THE SEMANTIC GENERALIZATION OF HABITUATION OF THE GALVANIC SKIN RESPONSE

A Thesis

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by

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ABSTRACT

This study was conducted to test the hypothesis that habituation of the galvanic skin response (GSR) will occur to the repeated presentation of words of similar meaning and that this habituation will generalize in gradient fashion along a semantic dimension.

Six equal groups of subjects were used. Three groups were habituated to the presentation of friendly words over a number of trials while the remaining groups were habituated to a corresponding list of hostile words. After habituation, the three groups of both habituation conditions (Hostile and Friendly) were tested to either a synonym, an antonym, or a neutral word, one group being exposed to each type of stimulus. The measure of generalization used was group mean log conductance change on the first test trial.

The results partially substantiated the hypothesis that generalized habituation of the GSR exists along a dimension of meaning. Reliable habituation occurred to both friendly and hostile words. For the Friendly category, generalized habituation occurred significantly to the antonym and neutral word, with a trend for greater generalization to the latter. The results for the Hostile category were inconclusive.

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CHAPTER I

INTRODUCTION

One of the most important concepts to arise from Pavlov's research is that of the orientation reaction or orienting reflex (OR). He described it in the following manner:

> It is this reflex which brings about the immediate response in man and animals to the slightest changes in the world around them, so that they immediately orientate their appropriate receptor organ in accordance with the perceptible quality in the agent bringing about the change, making a full investigation of it. (Pavlov, 1960, p. 12)

Over the past two decades, the orienting reflex has been the subject of an increasing amount of research by psychologists. Much of this work has been carried out in the U.S.S.R. where the concepts of the OR have been refined and widely demonstrated (Berlyne, 1960; Luria & Vinogradova, 1959; Sokolov, 1963). Besides the simple orientation of sensory receptors towards the origin of the novel stimulus, it has been determined that the OR involves a large number of physiological changes. These changes increase the organism's sensitivity to impinging stimuli and intensify bodily activity in preparation for action. More specifically, the orienting reflex may be evoked as an initial response by qualitative, intensive, or temporal changes in stimulation. Its objective measures include changes in skeletal musculature, an increase in sensitivity of the sense organs, depression of the cortical alpha rhythm, the galvanic skin response, and a complex vasomotor response which includes cephalic vasodilation and peripheral vasoconstriction (Lynn, 1966;

Maltzman, 1968). According to Maltzman (1968), the orienting reflex occurs not only because of changes in physical stimuli, but also "as a consequence of more complex verbal stimulus changes as well, changes that presuppose prior learning histories, e.g., shifting from one word class to another." (p. 318)

When a novel or altered stimulus is presented over and over again, the orienting reflex gets progressively weaker and eventually disappears. This phenomenon is one type of reaction which replaces the transitory OR and is known as habituation (Sokolov, 1963; Sharpless & Jasper, 1956). In his article on the theoretical conceptions underlying semantic generalization, Maltzman (1968, p. 318) says that "habituation of the OR may be readily produced, as indicated by the decrement in magnitude of its response measures with repeated stimulation of an unvarying sort."

The principle of stimulus generalization states that the original stimulus (usually the training stimulus) will elicit the strongest response, but other stimuli that are like the original will also call forth the same or very similar responses. In the case of habituation, the response is one of not responding in the face of repeated stimulation. As Lynn (1966, p. 28) notes, "the specificity of habituation of the orientation reaction is not absolute but involves a certain amount of generalization." Apelbaum, Silva, and Frick (1959) have substantiated this with their studies on the generalization of habituation of EEG arousal to tones in the cat. A cat primarily habituated to a tone of

200 cps does not respond to the presentation of tones up to 220 cps, but begins to respond to those of 230-500 cps.

This brief overview of the nature and characteristics of the orienting reflex is pertinent to this and any similar experiment on semantic conditioning or generalization. These studies involve effects of the OR through their utilization of its sensitivity to changes in conditions. Some measure of the OR (usually GSR or plethysmographic recordings) is used as the dependent variable since any alteration in the pattern of stimulation during the course of an experiment may evoke it. This "ability" of the orienting reflex to discriminate the novel from the familiar is inherent in the method for inquiry into stimulus generalization of association (of which semantic generalization is a type). This entails repeated stimulation, after which an inhibition occurs, as manifested in a decrement of the elicited GSR-OR. "This inhibitory process generalizes to a decreasing degree to other stimuli subsequently presented along a dimension of similarity" (Corman, 1967, p. 239). That is, the greater the disparity in sound or meaning between the original and the test stimulus elements, the greater will be the divergence in the degree to which they elicit the OR.

The existence of semantic generalization has been well substantiated by investigators and authors such as Razran (1939, 1949b, 1961), Mednick (1957), Feather (1965), Maltzman and Raskin (1965) and Luria and Vinogradova (1959). In the main,they have dealt with the semantic generalization of classically conditioned responses. Cofer and Foley (1942) suggest that this conditioning has occurred when a response

conditioned to a given word will generalize to synonymous words and to words which are homonyms of the conditioned stimulus word.

Lynn (1966) has gone one step further than the studies of semantic generalization based on conditioning with his statement (p. 44) on the existence of a phenomenon called "semantic habituation." He says that "it is possible to habituate a subject to a whole group of words of similar meaning, and when a word of different meaning is presented, the subject once again gives an orientation reaction." Unfortunately, Lynn does not cite the origin of his assertion, whether in Soviet literature or his own experimental findings, nor does he provide any supportive evidence other than an oblique reference to the comparative studies of Veronin (1962) and Sharpless and Jasper (1956).

Statement of the Problem

With the data at hand from existing studies on semantic generalization of conditioned responses and the recent evidence promulgated by Williams (1963) and Corman (1967) for the occurrence of a generalization gradient of habituation of the OR to primary stimuli (tones), this study was devised to investigate and perhaps lend credence to the hypothesis of "semantic habituation."

CHAPTER II

HISTORICAL BACKGROUND

The review of the literature will be presented in three sections beginning with a survey of studies investigating the nature of the orienting reflex, followed by a consideration of semantic conditioning and generalization. Finally, an examination will be made of those experiments dealing with the generalization of habituation.

The Nature of the Orienting Reflex and its Components

Although a large number of investigations into the nature of the OR have been carried out, primarily since the 1930's, the majority of these studies have taken place in the Soviet Union and their reports have not been translated into English. This survey will necessarily be limited to a report of characteristic research as taken from publications in English and translations from the Russian.

Historically, the first mention of the existence of the OR came in context with the older ideas on "attention." This was because the orienting reflex and "attention" are concepts having a partial correspondence with regard to their basic tenets. As an example, stimulus change was recognized as an initial condition for "attention" and it is now accepted as the elicitor of the orienting reflex. It would appear that most of the objective measures of what is presently known as the OR were subsumed under the concept of "attention." For instance, Pillsbury (1908) reported that while a subject was "paying attention," there was

an increase in cerebral blood volume and a decrease in the limbs. Forty years later, these response changes were adopted by Russian investigators as measures of the orienting reflex (Rogova, 1951; Sokolov, 1954).

The idea of the OR as being an important adaptation reaction is first found in Sechenov's works (most recently published in 1952) on sensation and perception. By 1910, Pavlov had formulated a broader conception of the orienting reflex, which he called the "investigatory reflex," and included it as one of the facets of his study of higher nervous activity (Pavlov, 1949; Sokolov, 1963). The ability of the OR to stimulate and inhibit various bodily systems and its effect on conditioned reflexes were of particular interest. In his series of lectures in the spring of 1924, Pavlov made the following classic statement which has relevance to all subsequent studies utilizing the orienting reflex as a measure of discriminability:

> It is obvious that the investigatory reflex can be used to determine the degree to which the nervous system of a given animal is capable of discriminating between various stimuli. If, for example, among the different environing agencies there is present a definite musical tone, any, even slight, alteration of its pitch will suffice to evoke an investigatory reflex ... in the animal in relation to the tone.
>
> (Pavlov, 1960, p. 112)

In a later lecture (p. 258), Pavlov mentions that a Dr. Rosenthal has observed that, under constant environmental conditions, monotonous repetition of a stimulus caused canine subjects to very quickly fall asleep. In the years that followed, this observation would become instrumental in subsequent research and theorizing. Sokolov denotes this sleep as the final stage of what he calls secondary habituation

(Lynn, 1966). Disagreement comes from Konorski (1948) who argues that dogs placed in an experimental setting without any stimulation go to sleep just as quickly. Consequently, he believes that Pavlov was incorrect in assuming that habituation of the OR leads to sleep. (Regardless of the validity of these opposing views, it is interesting to note that some of the ideas of Pavlov and his associates are still the subject of current research.) Pavlov goes on to say that a member of his research staff has shown that "while in a normal dog an investigatory reflex to a definite sound quickly vanished, the same sound in a dog with extirpated cortex, under identical conditions, called forth an investigatory reflex in a stereotyped manner and for an unlimited number of times" (p. 259). Continuing along the same line, Vinogradova (1957), in the course of her studies of the vasomotor constituent of the OR, observed the ease with which inextinguishable orienting reactions could be produced in mentally deficient subjects who had diffuse cortical involvement.

