the fact that the GSR subsides with far greater speed than would be possible through the evaporation of sweat.

The consensus of evidence lends support to the theory that some presecretory activity of the sweat glands forms the basis of the GSR. Martin (1962), has attempted to manipulate the number of active sweat glands, using iontophoresis with atropine to abolish sweat gland activity. It was found that skin resistance levels rise markedly as the atropine takes effect and active sweat glands decrease in number. GSRs appeared to be completely eliminated by atropine, when sweat gland counts were zero. The exact nature of the changes which occur in the sweat gland to produce the GSR is not known, but it is known that there are electrical changes in these cells just before and during the active phase of secretion.

NERVOUS CONTROL OF THE GSR

Evidence indicates that the sweat glands are innervated exclusively by post-ganglionic fibers of the sympathetic nervous system. Insofar as this system tends to function as a unit, skin conductance may be interpreted as an indicator of sympathetic activity. Woodworth and Schlosberg (1954), conclude that, the sympathetic system
is basic to emotion, more specifically, to activation, and that skin conductance is a valuable measure of activation. There is one factor which complicates the interpretation of the meaning of the GSR as an indicator of activation, the neurohumoral agent at the effector is acetylcholine rather than an adrenergic substance. Hence Darrow suggests that the GSR may not be an adequate measure of changes in activation level, during strong emotion.

Since the GSR can be affected considerably by conscious processes, it appears likely that there is a cortical center mediating control over the response. Wang and Lu (1930), have shown that stimulation of the motor cortex induces a GSR which is abolished by section of the cerebral peduncles, but not by destruction of the hypothalamus. Hence it seems that the motor cortex and pyramidal tract relay impulses to autonomic motor nerves just as they do to somatic motor nerves. Bechterev (1928), found stimulation of the pre-motor (area 6) cortex to elicit the GSR and conversely, removal of the pre-motor area to abolish the reflex. Wang and Richter (1928), have stimulated the tuber-cinereum, in the hypothalamus of cats, producing GSRs in all footpads. Hence the autonomic changes reflected by the GSR appear to be mediated via both the pyramidal and extra-pyramidal areas of the cortex and the hypothalamus at higher levels;
its fibers descending in the front-pontile and temperopon-
tile pathways and finally joining the sympathetic ganglion.

**PSYCHOLOGICAL DETERMINERS OF THE GSR**

There is a great diversity of opinion concerning the psychological correlates of the GSR. Since the GSR is innervated by the sympathetic nervous system, the most numerous claims are those which maintain its correlation with emotion. Woodworth (1938), concludes that if we use the term emotion to describe the individual who is highly energized, tense, or activated; then both level of skin conductance and the GSR are pretty good measures. He describes the condition of danger calling for escape, or avoidance as one of the factors most closely related to the GSR. According to Thouless (1925), the condition of low resistance is apparently a condition of preparedness to react to a stimulus.

In 1926 Wechsler published a study in which he reported on the correspondence between the GSR and subjective judgments of the emotion causing value of a set of stimulus words. Bartlett (1927), characterizes the GSR as a "shift from unpreparedness toward preparedness". Darrow (1927), cites it as an indicator of "mobilization for action." Landis and Hunt (1935), have found the conscious content reported most frequently
when the largest changes in sympathetic activity took place, was that called by the observers, "tension or startle."

Grumbaum (1922), correlates the GSR with attention. Cattell (1933), has accepted this response as a measure of the conative tendency and has accepted it in a battery of temperament tests. Staudt and Kubis (1948), found the GSR to be influenced by the "amount of attention" which the subject can effectively direct toward the stimulus. McCleary states: "Like other autonomic responses, the GSR cannot be voluntarily inhibited when an adequate stimulus situation is present" (1950, p. 99).

McCurdy (1950), has compiled the following table from the findings of a number of studies attempting to correlate GSR magnitude and experienced intensity of stimulation.

Table 1.
Correlation between GSR and Experienced Intensity of Stimulation

<table>
<thead>
<tr>
<th>Study</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch (1910)</td>
<td>.81</td>
</tr>
<tr>
<td>Wells &amp; Forbes (1911)</td>
<td>.93</td>
</tr>
<tr>
<td>Wells (1924)</td>
<td>.82</td>
</tr>
<tr>
<td>Wechsler (1925)</td>
<td>.59</td>
</tr>
<tr>
<td>Syz (1926)</td>
<td>.45</td>
</tr>
<tr>
<td>Bartlett (1927)</td>
<td>.78</td>
</tr>
<tr>
<td>Cattell (1929)</td>
<td>1.00</td>
</tr>
<tr>
<td>Patterson (1930)</td>
<td>.59</td>
</tr>
<tr>
<td>Dysinger (1931)</td>
<td>.87</td>
</tr>
<tr>
<td>McCurdy (1948)</td>
<td>.76</td>
</tr>
</tbody>
</table>
This table would seem to indicate a definite relationship between GSR magnitude and intensity of stimulation.

Lindsley has cogently summarized current opinion as to the significance of this response, "the GSR is particularly sensitive to sensory and ideational stimuli, especially those associated with alertness, attention, apprehension and arousal" (1951, p. 475).
STATEMENT OF PROBLEM

The purpose of the present study was to investigate the attentional processes which mediate the instrumental elicitation and inhibition of the GSR, to a discriminatory stimulus for shock. It was anticipated that this procedure would offer evidence in regard to two hypotheses recently formulated by Mowrer (1960) and Solley and Murphy (1960) respectively. These hypotheses were: 1. Attention diversion is one mechanism by which the mechanism of "repression" can be effected (Solley and Murphy, 1960). 2. Punishment of an autonomic response will augment rather than inhibit the response (Mowrer, 1960).

