EFFECTS OF AMOUNT AND DIRECTION OF CHANGE IN STIMULUS INTENSITY ON THE GENERALIZATION OF HABITUATION OF THE GALVANIC SKIN RESPONSE

A Thesis

Presented to

the Faculty of Graduate Studies

University of Manitoba

In Partial Fulfillment

of the Requirements for the Degree of

Master of Arts

by

Gary Reigh Hughes

August, 1969

TO EARL J. TYLER, Ph.D.,

FOR MAKING IT POSSIBLE

ABSTRACT

Two experiments were performed to determine the slope of the gradient of generalization of habituation of the galvanic skin response (GSR) to increases and decreases in the intensity of a white noise stimulus. Four groups of 20 introductory psychology students with equal numbers of males and females in each group were used as subjects in each experiment. All subjects in any given group experienced only an increase or a decrease or no change in stimulus intensity during the test trials. Base level resistance immediately prior to stimulation and change in resistance following each stimulus were recorded.

Habituation of the GSR to repeated presentation of a white noise stimulus was reliably obtained. A significant increase in base level resistance over trials was also found. The gradient of generalization of habituation to increases in stimulus intensity tended to slope upward while the gradient of generalization to decreases in intensity appeared to be flat.

The results were interpreted as favoring a stimulus intensity dynamism theory of generalization of habituation as opposed to a stimulus dissimilarity theory such as that advanced by Sokolov (1960).

ACKNOWLEDGEMENTS

The author wishes to express his appreciation to Dr. J. P. James for his guidance and assistance throughout all phases of this study. Thanks are also extended to Dr. J. J. Pear for his critical reading of the paper and helpful suggestions, and to Professor J. A. Foster for his valuable assistance.

This research was supported, in part, by a grant (APA-223) from the National Research Council of Canada.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FIGURE PAGE

CHAPTER I

INTRODUCTION

Historical and Theoretical Background

In the present study, the galvanic skin response (GSR) has been employed as a measure of the orienting response (OR). Lynn (1966) has listed a number of changes that take place in an organism when an OR is elicited, the GSR being classified (along with peripheral vasoconstriction, central vasodilation, changes in respiration and heart rate) in the category of vegetative changes. The GSR appears to be the most reliable component of the OR in terms of frequency of occurrence. Lynn suggests that typically the GSR is elicited by auditory stimulation in about 95 out of 100 cases. For this reason, the GSR appears to be particularly suitable as an indicator of the occurrence of an OR and as a measure of its magnitude.

The OR is a phenomenon that has commanded the attention of experimenters throughout the history of the behavioral sciences. Although credit has been given to Pavlov for introducing the term orienting reflex (Sokolov, 1960, p. 189), the OR and the phenomenon of its habituation had been noted prior to the time of Pavlov's writing. Jennings, for example, observed and described the occurrence of these phenomena in lower organisms in 1906. However, Pavlov did give these topics a rather more detailed treatment and has provided a definition of the OR which is still relevant today. He described the OR as "this reflex which brings about the immediate response in man and animals to the slightest changes in the world around them...(Pavlov, 1927, p. 12)." Habituation of the OR took place, Pavlov noted, when a neutral stimulus kept recurring. A somewhat more comprehensive definition of habituation of the OR has been provided by Thorpe (1956), who wrote that "Habituation can, therefore, be defined as the relatively permanent waning of a response as a result of repeated stimulation which is not followed by any kind of reinforcement. It is specific to the stimulus and relatively enduring, and so it is natural to regard it, provisionally at any rate, as distinct from fatigue and sensory adaptation (pp. 54-55)."

Although a number of models for the habituation of the OR have been advanced, a small sample, representing the major positions in the area, has been selected for discussion here. These are the models of Pavlov (1927), Sharpless and Jasper (1956), Sokolov (1960), and Stein (1966). Other models have been proposed and a review and critique of these theories may be found in Lynn (1966).

Pavlov's model for habituation of the OR assumed that "with repeated stimulation the cortical neurons of the analyser become exhausted (Lynn, 1966, p. 33)." Internal inhibition is thus built up and the OR ceases to occur. Although Lynn (1966) contends that this type of "one-stage model" of habituation (which postulates the generation of an inhibitory process) is untenable for a variety of reasons, the inclusion of the theory here is of at least historical value.

Following a series of experiments performed on cats, Sharpless and Jasper (1956) proposed that two kinds of activation reaction exist, the "tonic" and the "phasic," each involving different pathways and levels of the central nervous system. While the two kinds of reaction occur together, the tonic reaction is subject to rapid habituation while the phasic reaction is very resistant to habituation. One of the conclusions that Sharpless and Jasper reached that is of most interest to the present study is that "Habituation of the arousal reaction is specific to the quality, modality, or pattern of a given stimulus (1956, p. 678)." This conclusion had been qualified, however, by an earlier remark that habituation of the tonic reaction is apt to be much less specific than habituation of the phasic reaction. Lynn (1966) suggests that while Sharpless and Jasper's model handles some of the evidence well, there are still some difficulties with the model which, like Pavlov's, is a one-stage theory of habituation.

The most comprehensive and widely accepted model of habituation of the OR is that advanced by Sokolov (1960). Sokolov proposed that stimuli leave traces or "nervous models" within the nervous system and especially in the cortex. Accordingly, he notes that "the model postulates a chain of neural cells which preserve information about the intensity, the quality, the duration, and the order of presentation of the stimuli (Sokolov, 1960, p. 205)." According to Sokolov's hypothesis, when a stimulus is compared with neuronal models present in the nervous system, one of two events may occur. If the stimulus does not coincide with an existing model, an OR will be elicited. On the other hand, if the stimulus and neuronal model do coincide, then the OR will not be evoked. The significance of these predictions of the model for the present study are immediately apparent. If the model holds true, one would predict that, regardless of the direction of change along a given stimulus dimension, any significant change in a stimulus parameter could cause the OR to be re-evoked. It follows logically that a decrease in the pitch or intensity should re-evoke the OR to approximately the same extent as an equivalent increase in one of these parameters. What this means in terms of generalization of habituation is that one should find similar gradients of generalization irrespective of direction of change. Support for this model has been obtained for variations in pitch (Corman, 1967) but not for changes in intensity (Bernstein, 1969; James & Hughes, 1969).

A model for generalization of habituation that can handle stimulus intensity effects has been advanced by Stein (1966). The theory is based upon the interaction of excitatory and conditioned inhibitory mechanisms. In cases where stimulus intensity is not involved, the theory assumes that excitatory potential is constant over all stimulus values. When a stimulus is presented repeatedly, a symmetrical gradient of conditioned inhibition develops around this stimulus. It follows, then, that an equivalent increase or decrease in one of the parameters of the stimulus will evoke an equivalent response. The response evoked will be equal to the difference between excitatory potential and the gradient of conditioned inhibition. A symmetrical gradient of generalization of habituation therefore results when stimulus intensity is not a factor. In cases where stimulus intensity is manipulated, excitatory potential is positively related to the intensity of the stimulus. While a symmetrical gradient of generalization of conditioned inhibition still develops around the repeatedly presented stimulus, the gradient of response strength to stimuli on either side of this stimulus is not symmetrical since the excitatory potential gradient now slopes upward. Thus, the distance between the excitatory potential gradient and the gradient of conditioned inhibition is smaller for stimuli of lower intensity and increasingly larger for stimuli of higher intensity than the repeatedly presented stimulus.