The ability of an orienting reflex to increase receptor sensitivity, as reflected in a lowering of absolute thresholds, was the topic of an experiment performed by Sokolov (1963) in 1958. A light stimulus, the intensity of which was 0.8 threshold, was administered before and after a sound of sufficient strength to produce an OR. The subject, completely dark adapted, was instructed to perform a prearranged signal as soon as he saw the light. It was found that if the sound did not elicit an orienting reflex, as evidenced by an α -rhythm depression in the region of the occiput, the test stimulus (light) remained subliminal. However,

if the sound was intensified to the point of producing α -rhythm depression in the occipital region, "the sensitivity of the visual analyzer was increased, on this background of depression, and the test stimulus was detected by the subject" (p. 285). As the OR to this sound habituated or was extinguished, the effect of increased visual sensitivity disappeared.

The type of galvanic skin change most often used as a manifestation of the OR is Fréré's phenomenon -- the change in the electrical resistance of the skin to the passage of a constant current. It was not until the publication of findings by researchers such as Sakhiulina (1944), Gershuni (1950) and Mundy - Castle and McKiever (1953) could it be confirmed that the GSR is essentially an indication of the orienting reflex. Sakhiulina convincingly demonstrated the significance of novel factors and proprioceptive stimuli as elicitors of the galvanic skin response. Through his investigation of the relationhip between sensitivity to light and GSR, Gershuni concluded that the galvanic skin response is but a component of the complex OR. This conclusion was supported by later experiments by Shakhnovich (1958) and Liberman (1958). They found that pupillary dilation and GSR were among the first reactions to novel stimulation whether visual or nonvisual in nature.

Numerous studies and theories currently exist on the physiological nature of the OR. One such study has been reported by French (1957) who, using monkeys, found that moderately intense stimulation of cortical areas projecting to the reticular formation resulted in orientation reactions. He noted that the animals so treated searched

around in a manner which suggested that they were seeking the source of the stimulation. Startle - defensive reactions could be elicited by more intense stimulation, the consequence of which was that the monkeys cringed in the corner of the cage or appeared agitated and ran fearfully about. At the same time, French's objective measures showed that stimulation of these cortical regions produced the autonomic and EEG components of the OR. Thus it would seem that these cortico-reticular areas may be the activation centre or, at least, a pathway carrying excitatory impulses to the reticular formation.

Allen, Hill and Wickens (1963) were interested in seeing how the OR varied as a function of the interstimulus interval of compound stimuli. Three stimuli were employed — a tone and two different lights. The duration of the first stimulus was 1300, 1050, or 750 milliseconds, with two groups of subjects at each interval. The second and third lasted 600 and 100 milliseconds respectively and were separated by 500 milliseconds between their onset. The three stimuli terminated together. After ten presentation trials of the compound stimulus, different groups were tested to the first or second stimulus alone. This change in stimulation conditions produced an OR (as shown by the GSR), the magnitude of which increased significantly over that obtained for the last two presentationstrials. With repeated presentation of the single stimulus, the response increment decreased. The size of the increment was less when the dominant or long stimulus in a pair was presented than when the short stimulus was delivered. This is because there is less disparity between the single long test stimulus (in both order of presentation

and length) and the compound training stimulus.

The effect of novelty, complexity, incongruity and extrinsic motivation on the GSR was investigated by Berlyne, Craw, Salapatek and Lewis in 1963. Human subjects received three successive three-second exposures of visual patterns at twelve-second intervals while their GSR was recorded. These visual patterns were categorized as being either low or high in complexity. The low-complexity category of stimuli included variations in regularity of arrangement, amount of material, heterogeneity of elements and irregularity of shape. The high-complexity category altered congruity, number of independent units, symmetry and randomness of distribution of stimulus material. Some subjects were extrinsically motivated, i.e., they were instructed to attend carefully because they would later be given a recognition test. The results indicated that there was a decrease in skin resistance with every new pattern but subsequent repetition of the pattern initiated an increase in resistance. There was an over-all decline over trials. Incongruous patterns elicited GSRs of greater mean amplitude than did non-incongruous patterns. The extrinsically motivated subjects gave more frequent GSRs than did those without such motivation. These researchers feel that some support was also obtained for the conclusion that the more irregular a pattern, the more likely it is to evoke a GSR.

Semantic Conditioning and Generalization

The origin of studies on semantic generalization lies in the object - word and word - object generalizations which were the topic of

experiments carried out by Krasnogorsky and Ivanov - Smolensky in the late 1920's and early 1930's. The two Russian investigators demonstrated that a conditioned reflex to the sound of a metronome would generalize to the sound of the word METRONOME and vice versa (Feather, 1965; Razran, 1961).

Razran, another forerunner in this area, reported his first study on salivary conditioning in 1939 (Razran, 1939; Feather, 1965). His procedure consisted of flashing four stimulus words - STYLE, URN, FREEZE, and SURF - on a screen in front of three subjects who were chewing gum, sucking lollipops, or eating sandwiches. Five eating periods, lasting three minutes each, were employed in each experimental session. During the eating periods, each conditioned stimulus (CS) word was presented fifteen times. After the completion of the second experimental session, tests for generalization were initiated. These consisted of measuring salivation by obtaining the weight increments of dental cotton rolls placed under the subject's tongue for one minute. The generalization words used were: FASHION, STILE, EARN, VASE, FRIEZE, CHILL, SERF, and WAVE. The amount (reported in weight) of salivation to the generalized words was expressed as a percentage of the salivation to the conditioned words. Thus the mean amount of synonyms was 59%, and to homonyms was 37%. Feather quotes Razran as saying that "the subject gets more conditioned to the meaning of the word than to its mere visual-auditory form ..." (Feather, 1965, p. 426). In other words, verbal conditioning is primarily semantic.

The conditioning of vasoconstriction in nine adult human subjects by Shvarts (1960) was reported in Razran's 1961 article. The vasoconstriction was conditioned by pairing the Russian words DOM (house) and DOCTOR (doctor) with the application of a metal disc at 10^{o}C. to the dorsal side of the subjects' left arms. Conditioned vasoconstriction in both arms was recorded photoplethysmographically i.e., by a technique which utilizes photocells to measure blood-volume changes. Shvarts then tested for CR transfers to the phonetographically related DYM (smoke) and DIKTOR (announcer) and to the semantically related words HOUSE (subjects knew the English language) and VRACH (physician). Testing was carried out in early and late stages of CR training and after the administration of 1 gm. of chloral hydrate. The phonetographic CR transfer to the word DYM was transient and disappeared when the CR was well established. Amazingly enough, the transfer reappeared thirty minutes after the chloral hydrate administration. Semantic CR transfer from DOM to the word HOUSE also disappeared thirty minutes after treatment with the same dosage of the drug. Quite similar results were obtained with the words DIKTOR and VRACH.

Lang, Geer and Hnatiow (1963) presented subjects with a series of verbal stimuli in the form of word lists. The words had previously been rated by independent observers as high hostile (HH), medium hostile (MH), low hostile (LH) or neutral (N). Four lists were made on tape recordings, each consisting of instructions, a twenty-two word conditioning series (ten neutral words randomly distributed among

twelve HH words), three neutral buffer words and a sixteen word generalization series which sampled all of the four classes of words. During conditioning, all twelve HH words were followed by shock. The subjects were then presented with the unreinforced generalization series whose sixteen words were organized in blocks of four (one word from each class) and counterbalanced as to order. Responses in three autonomic components of the OR were monitored (finger plethysmograph, heart rate, and GSR). Generalized responses were obtained to words very similar in meaning to the reinforced conditioned stimuli. However, response amplitude fell off sharply with the presentation of words of lesser similarity to these training stimuli.

In an unpublished study reported by Feather (1965), Peastral postulated that schizophrenics would generalize to a greater degree to homonyms and relatively less to synonyms than would normals. Thirty-two subjects were used, sixteen from each diagnostic category. Using a loud buzzer as the UCS, Peastral conditioned the GSR to a stimulus word. One-half of the subjects in each diagnostic group received the visually presented word TALE as the CS, the other half got the word SENT. For the first subgroup, SENT was used as a control word, and for the second subgroup, TALE was used. After conditioning, generalization of the GSR was tested to the words STORY, PENNY, TAIL, AND SCENT. Counterbalancing was used in the order of presentation, and the synonym and homonym of the control word served as control stimuli during extinction-generalization trials. Normal subjects generalized significantly

more to the experimental synonyms than to the control synonym, while schizophrenic subjects generalized in significantly greater fashion to the experimental rather than the control homonym.

Maltzman and Raskin (1965) studied the simultaneous conditioning of the GSR and vasomotor responses to the CS word LIGHT. Subjects were divided into High and Low Orienters on the basis of whether they were above or below the median response magnitude evoked by the first unconditioned stimulus (a loud noise). After conditioning, the subject was presented with a list of words consisting of neutral filler words, the CS, and the generalization test words DARK, LAMP, HEAVY, SOFT, and SQUARE. The subject was asked to rate the words against a seven-point evaluative semantic differential scale. Since the words were all relatively neutral, any rating of unpleasantness was indicative of the effects of conditioning. Most subjects rated the CS as unpleasant. Those subjects who, when asked, could verbalize the relevant contingency between the CS and US were called "verbalizers." Those who could not verbalize the relevant contingency were designated "nonverbalizers." Some subjects also rated one or more generalization words as unpleasant. When asked why they rated these words as unpleasant, the subjects usually indicated that when they heard LAMP it make them think of LIGHT. It was found that verbalizers gave reliably larger responses than the nonverbalizers. The high-orienting verbalizers also showed significantly better semantic conditioning than the low-orienting nonverbalizers. Verbalizers showed greater semantic generalization of the conditioned GSR than did the non-

verbalizers. Although the vasomotor response showed a similar trend, it was not reliable.