The study was designed as a series of experiments comparing the effects of two instrumental avoidance contingencies on the GSR. In one, the avoidance of shock was contingent upon the occurrence of a GSR to a fear stimulus; in the other, avoidance was contingent upon inhibition of the GSR. For purposes of exposition, the former will be termed the eliciting stimulus, the latter the inhibitory stimulus. Preliminary results indicated that those subjects who were most successful in avoiding shock were able to do so by adopting certain attentional
sets before the presentation of the two stimuli. The experimental procedure was modified to facilitate these attentional sets.

An additional experiment was designed to determine the extent to which "voluntary control" was accomplished by means of selective attention. The measure of selective attention was post-experimental recognition of incidental verbal stimuli. All conditioned and incidental stimuli in this study were visual.
METHOD

SUBJECTS

The subjects were 37 volunteer male students enrolled at the University of Arizona.

APPARATUS

A Grass Model 5 polygraph was used for continuous recording of the subject's GSRs. In addition to the pen recording the GSR, another event marking pen was also triggered from appropriate leads from the Hunter timing equipment. It was used to indicate the onset and termination of the eliciting and inhibitory stimuli, and the unconditioned stimulus (shock).

Shock was faradic stimulation from a Lafayette inductorium supplied with a 1½ volt, DC source in the primary. The eliciting and inhibitory stimuli used in the experiment were two 15 watt light bulbs, one a standard white bulb (eliciting), the other a medium green (inhibitory).

PROCEDURE

The research reported here was conducted as a series of related studies.
When the subject arrived at the laboratory, he was taken into a dimly lit, sound insulated and electrically shielded room and seated in a standard classroom desk. He was instructed to relax his right arm, and the palm, index and third fingers of the right hand were cleaned with alcohol. The GSR (\(\frac{3}{4}''\) zinc) electrodes, coated with bentonite electrode compound (Medcraft) were taped to the subject's fingers. Shock electrodes were attached to the calf of the right leg. The subject was informed that the experiment involved electric shock and that the experimenter wished to gradually increase the shock level to the highest intensity which he could tolerate. The shock level was adjusted and the apparatus, which was located in an adjoining room, was adjusted to the subject's basal resistance level.

**PROCEDURE I:**

The following instructions were then read to each of the seventeen subjects run in this procedure. The doors to the experimental room were closed.

Throughout the experiment, this light will come on here, like this (demonstrate). When it comes on, it means that sometime later a shock will follow unless you do something to prevent the shock from occurring. What you are to do is to learn what to do that will enable you to avoid the shock.

Remember, the light will come on and then sometime later you will be shocked if you don't do the correct thing. If you do the correct
thing then you won't be shocked. When the light
goes off and you haven't received a shock, this
will indicate that you won't be shocked on this
trial. (The subjects were instructed to relax
and to refrain from any abrupt movements and
deep or uneven breathing, while still remaining
alert and attentive to the environment.)

The light will come on and the shock will
follow. If the light goes out and you are not
shocked, then that means that you have been
successful in avoiding the shock.

Any questions?

A 15 watt white light served as both the eliciting
and inhibitory stimuli. The first two presentations of
the stimulus were followed by the UCS (shock) as in a
classical conditioning procedure. The subjects were then
given 30 successive eliciting trials. In the eliciting
phase, the avoidant response was originally defined as
a resistance drop of at least 1,000 ohms. The occurrence
of this response at any time during a five second interval
in which a light preceded shock, terminated the stimulus-
light and prevented the shock. Otherwise, a .5 second
shock was administered after five seconds of the stimulus
(light).

After the 30 successive eliciting trials the
following instructions were read to the subjects: Now
we are going to reverse the procedure. This time you can
avoid the shock by simply not making any response to the
light.

In the inhibitory phase, a resistance drop of 500
ohms or greater at any time during the five seconds of
stimulus presentation was punished by a .5 second shock. If a resistance drop of no more than 500 ohms occurred, the stimulus remained on, terminating without shock, after a total of five seconds.

While the experimenter attempted to adhere to these criteria, it was found to be extremely difficult to judge responses in this manner while conducting the experiment. Responses were most frequently judged in reference to a subjective "norm" of the magnitude of resistance change to the eliciting stimulus on previous trials. In effect, the inhibitory response criterion was modified so that if the resistance drop to the inhibitory stimulus was not more than approximately one-fourth of the "subjective norm" response magnitude to the eliciting stimulus, the subject was not shocked.

A second factor which complicated the continued use of these criteria was the fact that the actual magnitude of these changes in resistance level was dependent, in large part, on the pre-stimulus basal resistance level and consequently conductance change could not readily be determined by visual inspection.

Since shock avoidance was less frequent during the inhibitory than the eliciting phase, the greater magnitude of the GSR to the eliciting stimulus could be interpreted as reflecting the effects of partial
reinforcement. The decrement during the inhibitory phase might also have been a function of habituation. Procedure 2 was devised as an attempt to control these variables.