It would seem, therefore, that something additional is operating in cases where stimulus intensity is manipulated. It follows logically that one of the most important variables involved would be stimulus intensity dynamism (SID; Hull, 1949). Although introduced by Hull to denote the positive relationship that exists between the intensity of a conditioned stimulus and the strength of a conditioned response, there is no apparent reason to assume that the phenomenon does not operate in the case of ORs. It has, in fact, been rather convincingly argued that the OR is a quickly conditioned reaction and not simply an unconditioned reflex to novel stimuli. As Grastyan (1961) has pointed out, "This surprising conclusion seems to be supported by the long known fact that the orientation reflex can be easily extinguished, like conditioned, but unlike unconditioned, reflexes (p. 244)." On the other hand, there is also no reason to assume that SID will operate in precisely the same way with ORs as it does with conditioned responses. In his rather extensive review of the SID concept, Gray (1965) has concluded that

"The GSR (and probably all other responses of an 'orienting' nature) does not display the usual relations between stimulus intensity and response strength (p. 193)." In view of this last statement, it seemed justifiable to formulate a simplified SID model for generalization of habituation of the OR. No attempt will be made to predict the shape of the gradient, since as Mednick and Freedman (1960) have pointed out, the shape of a gradient "may be altered simply by manipulating the units of the axes (p. 190)." Theorizing with respect to the gradient will therefore be limited to predictions as to its direction; that is, whether it slopes upward, downward, or is relatively flat.

In order to avoid confusion, it might be helpful here to note the difference between ordinary stimulus generalization gradients of generalization of habituation. In the case of the ordinary stimulus generalization gradient, relatively less stimulus generalization is occurring when the gradient slopes downward from the original CS. In this situation, response strength to the generalized stimuli becomes increasingly lower as the distance between the generalized stimuli and the original CS increases. In the case of the gradient of generalization of habituation, relatively less generalization of habituation is occurring when the gradient slopes upward from the original CS. Under these circumstances, response strength to the generalized stimuli becomes increasingly greater as the distance between the generalized stimuli and the original habituated stimulus increases.

Now that this point has been clarified, an understanding of the gradient that would be expected to result in a study of generalization of habituation of the GSR should be facilitated. It would be predicted that, when a stimulus of a given intensity is habituated, the gradient of generalization to stimuli of higher intensity would slope upward. This would be expected because stimulus generalization (SG) alone predicts a greater response as the distance between the original stimulus and the test stimulus increases. In addition, SID alone dictates that the higher the intensity of the stimulus, the greater will be the response. In the case of generalization to stimuli of higher intensities then, the effects of SG and SID act together to produce an increased response as the distance between the habituated stimulus and the test stimulus increases. Predicting the slope of the gradient when test stimuli of intensities lower than the habituated stimulus are employed is not as clear-cut. In this case, SG again suggests that the gradient will slope upward as the distance between the habituated stimulus and test stimuli increases. However, under these circumstances SID predicts that a smaller response will be elicited as this distance increases, since stimulus intensity is decreasing. Therefore, if the influence of SG and SID were approximately equal, a flat gradient would be predicted since they are acting in opposite directions. Of course, any significant discrepancy between the effectiveness of these two forces would cause the gradient to be deflected either upward or downward depending on which of the two, SG or SID, was the more powerful variable. But since the relative strength of the two variables is not of direct concern at the moment, it will be assumed, for purposes of discussion, that the action of the two forces is equal and that the predicted resulting gradient will be flat. Hull himself did not predict the slope of the gradient that has been predicted here, but it must be recalled that Hull was theorizing on the effects of SID and SG in the context of conditioned responses. In order to make it clear that the predictions made here are distinct from formal Hullian theory, the gradients of generalization formulated above will be referred to as the predictions of the SID-SG position.

Statement of the Problem

While Sokolov's model and SID-SG position both predict an upward gradient in the case of generalization of habituation to stimuli of higher intensities, they differ in their predictions in the case of generalization to lower intensity stimuli. In this latter case, Sokolov's model would predict that the gradient would slope upward as stimulus intensity decreased, since the degree of noncoincidence between the neuronal model and the incoming stimulus is increasing. The SID-SG position, on the other hand, would predict a flat gradient (if one parsimoniously assumes that the effects of SG and SID are equal and opposite). The present problem, therefore, is to determine which theoretical position handles the data most adequately. In the review of the literature which follows, some of the results favor one position while some favor the other. While it has not been performed with the intention of providing the definitive work in the area, it is hoped that the present study will shed some light on the subject by adding whatever weight it may have to the body of evidence that has so far accumulated.

Review of the Literature

Numerous studies have been performed in which the GSR component of the OR has been employed as a response measure. The earlier work has involved GSR conditioning paradigms. Because these studies have provided the background for the more recent GSR habituation studies and because the processes appear to be quite similar, it should be worthwhile to review them. In fact, some writers contend that habituation of the OR and extinction of a conditioned reflex are completely analogous processes (e.g., Konorski, 1948). It is necessary to bear in mind, however, that while this work is certainly relevant, one cannot make an a priori assumption that the findings of the conditioning studies will accurately predict the results of the habituation studies.

In the present review of the literature, the relevant studies on generalization of conditioned GSRs will be discussed first. In this section, studies which employed paradigms other than classical conditioning of the GSR, e.g., instrumental conditioning (Grice and Saltz, 1950; Kling, 1952; Guttman and Kalish, 1956), voluntary responses (Brown, Bilodeau and Baron, 1951), secondary stimulus generalization (Lang, Geer and Hnatiow, 1963; Hanson, 1968) to name but a few, will not be discussed. It is not that these studies are less important, but simply that they are less directly related to the problem at hand. The next section will contain an examination of the studies on generalization of habituation of the GSR. The final section of the literature review will constitute a statement of the purpose of the present study and the manner in which the study was designed to achieve this purpose.

Generalization of the Conditioned GSR

In the typical GSR conditioning study, a tone (conditioned stimulus, CS) is paired with a shock (unconditioned stimulus, UCS) which elicits a GSR (unconditioned response, UCR). After a number of pairings, the CS alone comes to elicit the GSR (conditioned response, CR). Stimulus generalization of a CR may be measured by presenting a different CS on the first extinction trial and noting any differences in the magnitude of the response. Generalization of extinction may be measured by conditioning a response to several stimuli, extinguishing the response to one of these stimuli and then noting any difference in response when the other stimuli are again presented. Often both generalization of conditioning and of extinction are measured in the same experiment.