Generalization of Habituation

Williams (1963) felt that since novelty or the surprise value of a stimulus change elicits a marked GSR, these "novelty-produced GSRs must confound the results of experiments which require stimulus change from the training to the test trials" (p. 60). Her method paralleled that generally used for stimulus generalization studies with the exception that no unconditioned stimulus was paired with either training or test trials. In other words, the subjects received sixteen presentations of a tone S_0 to which they would habituate and were then tested for generalization to S_1, S_2, S_3, and S_4, four permutations of the original tone (S_0). This procedure was repeated a second time. From the resulting mean log conductance change scores, it was shown that there was: (1) a noticeable drop in skin resistance on test trials probably due to the novelty of tone changes; (2) an ordering of GSR magnitudes as a function of increased familiarity with stimulus change; and (3) a lesser, but uniform, predilection for response magnitudes to be ordered according to the perceived distance between the test tones and S_0. Her hypothesis was confirmed.

In an investigation based on Williams' study, Corman (1967) sought to determine if exposure to the range of test stimuli is required to demonstrate the generalization of habituation of the GSR to primary stimuli. Using a between-subjects design, he presented each subject

with ten habituation trials to tone S_0. Half of the subjects received a tone of 670 cps and half received a tone of 1850 cps. Each subject was then tested with five presentations of one new tone (670, 1000, 1400 or 1850 cps). This is unlike Williams' method in which the subject received the range of test stimuli. Thus there were test trials to S_1, S_2, or S_3, with half of the subjects receiving a tone higher than the habituation tone, and half receiving a tone lower than S_0. All tones were equal in loudness and duration. Corman observed that there was habituation to repeated presentations of S_0. When a test tone was presented, a GSR occurred whose magnitude was a function of the similarity in pitch between the test tone and S_0. That is, there was a gradient of generalization. An "overlearning" phenomenon was also noted. Continued habituation trials past the point where the subject had stopped responding to S_0 increased the generalized habituation.

Elucidation

This study was undertaken in an attempt to determine if gradients or generalization of habituation along a dimension of meaning could be obtained analogous to those along a primary dimension, as represented by tones, that were demonstrated by Corman (1967).

CHAPTER III

METHOD

Subjects. The subjects were 155 university students, both male and female, who chose to participate in the experiment as partial fulfillment of a requirement for an introductory psychology course. The data for 132 subjects are reported, the remainder being eliminated because of base resistance above 150,000 ohms, experimenter errors, or equipment failure. There were 22 subjects in each of the six groups of the experiment. Subjects were assigned to conditions in the order of their appearance at the laboratory.

Apparatus. The stimuli consisted of a list of "friendly" words, a list of "hostile" words, and the three test words "love," "hate," and "think." Six combinations of these habituation lists and the test words were thus possible, one combination for each group (see Table I). The habituation lists were selected from two larger lists of synonyms by two observers who chose the seven words which seemed most similar in pleasantness (the friendly list) and an equal number most similar in unpleasantness (the hostile list). The aforementioned larger groups of synonyms were assembled by the experimenter from Roget's College Thesaurus and the Minnesota norms for the Kent-Rosanoff word list. After selection, the stimulus words were pre-recorded on tape before the running of the subjects in each group. An inter-stimulus interval of approximately one minute was maintained between the 10 words which comprised a presentation. The taped stimuli were then administered to

TABLE I

EXPERIMENTAL GROUPING
ON THE BASIS OF
STIMULUS LISTS

STIMULI	TRIAL	EXPERIMENTAL GROUPS					
		LEVEL I (FRIENDLY)			LEVEL II (HOSTILE)		
HABITUATION	1	ADMIRE	ADMIRE	ADMIRE	ATTACK	ATTACK	ATTACK
	2	LIKE	LIKE	LIKE	ASSAULT	ASSAULT	ASSAULT
	3	ENJOY	ENJOY	ENJOY	OFFEND	OFFEND	OFFEND
	4	CHERISH	CHERISH	CHERISH	MURDER	MURDER	MURDER
	5	AMUSE	AMUSE	AMUSE	TORTURE	TORTURE	TORTURE
	6	BEFRIEND	BEFRIEND	BEFRIEND	AGGRESS	AGGRESS	AGGRESS
	7	AGREE	AGREE	AGREE	KILL	KILL	KILL
TEST	8	LOVE	HATE	THINK	HATE	LOVE	THINK
	9	LOVE	HATE	THINK	HATE	LOVE	THINK
	10	LOVE	HATE	THINK	HATE	LOVE	THINK

an observer for his judgment on the between-list and inter-list similarity of the words with regard to the loudness of and the degree of affect in the recorder's voice. Conductance of the stimuli to the test "booth" was achieved via the earphone output of a Sony TC-211 and later a Phillips 301 tape recorder. The words were presented through a Roberts stereophonic headset. Another headset spliced into the output allowed the experimenter to monitor the quality and the progress of the tape recorder. An office armchair with widened, sponge-padded arms and enclosed on the back and sides by a 5 ft. high plywood screen comprised the test "booth." The inside of the screen was painted flat black and had a hole drilled in one side for the passage of the headset wires. Its purpose was to further reduce the effect of extraneous noise and/or light. Since the subject was required to wear opaque plastic goggles and the earphones, this screen also served to give him a more "secure feeling," i.e., it lessened his suspicions about being surprised. This would, by increasing the subject's willingness to relax, promote the occurrence of habituation to the stimuli.

The GSR was measured on a modified Hunter GSR amplifier and recorded from electrodes affixed by means of plastic clamps to the palm and back of the subject's left hand. The 3/4 inch diameter zinc electrodes were contained in plastic cups and were washed and freshly filled with jelly for each subject. It was found that an electrode jelly consisting of zinc sulphate, bacto-agar, and distilled water gave the most satisfactory results. Responses, as indicated by the instruments on

the face of the amplifier, were recorded visually by the experimenter to the nearest 200 ohms. A response was defined as any decrease in his skin resistance greater than 200 ohms occurring before a lapse of three seconds after stimulus onset.

The subject's room was adjacent to the room containing the amplifier, tape recorder and experimenter. Besides being quite isolated, the test room was carpeted and contained a ventilating fan, all of which further reduced the likelihood of interference from external noise. During the test phase of the experiment, the subject's room was not illuminated.

Procedure. The subject was seated in the chair of the test booth. The experimenter then roughened the epidermis on the back of the subject's left hand with a 1 in. square of very fine surface grade sandpaper. Then the two electrodes were applied to the palm and back of the same hand. Instructions (Appendix A) were read to the subject about the nature of the experiment with regard to the measuring of physiological responses and to the type of stimuli being used. He was also told that he would be required to recall the words by listing them on a questionnaire after the test phase. It was suggested at the same time that the subject's I.Q. might be reflected by the number of words he was able to recall. This was used as a convenient way of maintaining his attention without openly requesting same. Finally, the experimenter placed the eye goggles and the earphones on the subject, and left the room, turning off the lights as he went. The tape recorder was turned to "forward" and

and approximately 2 min. later, the first stimulus word was presented. One-half of the subjects received the friendly habituation word list followed by three repetitions of a single test word on trials 8, 9, and 10. The remaining subjects received the hostile habituation word list and were similarly tested for generalization on the last three trials. The basic design of this procedure is indicated in Table II. No student who had participated in other research dealing with GSR was knowingly used as a subject. Following the ten trials, the experimenter re-entered the subject's room, turned on the lights and removed the earphones, goggles and electrodes from him. The subject was then requested to complete a short standard questionnaire (Appendix B) of two parts. The first part asked him to list, in any order, the words which he had just heard. A repeated word was to be written only once. The second part required the subject to briefly, in his own words, surmise as to the real purpose of the experiment. This last section was mainly to satisfy an interest on the part of the experimenter. However, it also served a checking function -- if a subject's reply was close to the main idea of the study, the list of subjects from previous GSR research was again scrutinized for his name.

Before analyzing the results, log conductance changes were computed for each response. This is in accordance with Haggard's findings (1949) on the selection of appropriate GSR measures for use in analysis of variance tests. The formula used is:

TABLE II

BASIC DESIGN OF THE EXPERIMENTAL METHOD

Major Category of Habituation Words		Test (Generalization) Stimuli S_1	S_2	S_3	
	Friendly	F - Love	F - Hate	F - Think	
		22 Ss*	22 Ss	22 Ss	66 Ss
	Hostile	H - Hate	H - Love	H - Think	
		22 Ss	22 Ss	22 Ss	66 Ss
		44 Ss	44 Ss	44 Ss	132 Ss

*Ss denotes subjects

$$\log_{10}\left[\left(\frac{1}{R_a}-\frac{1}{R_b}\right)\times 10^{8}+1\right]$$

where R_b is the resistance in ohms at the time of initiation of the stimulus and R_a is the lowest resistance occurring within a period of three sec. after stimulus onset.