PROCEDURE 2A (DISCRIMINATION)

In this experiment a discrimination procedure was used. The stimulus for the eliciting trials was a 15 watt white light; for the inhibitory trials, a 15 watt green light. There were fifteen eliciting and fifteen inhibitory trials which were alternated so that startle effects would be minimized. The inhibitory response criterion was modified so that if the resistance drop to this stimulus was not more than approximately one-fourth of that which constituted the experimenter's "subjective norm", of the subject's average response magnitude to the eliciting stimulus; the subject was not shocked.

The instructions given to the 13 subjects run in the discrimination procedure were as follows:

Throughout the experiment, one of these lights will come on here, like this (demonstrate). When either of these lights come on, it means that sometime later a shock will follow unless you make the correct response and prevent the shock from occurring. In other words, by making the correct response you can avoid the shock.

The responses you are to make to the different lights are as follows:

a.) Upon presentation of the white bulb you can avoid the shock by reacting fearfully. In other
words, I want you to react to the white light with an internal fear response; by doing so you can avoid the shock.

b.) Upon presentation of the green light, the response which will enable you to avoid the shock is one of complete relaxation. In other words, when the green light comes on, you are to relax and inhibit any response. If you do not react fearfully to the green light you will avoid the shock. (The subjects were instructed to relax and to refrain from any abrupt movements and deep or uneven breathing, while still remaining alert and attentive to the environment.)

Remember, the white light will come on and the shock will follow, unless you give an internal fear response to the light. When the green light comes on the correct response is one of relaxation; or no response. Some subjects find it easiest to avoid responding to the green light by imagining a peaceful scene.

One of these lights will come on and the shock will follow unless you make the correct response. If the light goes out and you are not shocked then that means that you have made the correct response and avoided the shock.

A pilot study conducted with this procedure indicated that there was still more successful shock avoidance to eliciting than to inhibitory stimuli. Extensive questioning of subjects revealed that those who were the least successful inhibitors, characteristically relied upon some method of estimating the temporal sequence between eliciting and inhibitory stimuli to determine when to adopt the proper "cognitive set" and control their responses to the stimuli. Since the interval between stimuli was varied between 10 and 20 seconds this was a difficult task.
PROCEDURE 2B (SIGNAL)

The procedure was modified further so as to facilitate the subjects' estimation of the temporal sequence between eliciting and inhibitory stimuli. Following the thirty trials as described, thirty additional trials were run with a ready signal. This signal consisted of a momentary flash of the appropriate stimulus, four to six seconds before each trial. The effect of this signal was to markedly increase the ability of the subjects to meet the inhibitory criterion without affecting responses to the eliciting stimulus, and to eliminate the difference in successful shock avoidance.

After the first thirty trials (discrimination procedure) the following instructions were given. Now we will flash each light a few seconds before each trial to let you know when to get ready. You are to continue making the same responses to the lights. Immediately following the sixty trials (discrimination and signal procedures) subjects were asked the following questions:

1. What did you do when the white light was on?
2. What did you do when the green light was on?
3. Which light did you dislike the most?
4. Were you more afraid of, or dread one of the lights more than the other?
Subjects were then extricated from the recording and shock electrodes and permitted to leave the experimental room.

PROCEDURE 3

Seven additional subjects were run in a procedure designed to yield more reliable information in regard to the ability to elicit or inhibit the GSR. These subjects were first run for thirty trials under the signal procedure; they were then read the following instructions:

Now we will present some words with the lights; you are to continue making the same responses to the lights.

Neutral words selected for equivalent frequency of occurrence were typed in large letters and mounted in 35 mm slides. A Kodak slide projector was used in projecting the stimuli on a ground glass screen located eighteen inches above the light stimuli. The neutral words were projected briefly above the eliciting and inhibitory stimuli approximately two seconds after the onset of each trial. No further changes were effected in the signal procedure.

Following thirty alternating eliciting and inhibitory trials, the subjects were presented with a mimeographed list of words (appendix A) containing the thirty projected and forty-five filler words and were
instructed to check which of the words they recognized as having occurred during the experiment.
RESULTS

Statistical evaluation of the data consisted of the following: (1) A three-way analysis of variance (subjects by conditions by trials) was performed on the three sets of data obtained in procedures 1 and 2 (discrimination and signal conditions). (2) A between subjects correlation was computed between prestimulus resistance level and conductance change (procedure 2, signal condition). (3) A within subjects correlation was computed between prestimulus resistance level and conductance change (procedure 2, signal condition). (4) A correlation was computed between prestimulus resistance level and conductance change for all scores obtained in procedure 2 (signal condition). (5) A t test was employed to test for differences in recognition of neutral words presented in procedure 3.

UNITS OF MEASUREMENT

Lacey (1949), reports that resistance change is correlated with basal resistance (prestimulus level). Since resistance level, in this experiment, most frequently increased as a function of trials, two discrete responses of the same magnitude but superimposed on this shifting resistance level could not be considered to be equivalent.
If a subject had a high resistance level immediately preceding the eliciting stimulus, it would be easier for him to respond with a 1,000 ohm, or greater resistance drop, than if he had a low prestimulus resistance level. Conversely, if he had a low prestimulus resistance level immediately prior to the inhibitory stimulus, he would be more likely to show a small resistance drop than if his prestimulus level were high.

Because of the above possibilities, the subject's responses to the eliciting and inhibitory stimuli, while different in terms of resistance change may have actually been the same (or different in the opposite direction) "psychologically" or "physiologically". Thus, the subject may have been more "afraid" of the inhibitory stimulus, although his GSR in terms of resistance change was actually less to the inhibitory than to the eliciting stimulus.