According to Beecroft (1966), the GSR was first successfully conditioned by the British physician, Colla, in 1921. A number of similar demonstrations followed but it was not until the Bass and Hull study in 1934 that generalization of conditioning of the GSR was demonstrated. In this classic study, Bass and Hull conditioned the GSR to a tactile stimulus placed at either the calf or the shoulder. Generalization to stimulation at other points on the body was then tested and a gradient of spatial generalization was obtained showing less generalization as the distance between the original stimulus and the test stimulus increased. Grant and Dittmer (1940a) obtained similar results using generally the same paradigm but placing the vibrators on different parts of the body.

Generalization has been demonstrated along many stimulus dimensions other than the tactile. Hovland (1937a) tested both generalization of conditioning and extinction to tones of varying pitch that had been equated for subjective loudness. The tones were 153, 468, 1000, and 1967 cycles per second (Hz), each tone being separated from the next higher (or lower) by 25 jnds. Half of Hovland's subjects were conditioned with the 153 Hz tone while half were conditioned with the 1967 Hz tone. Hovland found that generalization decreased as the distance between the test tones and original CS increased. There was no difference between groups as a function of direction of stimulus change, i.e., the generalization gradient of the group conditioned to the low-pitch CS did not differ significantly from that of the group conditioned to the high-pitch CS. Littman (1949) replicated the Hovland (1937a) study and found shallower gradients. He attributed this difference in findings to techniques and methods of analysis. Beecroft (1966) has pointed out that the data from the Hovland and Littman studies suggest that a certain amount of extinction must take place before the generalization gradient becomes apparent. However, Grant and Schiller (1953) have argued that stimulus generalization gradients should be determined from performance on the first extinction trial. Otherwise, discrimination training is introduced and this obscures so-called "pure" generalization effects. The fact that the generalization gradient changes as a function of extinction trials is particularly apparent in the Wickens, Schroder and Snide (1954) study. These investigators, using a counterbalanced design, trained Ss with a tone of 153, 468, or 1000 Hz as the CS and extinguished to either the same tone or one of the others. The generalization gradient was quite flat for the first two extinction trials but showed greater slope by extinction Trial 3. By Trial 8, the gradient showed a marked and progressively increasing slope as the distance between the original CS and the test stimulus increased. The data for increases and decreases in pitch are reported together, so presumably any differences in amount of generalization as a function of direction of change was not significant. Epstein and Burstein (1966) performed yet another replication of Hovland's (1937a) study. This experiment was performed in view of the fact that "a review of the total evidence to date leads to the conclusion that monotonic decremental gradients of the GSR, regardless of exact shape, have not been reliably established in humans (Epstein and Burstein, 1966, p. 783)." These investigators made use of both the skin potential (Tarchanoff) method of measuring the GSR as used by Hovland and the skin resistance (Féré) technique used by subsequent investigators. Test trials were conducted with shock leads off for half of the Ss and on for the other half. It was found that these procedural variables exerted no significant effect. However, they did find a significant effect due to differences in frequency of the tones. A U-shaped function was obtained with the greatest response occurring to the stimulus that was farthest from the CS in frequency, irrespective of whether the CS was the highest tone or the lowest tone. The authors suggested that the inconsistencies in the results of the studies in this area might be due to the fact that cognitive factors have not been taken into account. Support for this hypothesis was provided by data from post-experimental interviews which revealed poor ability on the part of the Ss to recall which tones had been accompanied by shock and which had not. This led the authors to design an experiment in which the responses could be plotted as a function of objective and subjective definition of the stimulus dimension. In this study, essentially a replication of Hovland's (1937a) experiment, Burstein, Epstein and Smith (1967) gave names to the four tones used and had the Ss identify the tones as they were presented to determine whether Ss could accurately perceive the stimulus conditions. In the first experiment, Ss labelled the tones during the pre-conditioning and test phase while in the second experiment, Ss labelled the tones in the conditioning phase as well as in the other two phases. The authors reported a failure to find decremental gradients of generalization as a function of either objective or subjective definition of stimulus dimension. In the first experiment they found a gradient of zero slope, while in the second experiment they found a U-shaped function. They suggested that "the elusiveness of conditioned generalization gradients in humans is directly related to the use of the galvanic skin response, the orienting component of which may be so sensitive as to obscure those aspects of the response which are a product of conditioning (Burstein et al., 1967, p. 130)." The role of the orienting reflex in the generalization of a conditioned GSR had, of course, been studied previously by Van Olst and Orlebeke (1965). These experimenters tested the hypothesis that Hovland's generalization gradient reflects the combined effect of "pure" generalization and the orienting reflex. They did this by training Ss with a 500 Hz tone CS and then testing equal groups of Ss to tones of 500, 1000, 2000, 4000, and 8000 Hz. Another group was tested to 500 Hz plus reinforcement in order to compare the response to 500 Hz with and without reinforcement. The overall generalization gradient obtained was U-shaped. Of greater importance and interest, however, was the finding that the response on the first test trial to the 500 Hz tone alone was significantly greater than the response to the 500 Hz tone plus reinforcement, indicating that omission of reinforcement alone has considerable OR-evoking effects.

Those conditioning studies which most closely resemble the present study are those involving generalization to stimuli of varying intensity. The classic reference study in this area was also performed by Hovland (1937b). In this study, Hovland used four tones of 1000 Hz each of which differed from each other by 50 jnds on the subjective loudness dimension. The actual intensities of the tones were 40, 60, 74, and 86 dB. Half the Ss were trained with the 40 dB tone as the CS and the other half were trained with the 86 dB tone as the CS. The group trained at 40 dB showed increasingly better generalization as the intensity of the test tone increased. That is, responses were even greater to the generalized stimuli than they were to the CS, although the differences were not significant. The group trained at 86 dB showed a more "normal" stimulus generalization gradient, with greatest responses being given to the CS tone and increasingly smaller responses being given to the generalized stimuli. Again the differences were not significant.

The tonal intensity study by Hovland (1937b) did not excite as many replications as his tonal frequency study did. However, one fairly recent study employing a very similar paradigm obtained essentially the same results. Hall and Prokasy (1961) selected three 1000 Hz tones having loudness values of 30, 54, and 80 dB from an equal discriminability scale constructed in previous research (Slivinske and Hall, 1960). One half of the Ss were conditioned to a 30-dB CS while the CS for the other half was the 80 dB tone. Both of these groups were further subdivided such that one third of the Ss in each were extinguished on the 30 dB tone, one third on the 54 dB tone, and one third on the 80 dB tone. For the 30-dB CS trained Ss, they found a generalized performance increment to both the 54 dB and 80 dB tones. Ss trained on the 80-dB CS showed a generalized performance decrement to the 54 dB and 30 dB tones. Thus, the gradients obtained in this study were similar in direction and slope to those obtained by Hovland (1937b). However, Hall and Prokasy concluded that the "results suggest the operation of stimulus intensity and adaptation effects, and if these variables are partialled out, a flat gradient is suggested (1961, p. 178)."