Only the responses (in log conductance change) on the first test trial (8) were used as a measure of stimulus generalization. This is due to the fact that the utilization of a measure based upon responses across the three test trials would have been confounded by reactions to the change in stimulus pattern, i.e., repetition of the generalized stimulus on the second and third test trials.

CHAPTER IV

RESULTS

The results of the experiment are presented in Figure 1. Across the first seven trials, mean log conductance change (mean GSR) is plotted for the two major groups which experienced either friendly or hostile words. On the test trials (8-10), the mean GSR is shown for the six groups, each receiving one of the generalized stimuli. The results of a mixed design analysis of variance on the data of trials 1-7 is presented in Table III. The highly significant trials effect and the non-significant treatment effect and Treatment by Trials interaction indicate that habituation to both friendly and hostile words did occur, and that the rate of habituation was the same for both classes of words.

Group mean log conductance change for each of the generalized stimuli summed across categories (H and F) are plotted over the three test trials in Figure 2. Table IV gives the results of a mixed design analysis of variance computed on the data of trials 8-10. The reliable trials effect and the significant Generalized Stimuli by Trials interaction show that these stimuli vary as a function of trials. Another effect, that of categories (H vs. F) was not significant. A test for simple effects on the BxC interaction, in which B is Generalized Stimuli at three levels and C is Trials at three levels, yielded the following as significant: (1) comparing trials 1 and 3 for groups tested to antonyms, $\underline{F}$ (1, 252) = 4.30, $\underline{p}$ <.05, (2) comparing groups tested to synonyms with those tested to antonyms on trial 1, $\underline{F}$ (1, 252) = 7.56,

FIGURE 1

THE OVERALL HABITUATION GRADIENTS OF THE TWO MAJOR STIMULUS CATEGORIES IN RELATION TO THE GRADIENTS OF GENERALIZATION OF THE SIX TEST GROUPS.

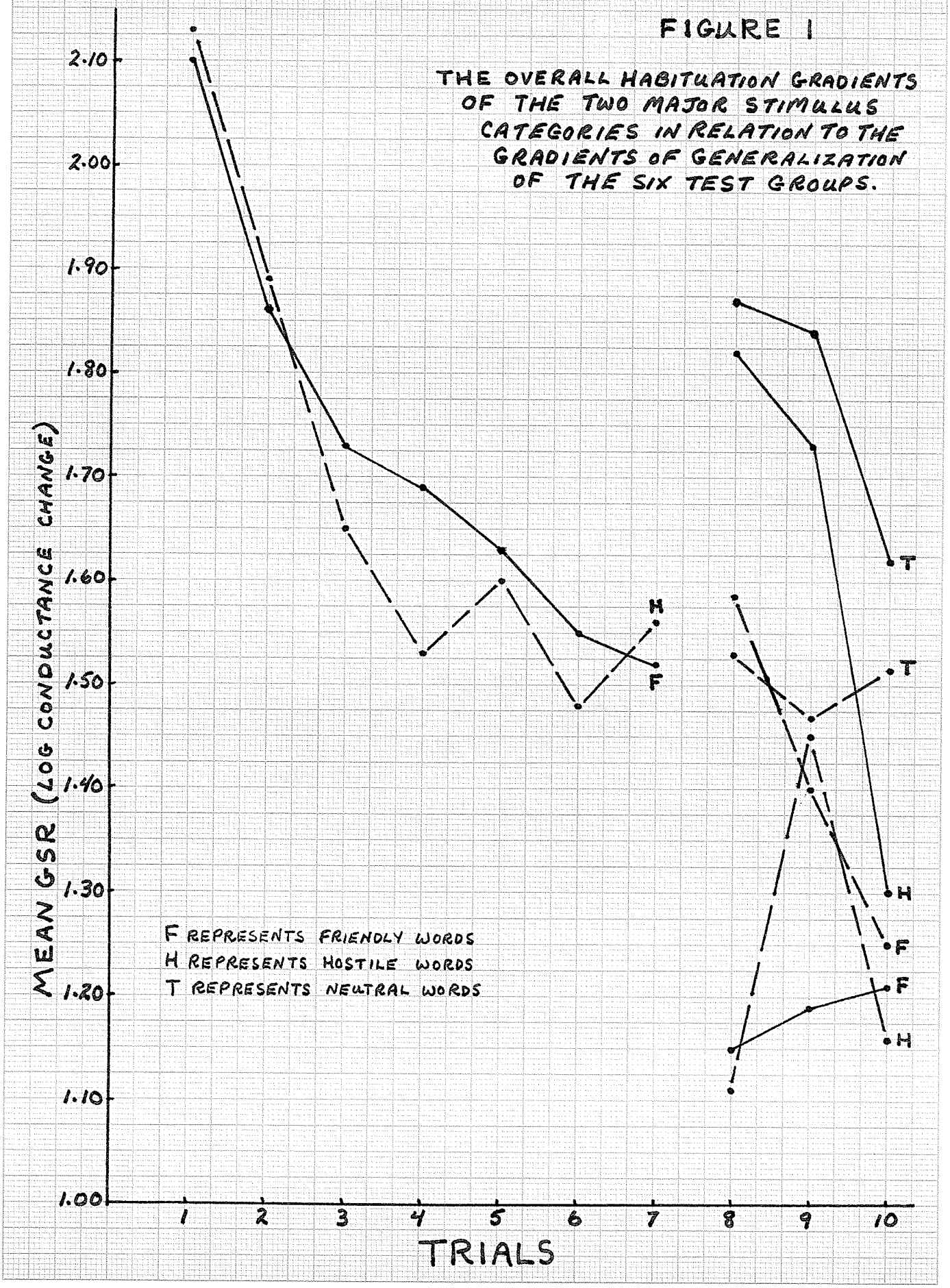

TABLE III

ANALYSIS OF VARIANCE: Sem Gen of Hab, Tr 1-7

(LOG CONDUCTANCE CHANGE)

SV	df	SS	MS	F
Total	923	331.61		
Between Ss	131	196.07	1.50	--
A (H vs. F)	1	.24	.24	.159
Error	130	195.83	1.51	--
Within Ss	792	135.54	.17	--
B (Trials)	6	36.20	6.03	46.385***
AxB	6	1.17	.20	1.538
Error	780	98.17	.13	--