Clearly then, defining the critical response magnitude in terms of resistance change presented problems in terms of the interpretation of analyses of responses to the eliciting and inhibitory stimuli. It was decided that measurement units other than resistance (ohms) would be used in plotting response magnitudes, statistical analyses, etc. In this experiment conductance (micromhos), or the reciprocal of resistance change, was used as the response measure analyzed. Lacey (1949), concludes that
such a measure is similar to a percent resistance change and corrects in part for the presumed correlation between prestimulus resistance and resistance change.

**PROCEDURE 1**

The results of the analysis of variance of conductance change to the eliciting and inhibitory stimuli, presented in procedure 1, appear in Table 2.

A significant difference was demonstrated between conductance change to the eliciting and inhibitory stimuli (.01 level). The interaction of conditions and trials was also significant (.05 level). Conductance change curves for the eliciting and inhibitory conditions are presented in Figure 1.

Because shock avoidance was less frequent to the inhibitory stimulus (252 shocks) than to the eliciting stimulus (67 shocks), procedure two was devised to attempt to eliminate this difference.
Table 2.

Analysis of Variance for Differences in Conductance Change to Eliciting and Inhibitory Stimuli in Procedure 1.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions (C)</td>
<td>1</td>
<td>32.98</td>
<td>32.98</td>
<td>10.46**</td>
</tr>
<tr>
<td>Trials (T)</td>
<td>4</td>
<td>5.55</td>
<td>1.39</td>
<td>1.51</td>
</tr>
<tr>
<td>Subjects (S)</td>
<td>16</td>
<td>221.34</td>
<td>13.83</td>
<td></td>
</tr>
<tr>
<td>C by T</td>
<td>4</td>
<td>11.42</td>
<td>2.86</td>
<td>3.62*</td>
</tr>
<tr>
<td>C by S</td>
<td>16</td>
<td>50.43</td>
<td>3.15</td>
<td></td>
</tr>
<tr>
<td>T by S</td>
<td>64</td>
<td>59.03</td>
<td>.93</td>
<td></td>
</tr>
<tr>
<td>C by T by S</td>
<td>64</td>
<td>50.62</td>
<td>.79</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>169</td>
<td>431.38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .05 level.

**Significant at .01 level.
Figure 1.

Conductance Change as a Function of Trials and Eliciting and Inhibitory Conditions, Procedure 1.
PROCEDURE 2 (DISCRIMINATION)

Table three shows the results of the analysis of variance of data obtained under procedure 2 (discrimination).

A significant difference was found between conductance change to the eliciting and inhibitory stimuli (.025 level). A significant effect was also obtained for trials (.025 level). Conductance change curves for the eliciting and inhibitory conditions are presented in Figure 2.

Shock avoidance was again, however, less frequent to the inhibitory criterion (130 shocks) than to the eliciting stimulus (22 shocks). A record of the shocks received during procedure 2 is presented in Appendix B.
### Table 3.

Analysis of Variance for Differences in Conductance Change to Eliciting and Inhibitory Stimuli, Procedure 2 (discrimination).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions (C)</td>
<td>1</td>
<td>576.75</td>
<td>576.75</td>
<td>6.55*</td>
</tr>
<tr>
<td>Trials (T)</td>
<td>14</td>
<td>448.96</td>
<td>32.07</td>
<td>2.04*</td>
</tr>
<tr>
<td>Subjects (S)</td>
<td>12</td>
<td>3298.04</td>
<td>274.84</td>
<td></td>
</tr>
<tr>
<td>C by T</td>
<td>14</td>
<td>163.86</td>
<td>11.70</td>
<td>.78</td>
</tr>
<tr>
<td>C by S</td>
<td>12</td>
<td>976.48</td>
<td>81.37</td>
<td></td>
</tr>
<tr>
<td>T by S</td>
<td>168</td>
<td>2640.64</td>
<td>15.72</td>
<td></td>
</tr>
<tr>
<td>C by T by S</td>
<td>168</td>
<td>2507.83</td>
<td>14.93</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>389</td>
<td>10612.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .025 level.
Figure 2.

Conductance Change as a Function of Trials and Eliciting and Inhibitory Conditions, Procedure 2 (Discrimination).
MEAN CONDUCTANCE CHANGE (MICROMHOS)

TRIALS

ELICITORY

INHIBITORY
PROCEDURE 2 (SIGNAL)

The results of an analysis of variance of conductance change to the eliciting and inhibitory stimuli obtained in procedure 2 (signal) appear in Table 4.