The final GSR conditioning study to be considered here is that of Kimmel (1960). His study extends over a very broad range of stimulus intensities and it will be interesting to compare his results with those obtained in the present study. Kimmel trained Ss on 1000 Hz tones of varying intensities and tested them at the same or other intensities such that at least one group each experienced stimulus intensity change of -70, -50, -40, -30, -20, -10, 0, 10, 20, 30, 40, 50, and 70 dB when the transition from conditioning to extinction was made. The results were expressed in terms of mean perceptual disparity responses which were obtained by subtracting each S's average response to pre-exposure to the extinction stimulus from his response on the first extinction trial. Kimmel found that larger responses occurred to the generalized stimuli than to the conditioned stimulus when the former were of higher intensity than the latter. When the generalized stimuli were lower in intensity than the CS, however, the generalized stimuli elicited smaller responses when the amount of change was -10 and -20 dB, but larger responses when the amount of change was -30, -40, -50, and -70 dB. These results would seem to indicate that while responsiveness is enhanced in a generally reliable fashion to positive changes in stimulus intensity, responsiveness is first diminished and then augmented by negative changes in stimulus intensity. This appears to suggest that responsiveness is not only a function of "pure" stimulus generalization effects and stimulus intensity effect, but that some other factor such as novelty may be operating. It was Kimmel's results, in fact, that provided the impetus for the present study, along with the results subsequently obtained by James and Hughes (1969) and Bernstein (1969). The manner in which Kimmel reported his results (combining the data to form four subgroups) did not lend itself to the formation of any definite conclusions with respect to the reliability of the sinusoidal shape of the obtained gradient. In spite of this, visual inspection of the generalization function did suggest the possibility that a non-monotic gradient might be obtained in the case of generalization to stimuli of lower intensities.

It has been noted that the gradients obtained in tonal frequency studies differ from those in the tonal intensity studies. For example, in Hovland's (1937a) study on pitch generalization, it was found that response amplitude decreased as the distance between test tones and the original CS increased, regardless of direction of change. However, in Hovland's (1937b) intensity generalization study, Ss trained on the low intensity CS showed greater response to the test tones than to the CS, while Ss trained on the high intensity CS showed smaller response to the test tones than to the CS.

Naturally, the tonal intensity generalization studies will be of most interest in the matter of predicting the shape of the gradients in the present study. As previously noted, Hovland (1937b) and Hall and Prokasy (1961) found increased responsiveness to increases in intensity and decreased responsiveness to decreases in intensity. Kimmel (1960) found increased responsiveness to increases in intensity, but for decreases in stimulus intensity, he found that responsiveness first decreased then increased as a function of the distance of test stimuli from the CS. This apparent lack of agreement between Kimmel's results and those of Hovland as well as Hall and Prokasy could possibly be accounted for by the fact that Kimmel used a wider range (35 dB to 115 dB) of stimulus intensities than these other investigators (40 dB to 86 dB and 30 dB to 80 dB, respectively). However, for a 50 dB decrease in stimulus intensity, Kimmel found a greater response to the test stimulus than for a group that experienced no change in intensity. Hall and Prokasy, on the other hand, found a smaller response to the test stimulus than to the CS when test stimulus was 50 dB lower in intensity than the CS. It is quite probable that procedural differences could account for these seemingly contradictory results.

The problem with GSR conditioning studies is that at least two factors are necessarily confounded. Response strength, as measured by the GSR, is affected not only by conditioning but also by the orienting component of the GSR which can be elicited by a variety of variables. The solution to this problem is to employ a paradigm that eliminates one of the factors mentioned above. In the GSR habituation studies which follow, the elimination of the conditioning component should permit a less contaminated assessment of the effects of amount and direction of change in stimulus intensity on the GSR.

Generalization of Habituation of the GSR

In the GSR habituation paradigm, the subject is customarily given a series of presentations of a certain stimulus (known as habituation trials) with the GSR component of the OR being measured following each presentation. After a predetermined number of trials have been administered or a specified criterion of habituation has been reached, some change in one of the stimulus parameters is made. This marks the end of the habituation series and the beginning of the test series. Typically, the difference in response magnitude between the last habituation trial and the first test trial is taken as an index of generalization of habituation. The studies to be reviewed next were performed under this general paradigm.

Systematic study of habituation of the GSR had its beginnings in the 1930's although, as mentioned earlier, it had been described previous to this time. Beecroft (1966) noted that Coombs (1938) was among the first to subject the phenomenon of habituation to a thorough experimental analysis. Among other things, Coombs tested for generalization of habituation among a variety of auditory stimuli and found that "galvanic adaptation to auditory stimuli is in part general and in part specific to the stimulus (1938, p. 267)." No doubt his failure to obtain conclusive results was due, at least in part, to the fact that the stimuli were not equated for intensity. Following Coombs' demonstration of generalization within a single modality, Porter (1938) was interested in determining whether generalization could take place across modalities. He found that generalization of habituation did take place from the visual to the auditory mode and from the auditory to the visual mode.

As Beecroft pointed out, a number of years intervened before the study of generalization of habituation excited much attention. Interest was revived fairly recently when Williams (1963) performed a study which was designed to obviate the confounding effects of the interaction between conditioning and orienting components of the conditioned GSR. Taking Hovland's (1937a) experiment as a model, Williams presented a 380 Hz tone for 16 trials (training series) followed by a test series of four trials in which tones of 670, 1000, 1400 and 1850 Hz were each presented once (in a different permutational order) to each S. The training and test series was then repeated in identical form. In addition to these obvious methodological differences, Williams' procedure differed from that of Hovland chiefly in the fact that no UCS was used. Instead, the GSR component of the OR was measured each time the OR was elicited by a stimulus. Williams found that the first stimulus in the test series elicited the largest response regardless of the degree of change from the training to the test stimulus. However, she also found that the ability of the stimuli to re-evoke the OR increased as the distance between the original stimulus and the test stimulus increased, although this trend reached significance only in the second test series. These results are in accord with those obtained by Hovland (1937b) in that both studies found that generalization becomes poorer as the distance between the original stimulus and the test stimulus increases. Recalling the earlier discussion on models for the orienting reflex, it might also be noted that Williams' results are compatible with Sokolov's model. Since intensity was equated for as frequencies were changed, stimulus intensity dynamism was not a factor in this study.