***p<.001

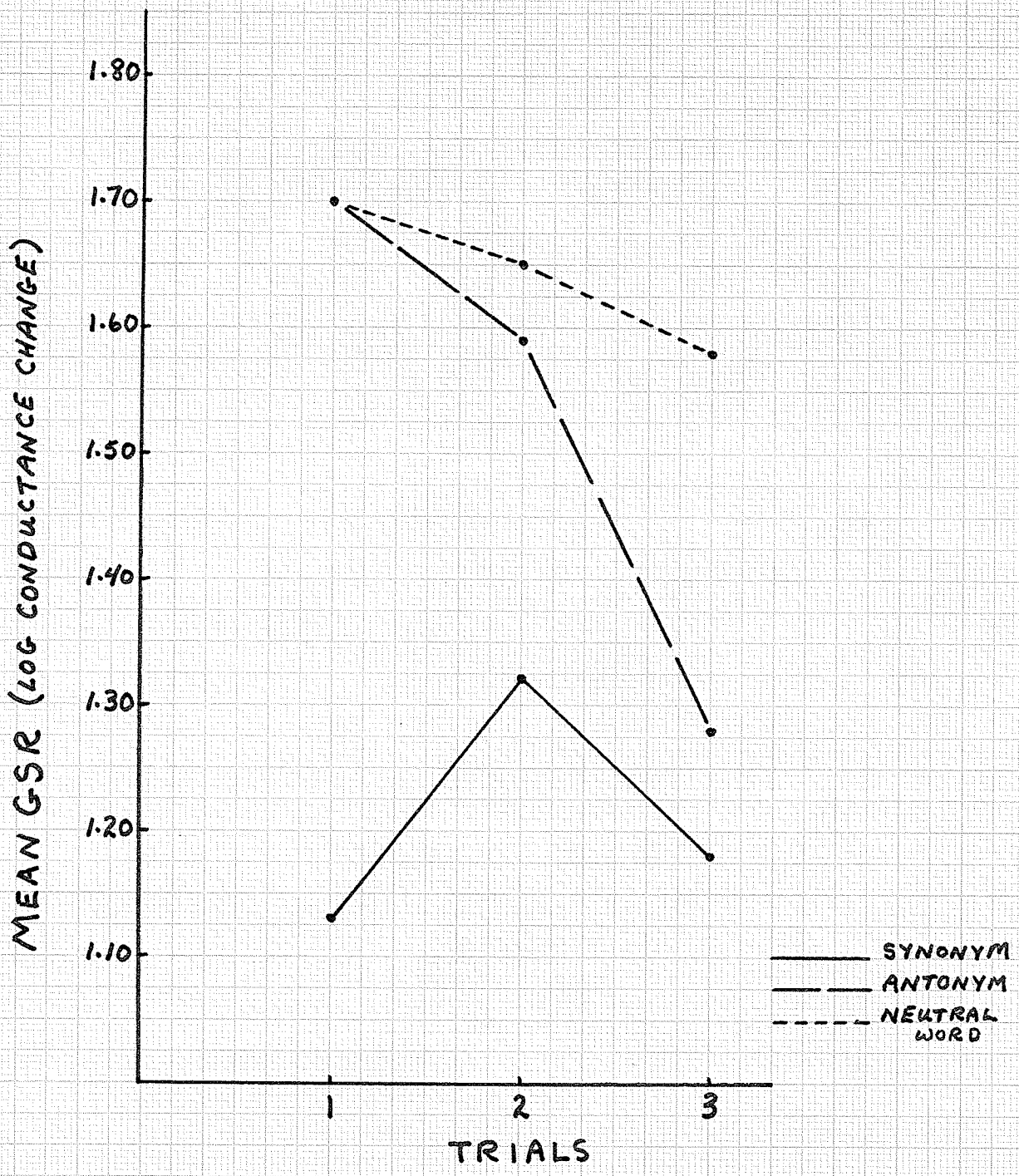

FIGURE 2

MEAN LOG CONDUCTANCE CHANGE AS A FUNCTION OF THE GENERALIZED STIMULI OVER TEST TRIALS

TABLE IV

ANALYSIS OF VARIANCE: Sem Gen of Hab, F-LHT, H-HLT x Tr 8-10

SV	df	SS	MS	F
Total	395	182.602		
Between Ss	131	122.603	.936	--
A (H vs.F)	1	1.887	1.887	2.249
B(Gen'l Stim.)	2	13.075	6.538	.779
AxB	2	1.969	.985	1.174
Error	126	105.672	.839	--
Within Ss	264	59.999	.227	--
C (Trials)	2	2.443	1.222	5.819**
AxC	2	.372	.186	.886
BxC	4	2.913	.728	3.467**
AxBxC	4	1.382	.346	1.648
Error	252	52.889	.210	--

**p<.01

$p < .01$, (3) comparing groups tested to synonyms with those tested to neutral words on trial 1, F (1, 252) = 7.56, $p < .01$. Thus, mean log conductance change for "synonym" maintained a relatively constant level over the three trials. Initial mean GSR for "antonym" and "neutral word" was significantly higher than that to "synonym" but decreased over trials, significantly for "antonym."

Figure 3 portrays the mean GSR for the subjects habituated to the friendly words. At trial 7, the mean GSR elicited by the stimulus word AGREE is plotted for each of the three subgroups. The mean GSR on the generalization test trial (8) is also presented for each of these three subgroups which received LOVE, HATE and THINK. Each subject's GSR for trial 7 and trial 8 were the scores used in the analysis of variance presented in Table V. While a reliable groups effect was found, the significant interaction of Groups by Trials indicates that the groups tested to the different words behaved differentially over trial 7 and trial 8. Because of the significant A by B interaction, a test for simple effects was performed where A is groups at three levels and B is trials at two levels. The following comparisons of trial 7 to trial 8 for the three subgroups were found to be significant: B at a_1 (tested to LOVE), F (1, 63) = 6.30, $p < .05$; B at a_2 (tested to THINK), F (1, 63) = 5.34, $p < .05$; B at a_3 (tested to HATE), F (1, 63) = 10.75, $p < .01$. With the presentation of the synonym on trial 8, the GSR recorded is significantly lower than that to the friendly word (AGREE) on trial 7. The mean GSR to the neutral word on trial 8 increased significantly over that to the friendly word on trial 7. A similar

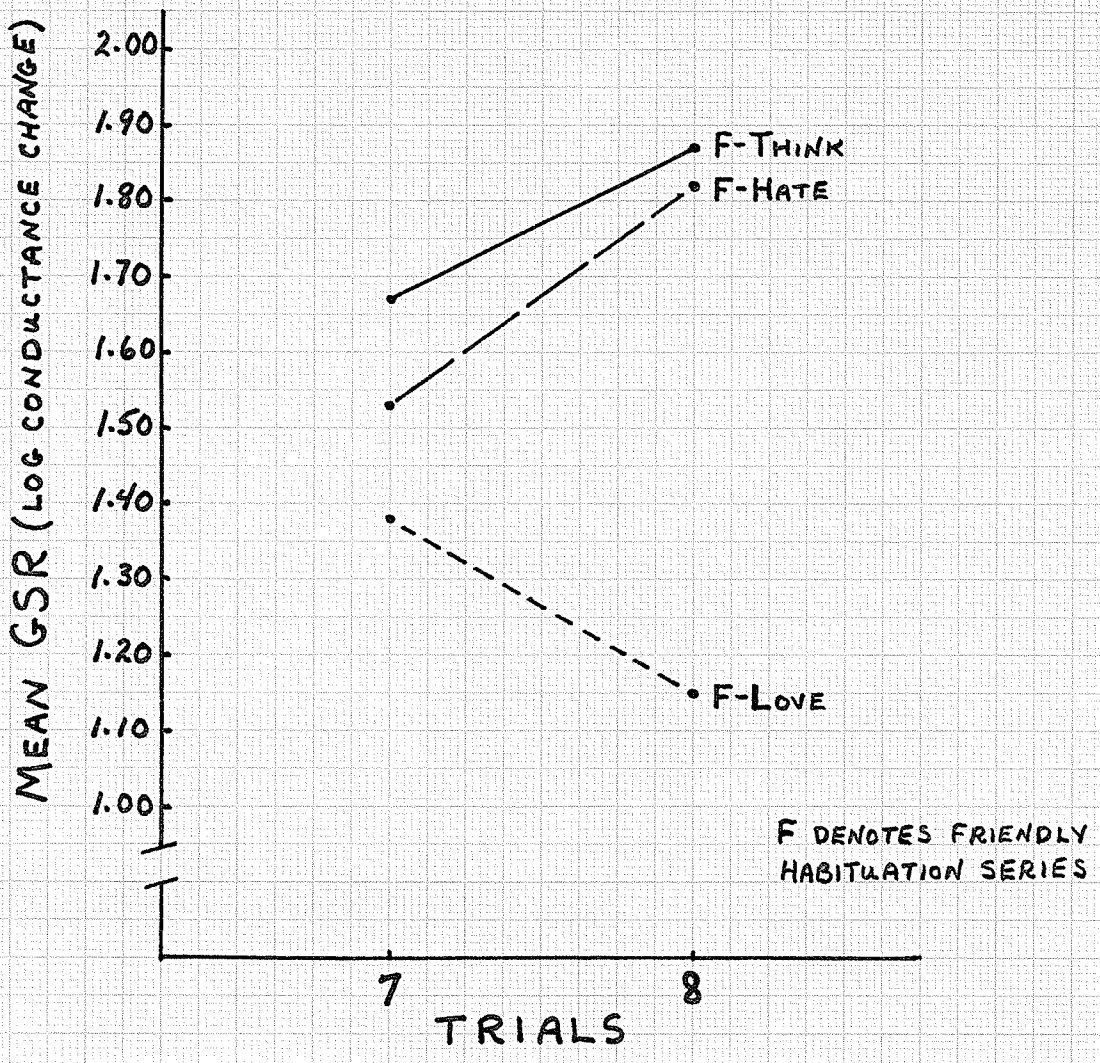

FIGURE 3

MEAN LOG CONDUCTANCE CHANGE FROM TRIAL 7 TO TRIAL 8 FOR THE TEST GROUPS OF THE FRIENDLY CATEGORY

TABLE V

ANALYSIS OF VARIANCE: Sem Gen of Hab, F-GP, Tr 7-8

(LOG CONDUCTANCE CHANGE)

SV	df	SS	MS	F
Total	131	48.732		
Between Ss	65	41.105	.632	--
A (Groups)	2	6.394	3.197	5.82**
Error	63	34.711	.550	--
Within Ss	66	7.627	.116	--
B (Trials)	1	.281	.281	3.11
AxB	2	1.712	.856	9.56**
Error	63	5.634	.089	--

**p<.01

increase occurred to the antonym on trial 8. Figure 4 illustrates the relative change in mean GSR from trial 7 to trial 8. The data point at S_0 represents the mean response at trial 7 for each of the three subgroups to the final word (AGREE) of the habituation series. In the figure, the groups are equated for differences in mean GSR on trial 7 and are assigned the arbitrary score of zero. At S_1, S_2, and S_3, the mean log conductance score is plotted as a change from the mean value of trial 7 for the groups receiving the generalization test on trial 8 to LOVE (synonym), THINK (neutral), and HATE (antonym), respectively. Thus in the case of the synonym, habituation appeared to continue while generalization of habituation tended to occur in an equal degree to both the antonym and the neutral word.