A significant difference was obtained between conductance change to the eliciting and inhibitory stimuli (.025 level). There was also a significant effect due to trials (.05 level). The interaction between conditions and trials approached significance with 14 and 168 degrees of freedom (F of 1.75 is required for significance at the .05 level). The conductance change curves of the eliciting and inhibitory trials are presented in Figure 3. Photocopies of the GSR records of three subjects (signal condition) are presented in Figures 4, 5 and 6. Shock avoidance was less frequent to the eliciting (60 shocks) than to the inhibitory stimulus (51 shocks).
Table 4.
Analysis of Variance for Differences in Conductance Change to Eliciting and Inhibitory Stimuli, Procedure 2 (Signal).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions (C)</td>
<td>1</td>
<td>1547.27</td>
<td>1547.27</td>
<td>6.56**</td>
</tr>
<tr>
<td>Trials (T)</td>
<td>14</td>
<td>390.88</td>
<td>27.92</td>
<td>1.76*</td>
</tr>
<tr>
<td>Subjects (S)</td>
<td>12</td>
<td>2246.79</td>
<td>187.23</td>
<td></td>
</tr>
<tr>
<td>C by T</td>
<td>14</td>
<td>357.37</td>
<td>25.53</td>
<td>1.55</td>
</tr>
<tr>
<td>C by S</td>
<td>12</td>
<td>2826.10</td>
<td>235.51</td>
<td></td>
</tr>
<tr>
<td>T by S</td>
<td>168</td>
<td>2657.79</td>
<td>15.82</td>
<td></td>
</tr>
<tr>
<td>C by T by S</td>
<td>168</td>
<td>2761.82</td>
<td>16.44</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>389</td>
<td>12788.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .05 level.

**Significant at .01 level.
Figure 3.
Conductance Change as a Function of Trials and Eliciting and Inhibitory Conditions, Procedure 2B (Signal).
The graph shows the mean conductance change (in microhmhos) across different trials. The solid line represents the elicitory condition, which shows an increasing trend, while the dashed line represents the inhibitory condition, which does not show significant changes across trials.
Figure 4.
Sample GSR Record of Subject 1, Procedure 2B (Signal).
Figure 5.

Sample GSR Record of Subject 2, Procedure 2B (Signal).
Figure 6.

Sample GSR Record of Subject 3, Procedure 2B (Signal).
The results of a between subjects correlation, computed for prestimulus resistance level and conductance change, are presented in Table 5.

No significant correlations were indicated between these variables.

A within subjects correlation was computed for prestimulus resistance level and conductance change. The results of this correlation are presented in Table 6.

Significant positive correlations between prestimulus resistance and conductance change were obtained for six subjects.
### Table 5.

<table>
<thead>
<tr>
<th>Trials</th>
<th>Eliciting r</th>
<th>Inhibitory r</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-.03</td>
<td>-.08</td>
</tr>
<tr>
<td>2</td>
<td>-.02</td>
<td>-.52</td>
</tr>
<tr>
<td>3</td>
<td>-.21</td>
<td>-.25</td>
</tr>
<tr>
<td>4</td>
<td>-.20</td>
<td>.01</td>
</tr>
<tr>
<td>5</td>
<td>-.42</td>
<td>-.37</td>
</tr>
<tr>
<td>6</td>
<td>-.28</td>
<td>-.17</td>
</tr>
<tr>
<td>7</td>
<td>-.16</td>
<td>-.25</td>
</tr>
<tr>
<td>8</td>
<td>-.32</td>
<td>-.30</td>
</tr>
<tr>
<td>9</td>
<td>-.23</td>
<td>-.25</td>
</tr>
<tr>
<td>10</td>
<td>-.34</td>
<td>.04</td>
</tr>
<tr>
<td>11</td>
<td>-.50</td>
<td>.06</td>
</tr>
<tr>
<td>12</td>
<td>-.39</td>
<td>-.14</td>
</tr>
<tr>
<td>13</td>
<td>-.16</td>
<td>.02</td>
</tr>
<tr>
<td>14</td>
<td>-.06</td>
<td>-.28</td>
</tr>
</tbody>
</table>

N=13
Table 6.

Within Subjects Correlations for Prestimulus Resistance Level and Conductance Change Procedure 2 (Signal).

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Correlation Coefficient</th>
<th>N=30</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.41*</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>.36*</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>-.17</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>.24</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>.30</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>.33</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>.43*</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>.18</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>.62**</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>-.01</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>.55**</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>-.10</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>.56</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the .05 level.

**Significant at the .01 level.
A correlation coefficient was computed between prestimulus resistance and conductance change, for all responses recorded during this procedure. Results indicate a significant negative relationship ($r = 0.17$, .01 level, $N = 390$) between these variables. Since the correlation between prestimulus resistance and conductance change accounted for only a very small proportion of the total variance ($r^2 = 0.0289$) possible use of the analysis of covariance was deemed unnecessary.

PROCEDURE 3

A $t$ test was computed for differences in recognition of neutral words (procedure 3). A significant difference was found ($t = 4.258$, .01 level) between recognition of the neutral words paired with the eliciting and inhibitory stimuli.
Discussion

The results of the present investigation are not in agreement with Mowrer's hypothesis that punishment of an autonomic "fear response" would augment rather than inhibit this response.

In procedure 1, the effects of two instrumental avoidance contingencies on the GSR were compared. In one (eliciting), the avoidance of shock was contingent upon the occurrence of a GSR to a shock stimulus; in the other (inhibitory), avoidance was contingent upon inhibition of the GSR. Contrary to Mowrer's hypothesis, punishment of the GSR resulted in a significant decrement in response magnitude. Results also indicated that subjects learned to control their responses to the appropriate stimuli more effectively as training increased.

A number of weaknesses in the experimental design employed in procedure 1 prevented an unambiguous interpretation of these results. Since shock avoidance was less frequent during the inhibitory condition, the greater magnitude of the GSR to the eliciting stimulus could be interpreted as reflecting the effects of partial reinforcement. That is the response decrement during the inhibitory phase might also have been due to a greater
degree of habituation to the inhibitory stimulus following the repeated experience of shock. The experimental procedure was modified to control this variable.