Zimny and Schwabe (1966) put Sokolov's theory to a rather thorough experimental test. Apparently they were motivated by the fact that Sokolov had not provided sufficiently detailed reports to permit evaluation of his research. These investigators derived eight hypotheses from Sokolov's theory and designed experiments to test them. The hypothesis that is most directly related to the present study is the one suggesting that the OR will be re-evoked to a greater extent as the dissimilarity between the original stimulus and the test stimulus increases. This was tested by giving Ss eight presentations of a 500 Hz, 86 dB tone, followed by one presentation of either a 1000 Hz, 67 dB tone or a 4000 Hz, 82 dB tone. (Although the authors did not make it clear, it is assumed that different stimulus intensities were used to equate for subjective loudness.) Mean GSR amplitude to the 1000 Hz tone was not significantly different from the GSR amplitude to the 4000 Hz tone. According to Zimny and Schwabe, this finding suggests that "within some broad limits, a change in stimulus which results in any disagreement between the parameters of the new stimulus and the parameters represented in an established neuronal model produces a substantial, or perhaps full, return of the OR (1966, p. 112)." These results are, of course, at variance with other work that has been done with generalization of habituation to varying frequencies of tones, but this may be attributed to the different intensities. As previously noted, Williams (1963) found different degrees of generalization to different frequencies and, more recently, Corman (1967) obtained results similar to those of Williams. Corman used tones of 670, 1000, 1400 and 1850 Hz (all at approximately 60 dB). Half of the Ss were given 10 habituation trials on the 670 Hz tone. Each S then received five presentations of one of the other tones. Corman found a significant difference between groups in terms of responses on test trials; that is, generalization of habituation became poorer as the distance between the habituation stimulus and the test stimulus increased. The results do not indicate any differential generalization as a function of habituation to the low pitch stimulus as opposed to the high pitch stimulus. Corman's results, then, appear to support Sokolov's theory.

Two studies performed quite recently in which generalization of habituation on the intensity dimension was investigated both fail to support Sokolov's theory. Bernstein (1969) tested generalization to varying intensities of light and varying intensities of tones. In his first experiment, Bernstein gave half of the Ss 10 habituation trials with a light-flash stimulus of five ft-c intensity while the other half were habituated with 25 ft-c light flashes. On Trial 11, the low intensity trained Ss received the high intensity stimulus while the high intensity trained Ss received the low intensity stimulus. It was found that 36.6 percent of the Ss who received an increase in stimulus intensity showed re-arousal of the OR (GSR) while only 12.3 percent of the Ss receiving a decrease in intensity did. Bernstein reports that this difference was highly significant. In his second experiment, one group of Ss was given 15 presentations of a 60 dB, 1000 Hz tones while an equal number of Ss received 15 presentations of a 90 dB, 1000 Hz tone. Both groups were then tested to a 75 dB, 1000 Hz tone. Bernstein found the 58.3 percent of the Ss of the low intensity trained group showed re-arousal while only 13.0 percent of the high intensity trained group did. Again, the difference was highly significant. Similar results were obtained in a study by James and Hughes (1969). Using white noise, these investigators habituated equal numbers of subjects to a stimulus of either 67 dB or 76 dB. After eight habituation trials, each group was divided with one-half of the Ss receiving four presentations of a test stimulus of 70 dB intensity and one-half receiving a 73 dB intensity stimulus. It was found that the groups habituated at 67 dB showed a significantly greater response to the test stimuli than to the habituation stimulus. The groups habituated to the 76 dB stimulus showed smaller responses to the test stimuli but this trend did not reach significance. The studies of Bernstein, as well as James and Hughes, both fail to support Sokolov's theory which would predict that the OR should be re-evoked regardless of the direction of change in stimulus intensity. In fact, the findings appear to suggest that stimulus intensity dynamism plays an important role in generalization of habituation to stimuli of varying intensities. It was the results of these studies that prompted the construction of present experiments.

The Purpose of the Study

It has been found that, in the case of a narrow range of stimuli on the intensity continuum, stimulus intensity dynamism effects appear to override the effects of stimulus dissimilarity (Sokolov's theory). Whereas the greatest distance between an habituation stimulus and a test stimulus in the James and Hughes (1969) study was only 6 dB; in the experiments which follow, this range has been increased to 20 dB. The purpose of the present study, then, is to attempt to extend the generality of the earlier findings by examining a broader range of stimulus intensities.

In studies of this nature, a considerable body of data is generated. While the gradients of generalization to increases and decreases in stimulus intensity are the data of central interest, other data such as that concerning base level resistance, sex effects and some of the numerous possible interactions will also be considered.

The next section of this paper constitutes a description of the method employed in attempting to realize the purpose of this study.

CHAPTER II

THE INVESTIGATION

General Method

The study was conducted in two separate experiments. The apparatus and general procedure were identical for both. Habituation stimulus intensities were different in each experiment, and there were some differences in the number of Ss that had to be discarded and the reasons for doing so.

Apparatus

The GSR was recorded on a Hunter GSR amplifier which had been modified to respond to a range of 0 to 150,000 ohms of base level resistance. The amplifier was attached to the subject by means of Fels zinc electrodes (Yellow Springs Instrument Co.) which were 20 mm. in diameter. The electrodes were housed in plastic cups which were freshly filled with Fels electrode jelly for each S. The GSR was recorded by the apparent resistance method or Féré phenomenon (Gormezano, 1966). In this method, the resistance of the subject's skin to the passage of a minute electrical current is used as the resistance in one leg of a Wheatstone bridge circuit (Sidowski and Smith, 1966). The white-noise stimuli were produced by a Grason-Stadler Twin Oscillator 950-D signal generator and presented to S through Roberts stereophonic earmuff-type headphones. Stimulus intensities were calibrated at the headphones by means of a Brüel and Kjaer precision sound level meter set on the linear fast scale (re: .0002 dynes/cm^2). Stimulus duration was controlled by a Hunter decade interval timer and interstimulus interval was controlled by a Gerbrands film timer. During the experiment, Ss wore Lafayette blindfold goggles and were seated in an upholstered chair to which padded armrests had been added. The chair was enclosed on three sides by a plywood booth which served to limit interference from unprogrammed stimuli. Flint sandpaper of very fine grade was used to prepare the dorsal surface of S's hand for attachment of one of the electrodes. While the experiment was in progress, S remained alone in one room while E was located in an adjacent room which contained the programming, recording and signal generating equipment.