The mean GSR for subjects habituated to the hostile words is illustrated in Figure 5. The mean GSR to the stimulus word KILL, is presented at trial 7 for the three subgroups. For each of these three subgroups, the mean GSR to HATE, LOVE and THINK is presented on trial 8. The individual GSRs for each subject on trials 7 and 8 were the scores used in the analysis of variance, as summarized in Table VI. A significant trials effect was found but the treatment effect and Treatment by Trials interaction were non-significant. This indicates that the group mean GSR diminished from trial 7 to trial 8. There was no reliable differentiation among the subgroups on the basis of response change from trial 7 to trial 8. Figure 5 shows that while mean GSR to the word HATE dropped considerably from its level at trial 7, the response to

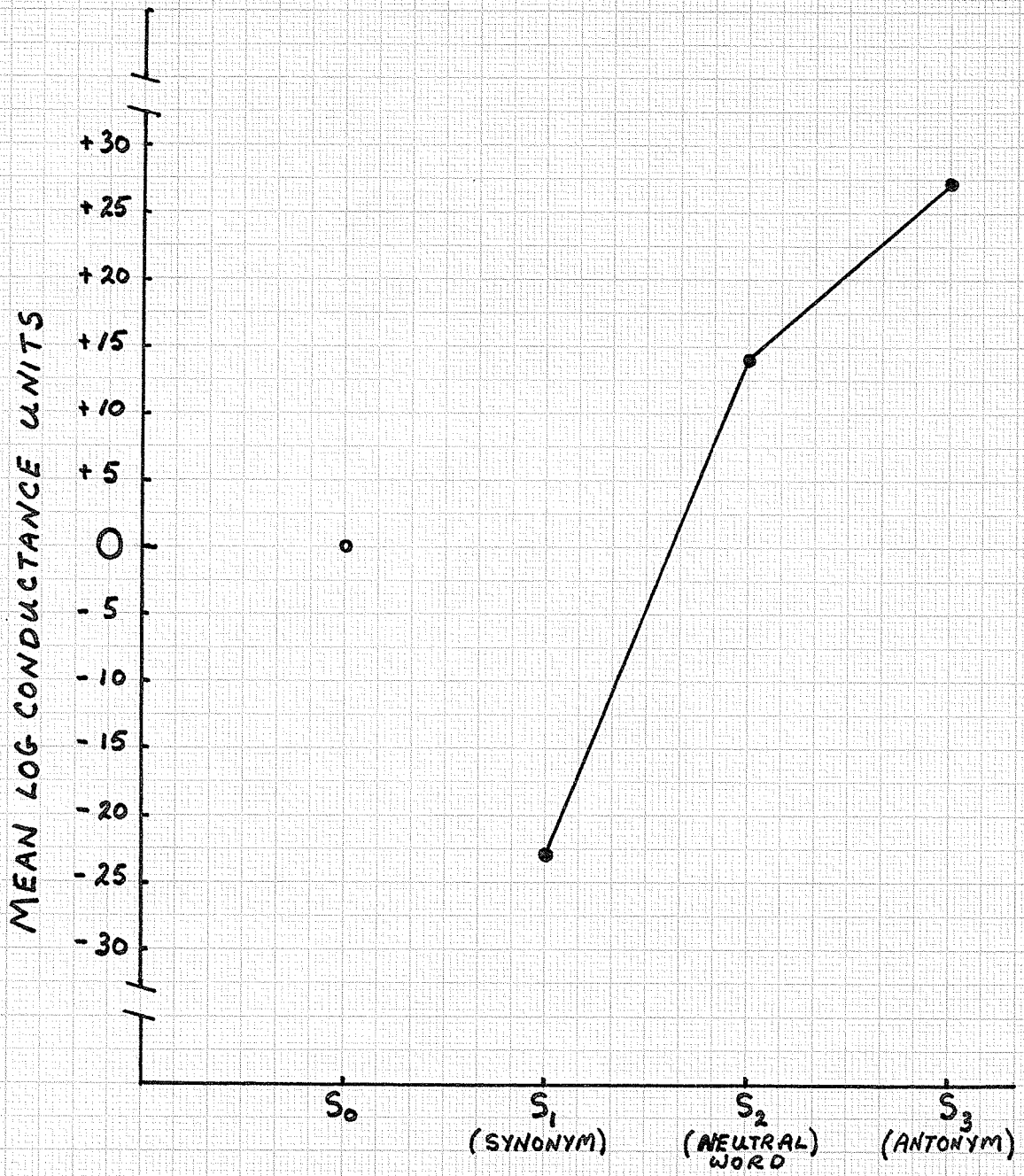

FIGURE 4

GENERALIZATION GRADIENT OF GROUPS HABITUATED TO FRIENDLY WORDS

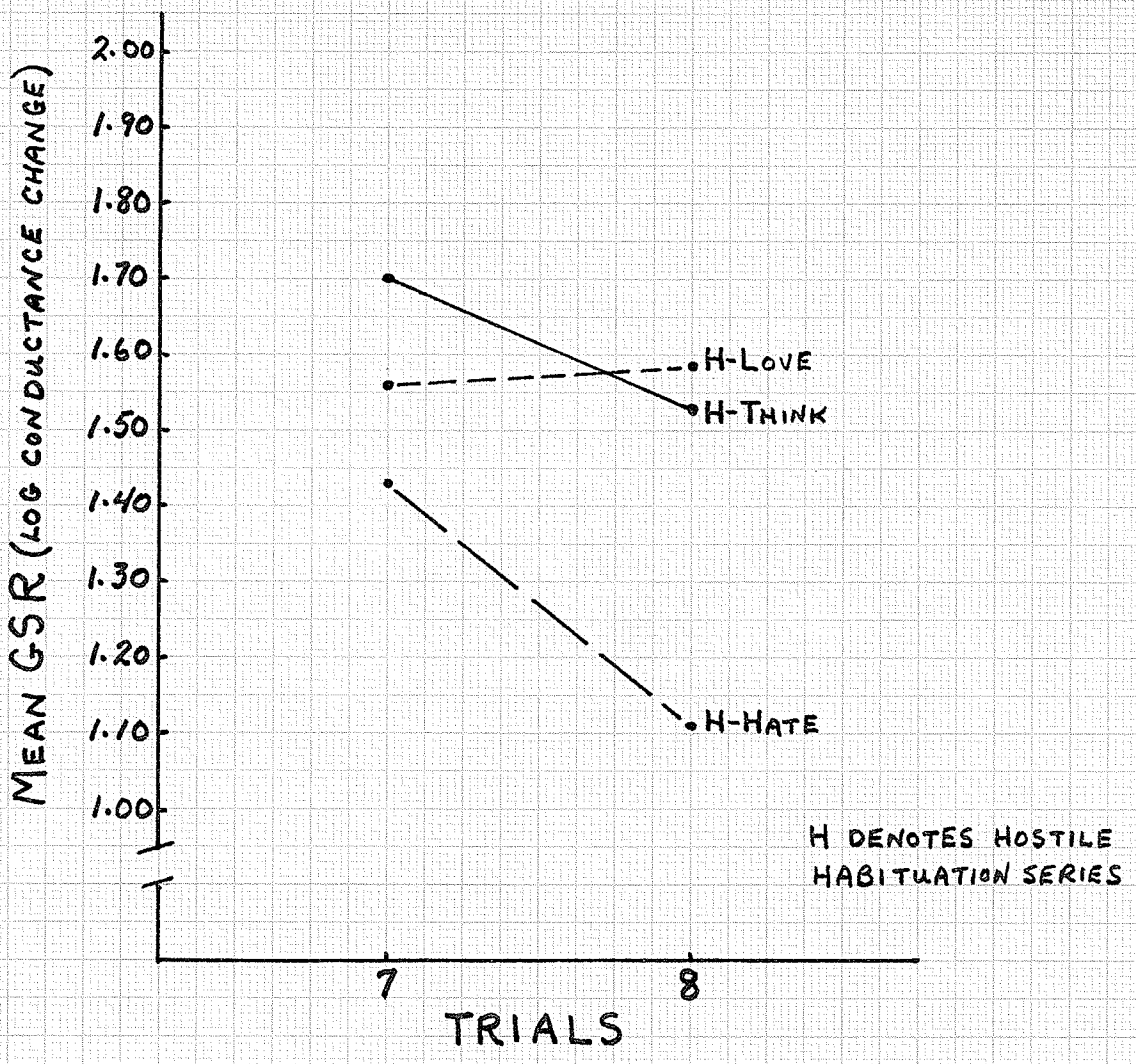

FIGURE 5

MEAN LOG CONDUCTANCE CHANGE FROM TRIAL 7 TO TRIAL 8 FOR THE TEST GROUPS OF THE HOSTILE CATEGORY

TABLE VI

ANALYSIS OF VARIANCE: Sem Gen of Hab, H-GP, Tr 7-8

(LOG CONDUCTANCE CHANGE)

SV	df	SS	MS	F
Total	131	56.12		
Between Ss	65	43.18	.66	--
A (Groups)	2	3.17	1.59	2.48
Error	63	40.01	.64	--
Within Ss	66	12.94	.20	--
B (Trials)	1	.82	.82	4.56*
AxB	2	.65	.32	1.78
Error	63	11.47	.18	--

*p<.05

LOVE maintained its position relative to that on trial 7. Mean GSR to THINK declined only slightly from trial 7 to trial 8. Thus, although there is a trend for response changes here to approximate those of the Friendly category with respect to stimulus generalization, the data for these groups give rather inconclusive results.

In regard to base-level resistances on trials 1-7, an analysis of variance (Table VII) revealed that the only significant effect was a gradual increase in resistance over trials. Since there was no significant difference in base levels between the two major groups, they were combined and an overall mean base-level resistance computed at each trial. This is shown in Figure 6.