In procedure 2, different colored lights, presented in alternation, served as the eliciting and inhibitory stimuli. In effect, this procedure presented the subject with a task in discrimination learning, that is he was required to respond to one stimulus and not to respond to the other. Again punishment of the GSR resulted in a significantly smaller response to the inhibitory stimulus. The greater frequency of shock avoidance to the eliciting stimulus again rendered interpretation of these results ambiguous.

Informal questioning of a number of pilot subjects revealed that they characteristically avoided shock during the inhibitory trials by adopting a "mental set" which enabled them to selectively attend to neutral stimuli. By diverting their attention to some "non-threatening" stimulus immediately before presentation of the inhibitory stimulus, the subjects were able to avoid the shock. The subjects frequently reported that those trials on which they were shocked were most often those in which they had failed to correctly anticipate the interval between presentation of stimuli.
The experimental procedure was modified further in order to facilitate the subject's correct estimation of the temporal sequence of stimulus presentation. The procedure was modified so that a signal, which consisted of a momentary flash of the appropriate stimulus, was presented from four to six seconds before each trial. The effect of this signal was to markedly increase the ability of the subjects to meet the inhibitory criterion without affecting responses to the eliciting stimulus, and to eliminate the difference in successful shock avoidance with respect to the two conditions.

The effects of the two instrumental avoidance contingencies on GSR magnitude obtained during this procedure appear amenable to unambiguous interpretation. The results indicate that in a situation where the GSR is punished, the subject will learn to inhibit this response in order to avoid punishment. It appears then, that insofar as the GSR can be considered an "autonomic fear response", Mowrer's prediction was not supported. These results also contradict a statement made by McCleary: "Like other autonomic responses, the GSR cannot usually be voluntarily inhibited when an adequate stimulus situation is present" (1950, P. 99). Apparently many researchers in the area of autonomic conditioning have failed to adequately account for the role of central factors, such as attentional sets, in the control of these responses.
Contrary to the anticipated adaptation of the GSR to the eliciting stimulus, the results indicated an increase in response magnitude as training progressed (Figure 3). Stewart, et al. (1961), report that the GSR rapidly extinguishes as the subject becomes habituated to the presentation of a conditioned stimulus. Perhaps the parallel between this procedure and a task in discrimination learning can account for this effect. As training progressed the subjects were better able to attend to those stimuli which most effectively enabled them to control the GSR.

The results of the within subjects correlation presented in Table 6, appear somewhat contradictory. As resistance level increases there is a progressively larger base for resistance change (ohms), since conductance is the reciprocal of this measure one would expect a negative relationship between increasing resistance level and conductance change. Contrary to expectations the significant correlations obtained between these variables were all positive.

The correlation coefficient computed between prestimulus resistance and conductance change for all responses (signal) was significant in the anticipated direction. Since this correlation coefficient accounted for only a small proportion of the total variance, further analyses were deemed unnecessary. Lacey reports: "It
seems safe to conclude, that any deviations from normality or correlation with basal level which may exist in the distributions of conductance units must be relatively unimportant. The application of ordinary statistical treatments will introduce no significant error" (1949, P. 125). While this statement appears well founded, one can but suggest caution in the interpretation of these results.

Analysis of the interview data obtained during the signal procedure (Appendix C) indicated that subjects reported distinctly different strategies in responding to the eliciting and inhibitory stimuli. Most subjects reported thinking of an "unpleasant" or "fearful" experience (often the shock) during the eliciting trials. Many reported that they were able to inhibit their GSRs to the inhibitory stimulus by thinking of a "relaxing scene". Most subjects reported that they were more afraid of, or dreaded most, the appearance of the inhibitory stimulus. A majority reported feeling much less confident about their ability to avoid shock to the inhibitory stimulus, yet shock avoidance was most frequent to this stimulus.

On the basis of these results it seems reasonable to conclude that, while the GSR data clearly contradicted Mowrer's hypothesis, the subject's introspective reports were in the predicted direction. Perhaps the most
definitive statement which can be derived from these results is that Mowrer is mistaken in his assumption that predictions derived from his paradigm are directly observable in autonomic activity. This experiment demonstrates that autonomic activity is markedly affected by factors such as the subject's feelings, mental set and the instructions given to the subject at the outset of the experiment.

Subjects appear to vary considerably in their ability to control the GSR. Most typically those subjects who responded with large GSRs to the eliciting stimulus were less successful in meeting the inhibitory criterion, and vice versa. It appears that those subjects who characteristically utilize the mechanism of selective attention as a means of coping with experience, were also able to meet the experimental criteria quite readily. The post-experimental interview with one such subject resulted in the following information:

I am a voice major and frequently sing in front of large audiences. I always get stage fright just before a performance and my mouth becomes dry. Well that obviously doesn't help my singing any, so I've learned to control my nerves by concentrating as hard as I can on what I have to do. That's what I did here, when that green light came on I just concentrated on being calm.

In his discussion of the Coppock study, Mowrer (1960), speaks of the similarity between the influence of attentional set on the GSR and the mechanism of
repression. Solley and Murphy (1960), have similarly attempted to conceptualize some aspects of this mechanism in terms of selective attention. The reports of the subjects as to the manner by which they were able to successfully control their GSRs, were strikingly similar to the Solley-Murphy hypothesis. By attending to some non-threatening stimulus the subjects were able to inhibit their GSRs to a discriminatory stimulus for painful shock.