Procedure

After entering the experimental room and completing a record sheet (for clerical use), S was asked to remove glasses and watch, if any. He was then instructed to be seated in the chair described above and to place the goggles over his eyes. S was allowed to move the goggles up to his forehead so that he could observe the remainder of the preparatory procedure. S was told that responses to auditory stimuli were being measured and that the purpose of the goggles was to cut down extraneous stimulation. Then he was informed that in order to measure his responses, it was necessary to attach electrodes to his hand and that it was also necessary to remove a little epidermis from the back of his hand. At this point, S was asked if he was willing to proceed. If he agreed, the back of his hand was lightly sanded. The electrode cups were then filled with jelly and clamped to S's hand, one on the palm and one on the prepared surface of the back of the hand. When the electrodes were in place, S's hand was placed in a comfortable position on the armrest of the chair. At this point, the instructions were read to S (see Appendix A). S was then asked to place the goggles back down over his eyes with his free hand, following which E placed the earphones on S's head. E then turned out the lights in the experimental room and went into the adjacent equipment room. While waiting for S to adapt to the experimental situation, E proceeded to record S's name and sex, and the date and time of participation on a data record sheet. S was then randomly assigned to one of the four groups in one of the two experiments. Assignment to a group was carried out after S and E were no longer in contact in order to eliminate the possibility of any communication of the expected performance of S taking place, whether verbally or non-verbally. Following this, the internal resistance of the GSR amplifier was calibrated after which the amplifier was switched to external resistance and the basal skin resistance level of S was determined. When a relatively stable baseline was obtained, two minutes of adaptation time was allowed to elapse before the first stimulus was presented. If the baseline was unstable, it was allowed to stabilize before S received the first stimulus. In any event, each S received at least two minutes of adaptation. When the stability requirements were met, the film timer controlling the stimulus presentation was activated and the signal generator was turned to the appropriate attentuator setting. The stimuli in both experiments were presented on a VI-1 minute schedule (range: 45 to 75 seconds) and were of 2.0 seconds duration. After eight presentations of an habituation stimulus, Ss were given four presentations of a test stimulus. The dB intensity of the habituation stimulus was different for the two experiments, and the intensity of the test stimulus was different for each of the four groups within each experiment. (Details of these differences appear in the sections below that designate the specific stimuli used in each experiment.) In the event of the occurrence of a spontaneous GSR during either the habituation or test phase of the experiments, the film timer was stopped. The stimulus was then presented after the base resistance had stabilized.

The skin resistance of S immediately prior to stimulus onset was recorded and used as a measure of base level resistance from which amount of change following stimulation could be calculated. A response was defined as any change in resistance of 200 ohms or more occurring one to five seconds after stimulus offset and the amount of this change was likewise recorded. Base level data were recorded and analysed in terms of ohm resistance. Responses to stimuli were recorded in ohms and subsequently converted to the logarithm of conductance change for analysis. Conversion to log conductance change was considered appropriate in view of Haggard's (1949a) paper, and the fact that it is currently the most widely used transformation for handling GSR data. The data were analysed by means of analysis of variance (ANOVA) with t tests being performed between pairs of groups where the comparison was of interest.

Experiment I

Subjects

The Ss were 92 undergraduate students from the introductory psychology course at the University of Manitoba. Twelve Ss were discarded for the following reasons: two Ss because their base level resistance exceeded 150,000 ohms (the upper limit of the equipment), two Ss because their response exceeded 10,000 ohms on Trials 7 and 8 (defined as failure to habituate), six Ss because they failed to show a measurable response on Trials 7 and 8 (defining below-zero habituation), and two Ss because it was discovered that they had previously participated in an habituation experiment. The remaining 80 Ss were randomly assigned to one of four groups of 20 Ss, each consisting of 10 males and 10 females.

Design and Stimuli

The experimental design in shown in Table 1. The Ss in Experiment I were all given eight presentations of a white noise stimulus of 65 dB intensity during the habituation phase of the experiment. Ss in Group I were then given four test trials with a white noise stimulus of 55 dB intensity. The test trial series followed the habituation series according to the VI schedule mentioned above with no cue or signal being provided to the Ss that such a change was taking place. In like manner, Ss in Groups II, III, and IV were given four test trials of white noise stimuli of 65, 75, and 85 dB intensity respectively.

Experiment II

Subjects

TABLE 1

DESIGN OF EXPERIMENTS I AND II SHOWING WHITE NOISE STIMULUS INTENSITIES BY GROUPS IN HABITUATION AND TEST PHASES

		Experiment	
Phase	Group	I	II
Habituation	All	65	75
Test	I	55	55
	II	65	65
	III	75	75
	IV	85	85

Note: Total N = 80 in each experiment. N per group = 20 (10 males and 10 females)

The Ss were 97 undergraduate students from the same introductory psychology course. Seventeen Ss were discarded for the following reasons: two Ss because their base level resistance exceeded 150,000 ohms, six Ss because their response exceeded 10,000 ohms of Trials 7 and 8, seven Ss because they failed to show a measurable response on Trials 7 and 8, one S because he had participated previously and one S because of experimenter error. As in Experiment I, the remaining 80 Ss were randomly assigned to one of four groups of 20 Ss, each group consisting of 10 males and 10 females.

Design and Stimuli

The experimental design is shown in Table 1. The Ss in Experiment II were given eight presentations of a 75 dB intensity stimulus during the habituation phase of the experiment. In a manner identical to that of Experiment I, Ss in Groups I, II, III, and IV were given four test trials of white noise stimuli 55, 65, 75 and 85 dB intensity respectively.

CHAPTER III

RESULTS

Experiment I

Mean GSR magnitudes to the 65 dB habituation stimulus across Trials 1 - 8 are presented in Figure 1. A Groups by Sex by Trials ANOVA of these responses is shown in Table 2. The significant trials effect (F = 27.59, df = 7/504, p <.0005) indicates that the GSR decreased reliably with repetition of the stimulus. Table 2 also shows that across Trials 1 - 8 there was a significant Sex effect (F = 6.40, df = 1/72, p <.025) and a Sex by Trials interaction (F = 2.08, df = 7/504, p <.05). These results are depicted in Figure 2.

Mean GSR to the test stimuli are also shown in Figure 1. An ANOVA of these results is shown in Table 3. There were significant Groups effect (F = 5.05, df = 3/72, p <.005), and Trials effect (F = 8.73, df = 3/216, p <.0005). A Groups by Sex by Trials interaction was also found (F = 2.33, df = 9/216, p <.025) and this is illustrated in Figure 2.

Figure 3 depicts the gradient of generalization of habituation of the GSR. The data are reported in terms of difference scores (Trial 9 minus Trial 8) in order to correct for differential habituation. A one-way ANOVA of these difference scores, presented in Table 4, indicated a significant stimulus intensity effect (F = 5.63, df = 3/76, p <.005). Two-tailed t tests for independent samples were performed comparing Group II, which did not experience intensity change, with each other