The mean base-level resistances of the three test groups of F are plotted with those of the three test groups of H across trials 8, 9, and 10 (Figure 7). For the groups habituated to hostile words, base-level resistance continues to increase over trials. In the groups habituated to friendly words, however, it maintains its relative level over trials, increasing only slightly with trial 3. The summary table (Table VIII) for the analysis of variance on this data indicates a highly significant trials effect and a significant Groups by Trials interaction. This suggests that any change in base-level resistance over test trials is a function not only of successive trials but also of the category (H or F) in which the subjects were habituated. Tests for simple effects on the interaction for A (H or F) at two levels and C (trials) at three levels indicated the following as significant: (1) comparing test trials 1 and

TABLE VII

ANALYSIS OF VARIANCE: Sem Gen of Hab, Tr 1-7 F or H x TRIALS (BASE LEVEL)

SV	df	SS	MS	F
Total	923	71,315,360		
Between Ss	131	63,060,672	481,380	--
A (H vs. F)	1	219	219	.0004
Error	130	63,060,453	485,080	--
Within Ss	792	8,254,688	10,423	--
B (Trials)	6	3,510,893	585,149	97.06***
AxB	6	41,279	6,880	1.14
Error	780	4,702,516	6,029	--

***p<.001

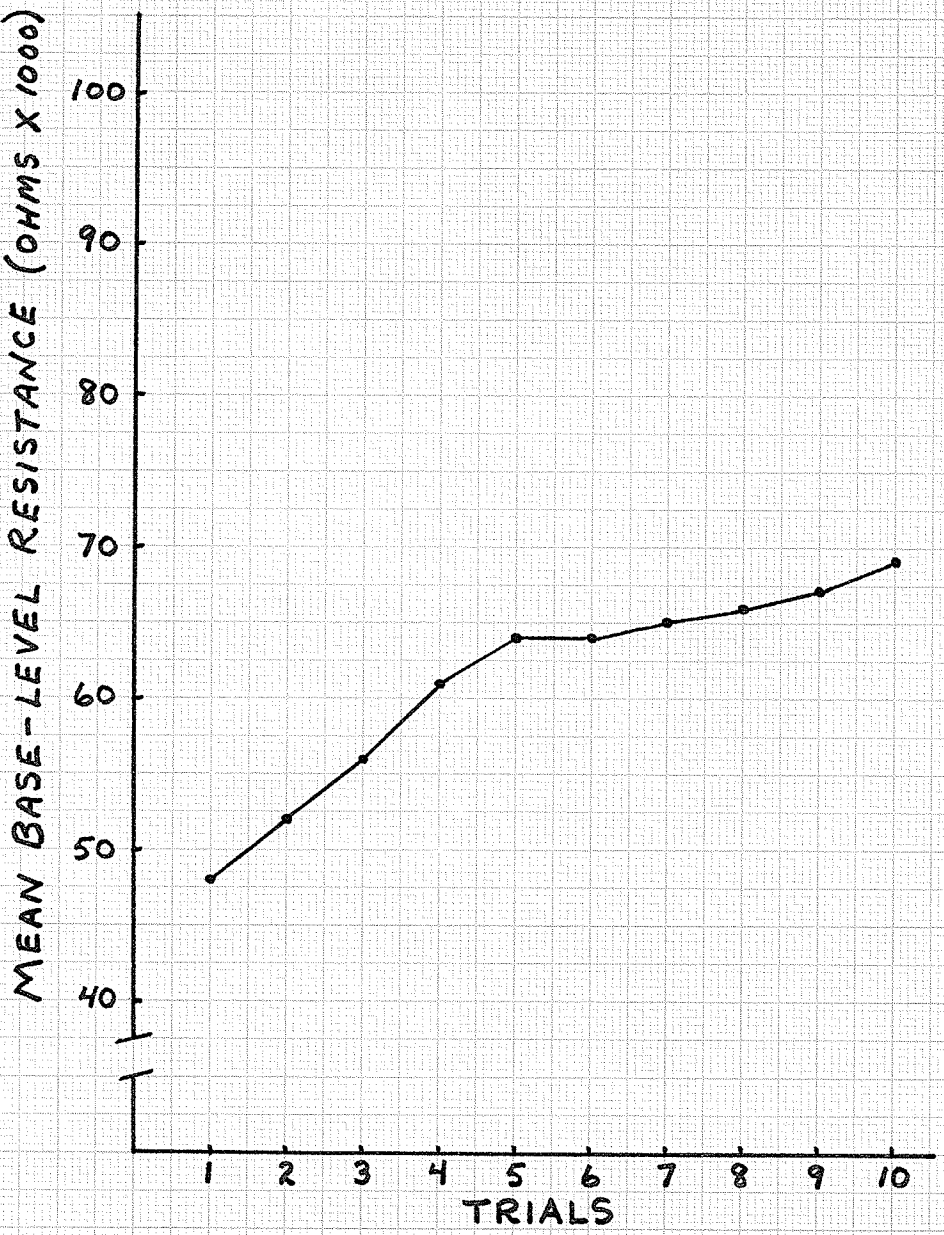

FIGURE 6

MEAN BASE-LEVEL RESISTANCE AS A FUNCTION OF TRIALS

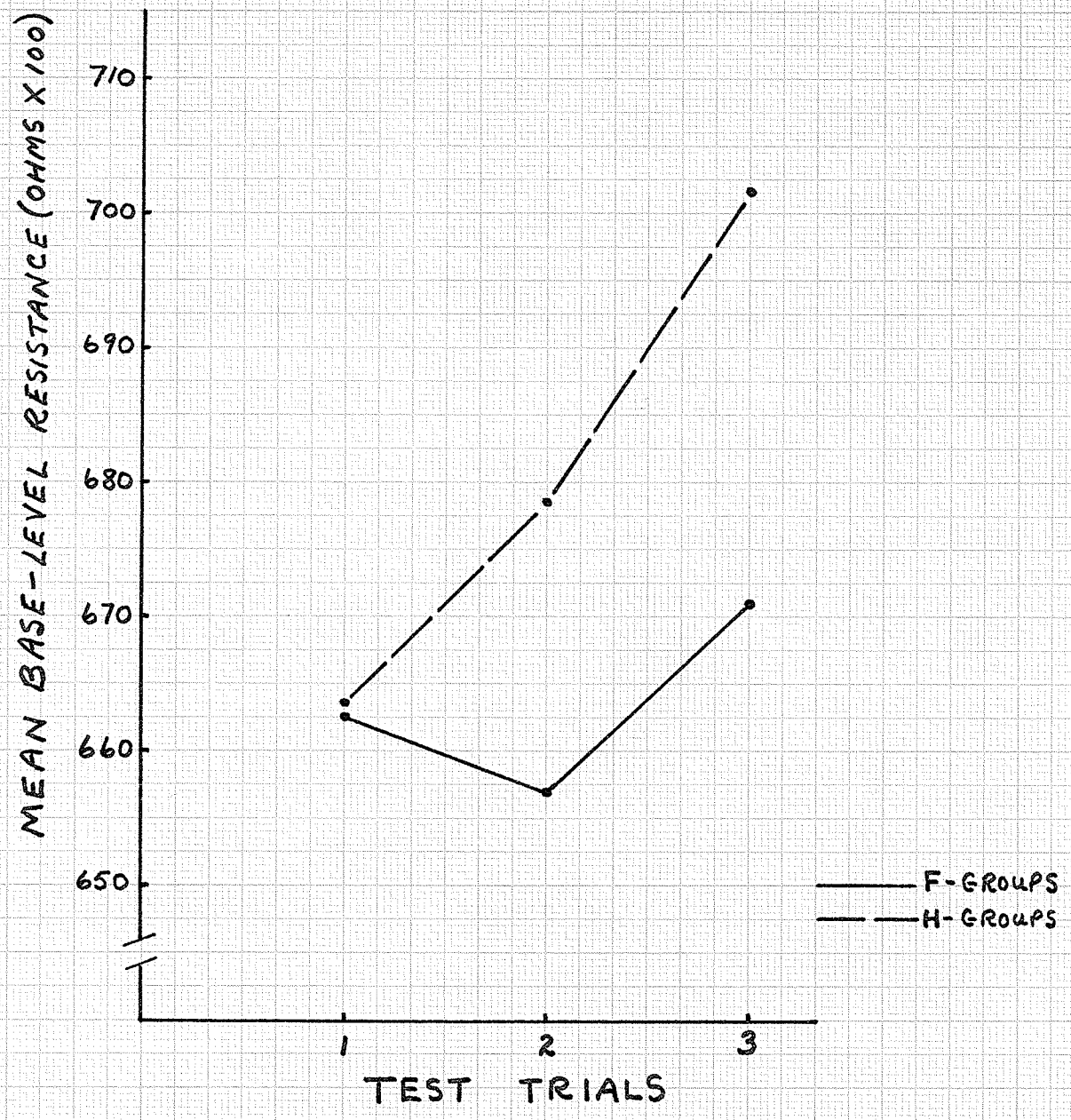

FIGURE 7

MEAN BASE-LEVEL RESISTANCE FOR EACH OF THE TWO MAJOR GROUPS (HABITUATED EITHER TO HOSTILE OR FRIENDLY WORDS) ON THE THREE TEST TRIALS

TABLE VIII

ANALYSIS OF VARIANCE: Sem Gen of Hab, F-LHT, H-HLT x Tr 8-10 (BASE LEVEL)

SV	df	SS	MS	F
Total	395	38,942,160		
Between Ss	131	38,453,584	293,539	--
A (H or F)	1	31,699	31,699	.11
B(Gen'l Stim.)	2	1,418,980	709,490	2.46
AxB	2	702,377	351,189	1.22
Error	126	36,300,528	288,099	--
Within Ss	264	488,576	1,851	--
C (Trials)	2	41,440	20,720	12.62***
AxC	2	16,719	8,360	5.09**
BxC	4	2,178	545	.33
AxBxC	4	14,427	3,607	2.14
Error	252	413,812	1,642	--

***p<.001

**p<.01

3 for level II (hostile) of A, F (1, 252) = 10.24, p <.01, (2) comparing level I (friendly) and level II (hostile) of A on trial 3, F (1, 252) = 6.44 p <.05.