The results of procedure 3 yield more reliable information as to the subjects' use of selective attention. The pairing of neutral words with the eliciting and inhibitory stimuli resulted in the recognition of fewer words which accompanied the inhibitory stimulus. Contrary to expectations, all subjects reported that they had looked at all of the words, but had attempted to attend to something else during the inhibitory trials. Thus it appears that the visual stimuli presented in this experiment were inhibited, or "shut out" by a central process (e.g. selective attention) prior to stimulation.

One effect of the various mechanisms of defense frequently commented upon is that they result in an inaccurate or restricted perception of reality. This effect was demonstrated in the subjects' estimates of the number of shocks received to the eliciting and inhibitory stimuli. In every case, the subjects reported receiving
a greater number of shocks to the inhibitory stimulus. One subject reported being shocked upon each presentation of the inhibitory stimulus and never to the eliciting stimulus. Contrary to these reports, each subject received a greater number of shocks during the eliciting trials.

We know that the strength of a behavior can be increased, given an experimental situation in which the avoidance of a painful stimulus is contingent upon some response. In this experiment the subject could avoid painful shock through the instrumental elicitation and inhibition of the GSR. This learning involved, principally, the active discrimination of perceptual cues which would permit the subject to recognize that punishing events were coming, thus giving him time to avoid the shock. Subjects were able to control their GSRs by selectively attending to those stimuli considered to be relaxing, or neutral during the inhibitory trials, and to those considered painful or fearful during the eliciting trials.

One interesting application of these findings might serve to further elucidate the personality dynamics frequently observed in hysteria. Schafer describes the behavioral characteristics of this diagnostic group as follows:

This term covers those persons who rigidly and pervasively resort to the defense of repression in their efforts to cope with their impulses and
the demands of the world about them. Excessive reliance on this defense appears to hamper the development of broad intellectual, cultural interests, to impair the ability for independent and creative thinking, and to make for striking emotional lability and naivete (1954, P. 48).

The author next interprets a patient's response to card 19 of the Thematic Apperception Test. "Not discerning the woman in bed is a further distortion and suggests unusually intense repression" (1954, P. 300). It seems clear that this response might more precisely be interpreted as suggesting unusually strong selective attention. Again, when Schafer speaks of the "excessive reliance on repression" as resulting in the restriction of the development of broad intellectual and cultural interests, one wonders if he isn't applying the term to behavior which might be less ambiguously labelled as selective attention.
Summary

An experiment was designed to test the relative effectiveness of two hypotheses to account for the instrumental elicitation and inhibition of the galvanic skin response to a discriminatory stimulus for painful shock. The hypotheses were; 1.) Attention diversion is one mechanism by which the mechanism of "repression", as defined by Solley and Murphy (1960), can be effected. 2.) Punishment of an autonomic response will result in augmentation, rather than inhibition of that response (Mowrer, 1960).

Thirty seven students were run in a series of studies designed to investigate the effects of the two instrumental avoidance contingencies on the GSR.

The results were interpreted as supporting the view that one manner in which "repression" can be effected is through the mechanism of selective attention. The GSR data did not confirm the second hypothesis in that, punishment of the GSR resulted in inhibition of this response. Most subjects were able to inhibit their GSR to the appropriate stimulus by "thinking of something pleasant; or relaxing." The subject's verbal reports were generally in support of Mowrer's hypothesis, in that most subjects reported being more afraid of the inhibitory stimulus.
# APPENDIX A

**RECOGNITION TASK, PROCEDURE 3**

<table>
<thead>
<tr>
<th>Millionaire</th>
<th>Spanking</th>
<th>Jump</th>
<th>Obvious</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrupt</td>
<td>Dusky</td>
<td>Politician</td>
<td>Mold</td>
</tr>
<tr>
<td>Hot</td>
<td>Dim</td>
<td>Hurried</td>
<td>Rigid</td>
</tr>
<tr>
<td>Pig</td>
<td>Plain</td>
<td>Severe</td>
<td>Somber</td>
</tr>
<tr>
<td>Narrow</td>
<td>Army</td>
<td>Rapid</td>
<td>Pungent</td>
</tr>
<tr>
<td>Dirt</td>
<td>Fiery</td>
<td>Dark</td>
<td>Low</td>
</tr>
<tr>
<td>Elegant</td>
<td>Heavy</td>
<td>Bottom</td>
<td>Rugged</td>
</tr>
<tr>
<td>Bristly</td>
<td>Far</td>
<td>Under</td>
<td>Intermittent</td>
</tr>
<tr>
<td>Boulder</td>
<td>Square</td>
<td>Briny</td>
<td>Round</td>
</tr>
<tr>
<td>Lemon</td>
<td>Hard</td>
<td>Curled</td>
<td>Liquor</td>
</tr>
<tr>
<td>High</td>
<td>Run</td>
<td>Base</td>
<td>Deep</td>
</tr>
<tr>
<td>City</td>
<td>Sword</td>
<td>Mallet</td>
<td>Coarse</td>
</tr>
<tr>
<td>Frosty</td>
<td>Continuous</td>
<td>Lofty</td>
<td>Slack</td>
</tr>
<tr>
<td>Easy</td>
<td>Slow</td>
<td>Sudden</td>
<td>Box</td>
</tr>
<tr>
<td>Obscure</td>
<td>Trunk</td>
<td>Hasty</td>
<td>Arched</td>
</tr>
<tr>
<td>Pigment</td>
<td>Small</td>
<td>Fervid</td>
<td>Fast</td>
</tr>
<tr>
<td>Snail</td>
<td>Shady</td>
<td>Long</td>
<td>Foot</td>
</tr>
<tr>
<td>Rough</td>
<td>Wagon</td>
<td>Boy</td>
<td>Coiled</td>
</tr>
<tr>
<td>Knife</td>
<td>Block</td>
<td>Short</td>
<td></td>
</tr>
</tbody>
</table>

68
APPENDIX B

SHOCKS RECEIVED BY ALL SUBJECTS, PROCEDURE 2 (DISCRIMINATION).