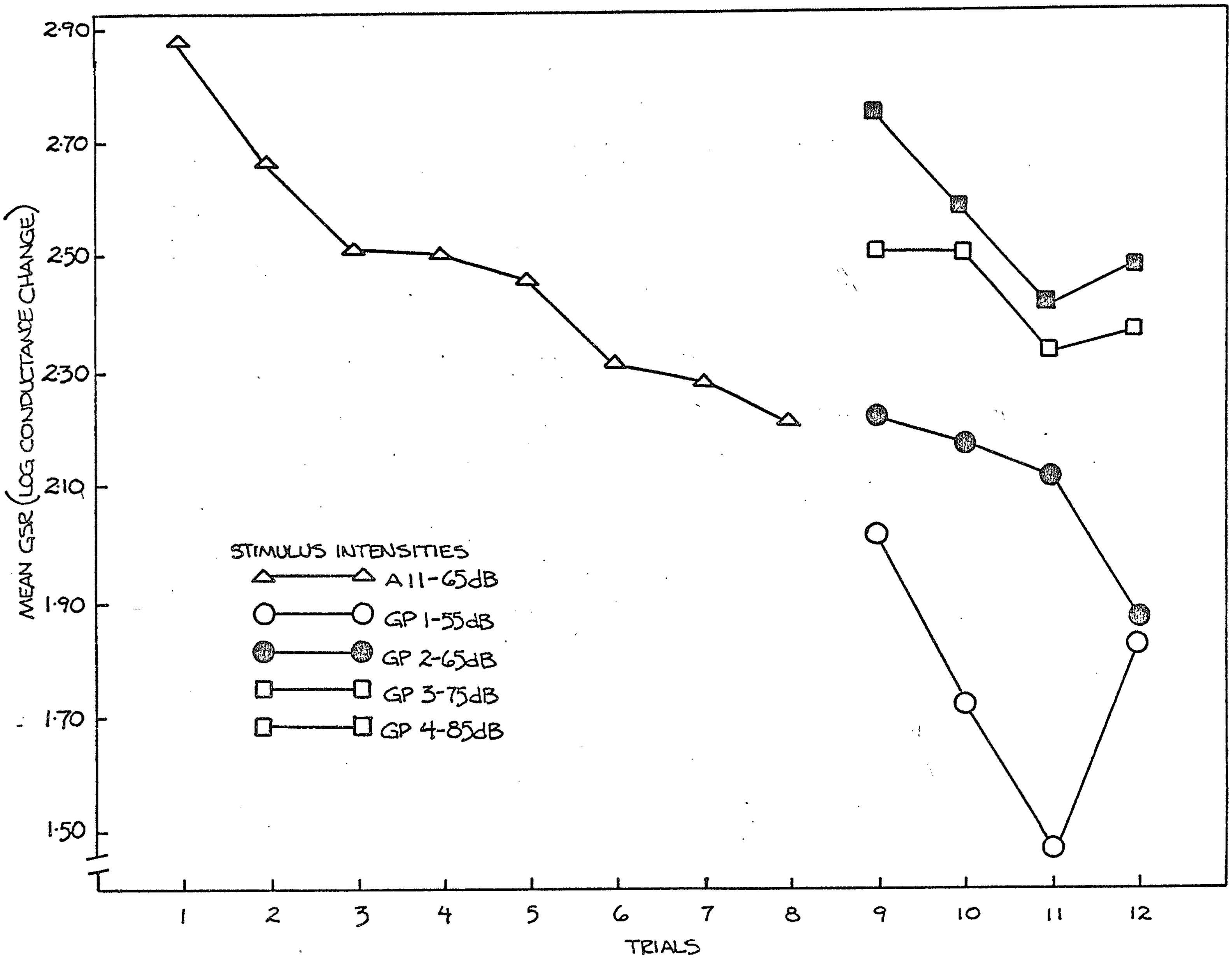

FIG. 1. Magnitude of the GSR to the habituation stimulus (Trials 1 to 8) and to the test stimuli (Trials 9 to 12) in Experiment I.

TABLE 2

ANALYSIS OF VARIANCE OF LOG CONDUCTANCE CHANGE
DATA FOR TRIALS 1 TO 8 IN EXPERIMENT I

Source of Variance	df	SS	MS	F	p
Total	639	196.23			
Between S	79	93.37			
Gps	3	4.72	1.57	1.42	n.s.
Sex	1	7.08	7.08	6.40	$<.025$
Gps X Sex	3	1.90	.63	<1	n.s.
Error (b)	72	79.68	1.11		
Within S	560	102.86			
Trl	7	26.42	3.77	27.59	$<.0005$
Gps X Trl	21	2.66	.13	<1	n.s.
Sex X Trl	7	2.00	.29	2.08	$<.05$
Gps X Sex X Trl	21	2.84	.14	1	n.s.
Error (w)	504	68.94	.14		

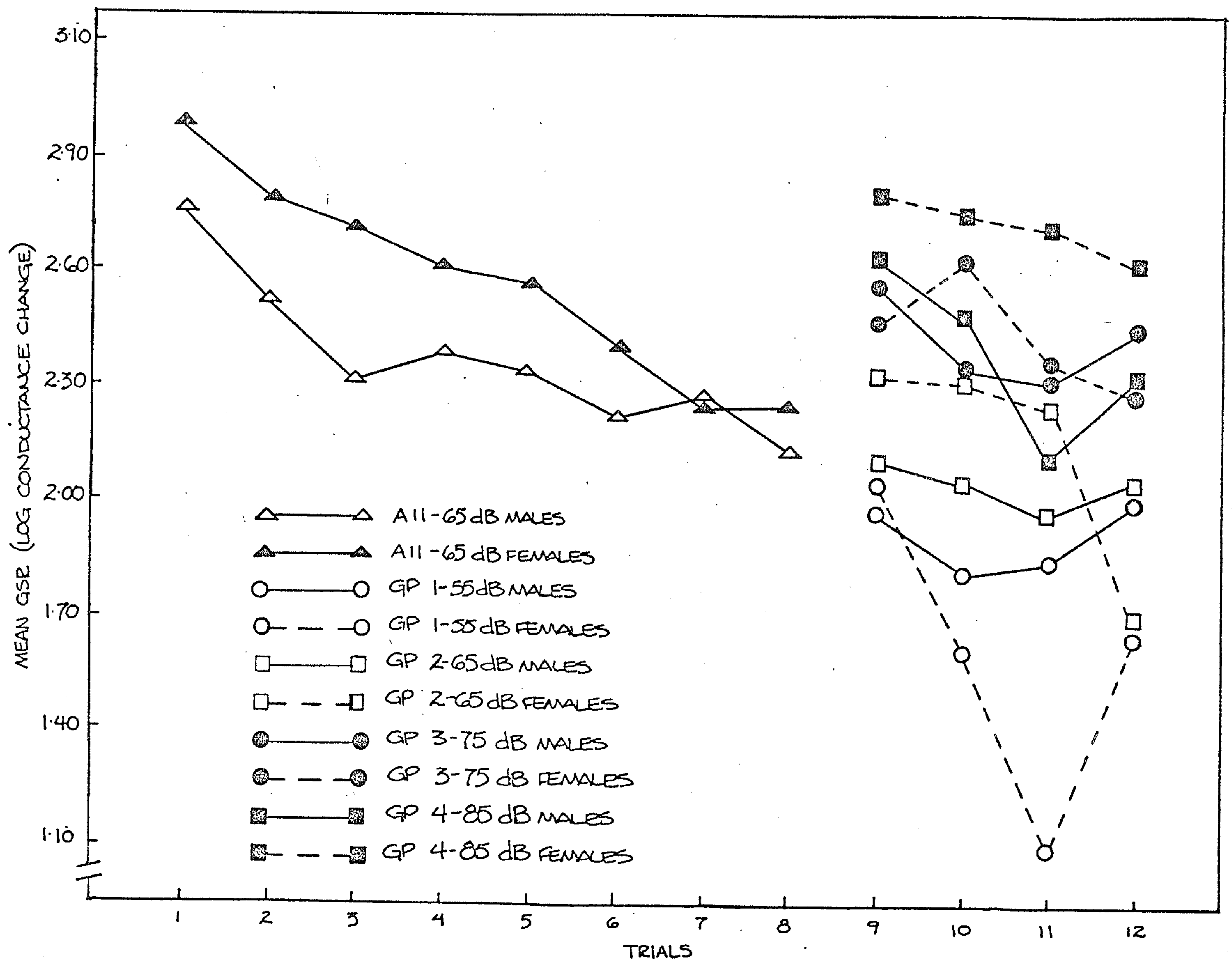

FIG. 2. Magnitude of the GSR to the habituation stimulus (Trials 1 to 8) and to the test stimuli (Trials 9 to 12) in Experiment I plotted by sex.