Of the 132 subjects whose data are reported, 18 (13.6%) were unable to completely or correctly recall the list of stimulus words which they had received. Only 5 subjects (3.8%) closely approximated the real nature of the experiment in their answers to the second part of the questionnaire by stating that the words had been selected with respect to a definite mood or meaning whose effect could be monitored by the GSR.

CHAPTER V

DISCUSSION

It was hypothesized at the outset of this study that if generalization of habituation existed along a dimension of meaning, it would occur in the greatest degree to synonyms and least to antonyms. That is, it was expected that the habituated GSR would be "re-elicited" on test trials in an increasing manner as the generalized stimuli decreased in similarity (of meaning) to the habituation series. Thus a type of generalization continuum was postulated having synonyms at one extreme and antonyms at the other, with neutral words lying in the interjacence.

For the groups habituated to friendly words, the results indicate that generalization of habituation did indeed occur along a semantic dimension. Unlike the original hypothesis, the generalization was significant only to the opposite and neutral words but was not reliably different for either one. However, the trend was for there to be more generalization to the neutral word than to the antonym. Koplin, Moates, and Burroughs (1968), in a study of semantic generalization based on paired-associate and free recall tasks, also demonstrated that significant generalization occurred to opposite words and not to similar words. However, these patterns were based on a comparison to neutral words -- used as controls because generalization was lowest to them.

In addition to the aforementioned study, Olson (1965) has investigated the effect of similar and opposite word pairs matched for association strength in a semantic generalization task. He found that in paired-

associate learning, generalization to similars and opposites was not significantly different, although both showed significant generalization when compared to control (neutral) words. In light of this evidence, the considerable and significant generalization to THINK by the Friendly subgroups is rather contradictory. The subjects may have thought that this word was merely a continuation of instructions and, because they were already habituated to the experimental setting, the OR was not evoked in magnitude representative of a novel stimulus. Perhaps there was association between the word THINK and the "task" which the subjects were performing -- that of thinking about the stimulus words, rehearsing the list sub-vocally and trying to remember them. The degree of similarity in meaning is not the only dimension of relatedness among words and generalization may have been affected by other equally influential dimensions. It may be too that, as postulated, a neutral word is less dissimilar in meaning to a given stimulus word (or words) than is this word's antonym. A significant difference between the degree to which generalization occurred to the neutral word and to the antonym, the antonym receiving the lesser of the two, would have lent credence to this hypothesis. In sum, it would appear that the word THINK is not as neutral as first believed, especially in a university setting, a factor which holds true for both major groups (H and F). The choice of a test stimulus which better represents the neutral category probably would have allowed more conclusive inferences on the nature of semantic generalization of habituation.

As indicated in the results, the response of the subgroup in the Friendly category to the presentation of LOVE was not generalization but rather a significant decrease in mean GSR magnitude from that of the previous trial. This continuation of habituation indicates that there was no discrimination between the stimulus list of trials 1-7 and the presentation of the synonym, LOVE.

Autonomic response measures such as base-level resistance are presently accepted as indicators of drive or arousal. The data reveals that while the base-level resistances for both the Hostile and Friendly categories increased in a similar manner over habituation trials, differences arose across the test trials (8-10). Figure 7 indicates that base-level resistance continued to increase over the three test trials for the Hostile subgroups but stopped and showed a temporary decline for groups habituated to friendly words. It may be speculated that the non-significant results for the groups habituated to hostile words are due to a difference in reactivity to the stimuli. The change in base-level resistance seems to indicate that the test words had a greater effect on the Friendly subgroups than on the Hostile subgroups. Possibly the intense nature of the hostile habituation words resulted in the occurrence of a kind of desensitization to words in general. This would account for the overall lowering of reactivity to words exhibited by the subjects of the Hostile groups.

Base-level resistance increased gradually over trials, an effect which has also been observed by Corman (1967), and is indicative of the

decrease in arousal usually accepted as signifying habituation. However, Figure 6 shows that this rise in base-level resistance followed a monotonic increasing fashion over trials 1-7. This gradient is unlike those obtained by other researchers (Corman, 1967; James & Hughes, 1968) who found a sharp drop in base-level resistance from trial 1 to trial 2 and then a linear increase with succeeding trials.

Possible extrinsic motivation may have been present in the form of the instructions which extolled the subjects to remember the word lists -- a task which supposedly was a function of their I.Q.. Reference to Berlyne, Craw, Salapatek, and Lewis (1963) reveals that in their study, extrinsically motivated subjects gave more frequent GSRs than did those without such motivation. Since GSRs were recorded only for an interval of three seconds from stimulus onset, the gradients presented in this study may not be totally indicative of the processes of habituation and generalization.

The small percentage of subjects who could not completely or correctly recall the word list and the even smaller number who closely understood the nature of the experiment would seemingly signify that these were not factors which greatly influenced the results.

One important aspect of this study is its relevance to research and theorization based on classical conditioning. This is especially true for investigations where the GSR is conditioned to verbal stimuli (words) and then tested for generalization (Lang, Geer & Hnatiow, 1963; Maltzman & Laskin, 1965). Typically, these experiments involve a

number of conditioning trials with a given stimulus (or category of similar stimuli) followed by a change in degree or kind of stimulus conditions with the movement from training to test trials. It has been suggested by Bindra (1961) and Williams (1963) that the reactions (OR) evoked by the novelty or unexpectedness of a change in sensory stimulation would contribute to the generalized responses thereby confounding the results. That is, "the obtained change in response would represent the combined effects of any true generalization of the trained response and reactions to the stimulus change per se" (Williams, p. 52). Thus the resultant gradients of generalized responses would deviate from the from the underlying true gradients by an amount representative of the degree to which reactions to novelty had been evoked. This reaction to novelty includes not only a response to stimulus change as such but also a response to the degree of stimulus change. That is, in a stimulus generalization study, testing to a range of stimuli or repeated presentations of a single stimulus, responses to the first few test trials include a reaction to the novelty of stimulus change while responses on later test trials contain an effect due to the degree of stimulus change from the training to test situations. This study has illustrated that the reactions of the GSR, its modifiability through repetition, and its re-occurrence in a novel setting, can be evoked by stimuli of a secondary as well as a primary modality. It is becoming increasingly evident that the GSR, which is so highly sensitive to stimulus alteration and novelty, may not be an appropriate measure for establishing the existence of stimulus generalization of association.

On the basis of the results, this investigation has demonstrated that habituation of the GSR can occur to the presentation of stimulus words having a similar basis in meaning. The results also tentatively indicate that this habituation generalizes to a decreasing degree to other words subsequently presented along the semantic dimension.

CHAPTER VI

SUMMARY AND CONCLUSIONS

It was hypothesized that gradients of generalization of habituation could be obtained along a semantic dimension analogous to those gradients obtained by Williams (1963) and Corman (1967) along a primary stimulus dimension. Further, it was predicted that substantiation of this hypothesis would constitute evidence for Lynn's concept (1966) of "semantic habituation."

One hundred and thirty-two university students were assigned in the order of their appearance at the laboratory to two major categories, Friendly and Hostile, based on the nature of the habituation stimuli to be received. Each category was further divided into three equal subgroups for testing to the words LOVE, HATE or THINK. Subjects, run individually, were auditorially presented with the list of seven hostile or seven friendly words, each presentation representing a trial. This was followed by three repetitions of the synonym, antonym, or neutral word on the last three trials. The GSR was monitored for three seconds after the onset of each stimulus word and the greatest decrease in skin resistance during this interval was recorded as the response. As previously instructed, the subjects were then required to recall the words on a questionnaire and give their conclusions on the real purpose of the experiment.

The data indicated that, for the groups habituated to friendly words, generalized habituation occurred in significant fashion to the

antonym (HATE) and neutral word (THINK). There was a trend for less generalization to the antonym which represents the opposite in meaning to the habituation stimuli. Continued habituation was the only reaction to the presentation of the synonym. For groups habituated to hostile words, the results were not conclusive -- habituation continued across trials but did not differentiate between the subgroups. A slight tendency was observed for the gradients of these groups to match those shown by the Friendly category.

These results were interpreted as lending partial credence to the hypothesis that habituation of the GSR will occur to repeated presentation of synonyms. Moreover, this habituation will generalize to a decreasing degree to other stimuli subsequently presented along a dimension of meaning extending from synonyms to antonyms.

The relevance of this investigation to studies of the classical conditioning was also noted. It now appears that the GSR may be inappropriate as a measure of stimulus generalization in these studies because of its extreme susceptibility to the influence of novel factors.

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APPENDIX

B

PSYCHOLOGY DEPARTMENT

To the Subject:

Please list below the eight words which you have just heard. These words need not be in the order of presentation.

1.

2.

3.

4.

5.

6.

7.

8.

In your own words what was the purpose of this experiment? Be as specific as possible.