<table>
<thead>
<tr>
<th>Trials</th>
<th>Eliciting</th>
<th>Inhibitory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 3</td>
<td>2</td>
<td>30</td>
</tr>
<tr>
<td>4 - 6</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>7 - 9</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td>10 - 12</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>13 - 15</td>
<td>6</td>
<td>25</td>
</tr>
</tbody>
</table>

SHOCKS RECEIVED, ALL SUBJECTS, PROCEDURE 2 (SIGNAL).

<table>
<thead>
<tr>
<th>Trials</th>
<th>Eliciting</th>
<th>Inhibitory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 3</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>4 - 6</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>7 - 9</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>10 - 12</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>13 - 15</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
APPENDIX C
SUBJECT'S RESPONSES TO QUESTIONS,
PROCEDURE 2 (SIGNAL).

QUESTIONS
1. What did you do when the white light was on?
2. What did you do when the green light was on?
3. Which light did you dislike the most?

ANSWERS

A 1.) I tensed up when the white light came on.
2.) I started counting the holes in the tile above the green light.
3.) I didn't like the green light, it seemed harder to do whatever I was supposed to be doing to that one.

B 1.) Tried to think of things that frighten me, like looking down from a high place.
2.) Pictured myself on a beach, relaxed, but sometimes I'd get nervous and just couldn't switch fast enough.
3.) Well, I'd rather the white light, seemed as though I wasn't shocked as much.

C 1.) Thought of that shock, just imagined that feeling in my leg.
2.) I'd tell myself, nothing is going to happen, that the other light (white) is the one to worry about.

3.) I wasn't afraid of either one, but would rather see the white light come on next.

D 1.) I would imagine something exciting, like the time I saw an auto accident.
2.) I would just concentrate on the white light.
3.) The green light because you shocked me more times to it.

E 1.) I would try to get an emotion going to the white light, try to feel scared or angry, or something.
2.) I just stared at that screw on the light panel.
3.) I'd rather see the white one come on.

F 1.) I'd just start thinking about being shocked as soon as the white signal flashed.
2.) Concentrated real hard on something, anything.
3.) I wasn't afraid of either one. Seemed as if I was shocked more to the white one.

G 1.) I'd think about how much I didn't want to be shocked.
2.) I concentrated on counting during the interval between lights. Everytime I stopped counting I was shocked.
3.) It was harder to control my emotions when the green light came on.
H 1.) I just stared at it and opened my eyes real wide.
   2.) Tried to think of something else like doing my math homework.
   3.) The green one.

I 1.) I just reacted with a total emotional response, tried to think about making my heart beat faster.
   2.) Just consciously ignored it, by concentrating on relaxation.
   3.) It didn't make much difference, just a little harder to ignore the green one than to respond to the white one.

J 1.) I was thinking about a fight that I had.
   2.) I tried to concentrate on something, so that I could be busy when it came on.
   3.) I got more shocks when the green one was on.

K 1.) I thought about the shock.
   2.) I tried to think about something else.
   3.) At first I was more afraid of the white light, but later I became more concerned over the green light.

L 1.) I would start feeling hostile about the experiment and start cussing you out under my breath.
   2.) Thought about a picnic with some really sharp chick.
3.) Neither one.

M 1.) No matter what I did it didn't work. You shocked me everytime to the green light and never to the white one.
2.) Nothing worked, I tried everything.
3.) I wasn't afraid of either one. Since you didn't shock me when the white one was on I like it better.

N 1.) Tried to act scared, thought about horrible scenes.
2.) Concentrated on repeating a poem over and over again.
3.) I was most worried about the green one.

O 1.) I thought about the shock.
2.) I tried to ignore it by staring right below it at that screw.
3.) Well, it was harder to ignore the green one.
REFERENCES


Bersh, P. J. Avoidance conditioning of heart rate. Amer. J. Psychol., 1956, 69, 244-251.

Branca, A. A. Semantic generalization at the level of the conditioning experiment. Amer. J. Psychol., 1957, 70, 541-549.


Darrow, C. W. Sensory, secretory and electrical changes in the skin following bodily excitation. J. exp. Psychol., 1927, 10, 197-226.
Darrow, C. W. Electrical and circulatory responses to brief sensory and ideational stimuli. J. exp. Psychol. 1929, 12, 267-300.


Darrow, C. W. Neural mechanisms controlling the palmar GSR and palmar sweating. Arch. Neural. and Psychiat., 1937, 37, 641-663.


Hudgins, C. V. Conditioning and the voluntary control of the pupillary light reflex. J. gen. Psychol., 1933, 8, 3-51.


Krogh, A. Anatomy and physiology of the capillaries. New Haven, Conn: Yale Univ. Press, 1929.


Wechsler, D. The measurement of emotional reaction. *Arch. Psychol. N. Y.*, 1925, #76.