TABLE 3

ANALYSIS OF VARIANCE OF LOG CONDUCTANCE CHANGE DATA FOR TRIALS 9 TO 12 IN EXPERIMENT I

Source of Variance	df	SS	MS	F	p
Total	319	223.55			
Between S	79	179.92			
Gps	3	30.44	10.15	5.05	$<.005$
Sex	1	.16	.16	<1	n.s.
Gps X Sex	3	4.41	1.47	<1	n.s.
Error (b)	72	144.91	2.01		
Within S	240	43.63			
Trl	3	3.92	1.31	8.73	$<.0005$
Gps X Trl	9	2.34	.26	1.63	n.s.
Sex X Trl	3	1.10	.37	2.47	n.s.
Gps X Sex X Trl	9	3.12	.35	2.33	$<.025$
Error (w)	216	33.15	.15		

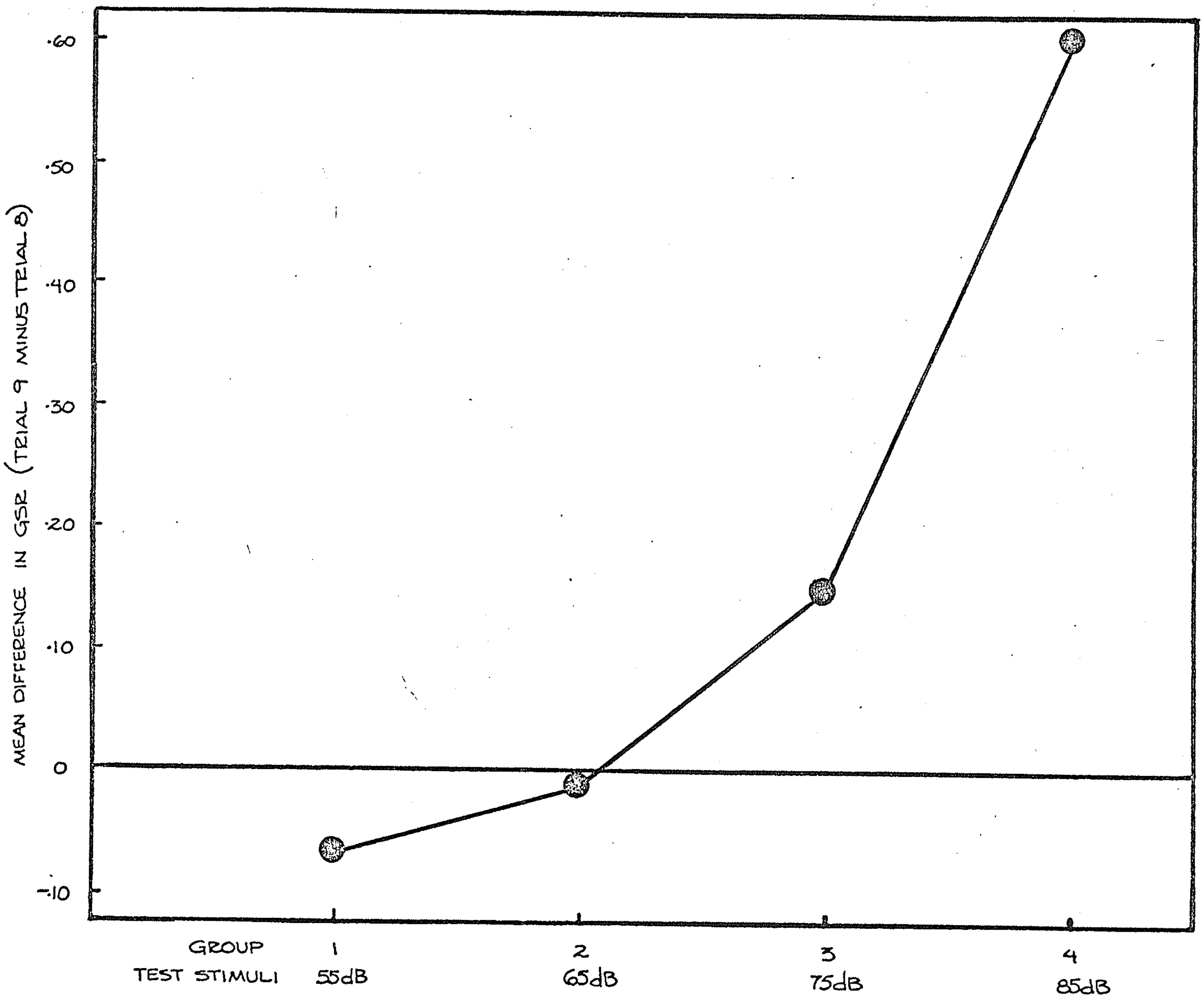

FIG. 3. Gradient of responses to test stimuli of varying intensities in Experiment I.

TABLE 4

ANALYSIS OF VARIANCE OF LOG CONDUCTANCE CHANGE DIFFERENCE SCORES DATA (TRIAL 9 MINUS TRIAL 8) IN EXPERIMENT I

Source of Variance	df	SS	MS	F	p
Total	79	30.73			
Test Stimulus Intensity	3	5.59	1.86	5.63	$<.005$
Error	76	25.14	.33		

group. Groups I and III did not differ significantly from Group II. Group IV was found to differ significantly from Group II ($\underline{t}$ = 3.33, $\underline{df}$ = 38, $\underline{p}$ <.005).

Base level resistances over both the habituation and the test phase are presented by sex in Figure 4. It will be noted from Table 5 that a significant Trials effect was found ($\underline{F}$ = 61.14, $\underline{df}$ = 7/504, $\underline{p}$ < .0005) along with a significant Sex by Trials interaction ($\underline{F}$ = 3.63, $\underline{df}$ = 7/504, $\underline{p}$ <.001) during the habituation phase of the experiment. As Table 6 shows, during the test phase there was also a significant Trials effect ($\underline{F}$ = 12.05, $\underline{df}$ = 3/216, $\underline{p}$ <.0005) and a significant Sex by Trials interaction ($\underline{F}$ = 2.85, $\underline{df}$ = 3/216, $\underline{p}$ <.05). It will also be noted in Figure 4 that there is a decrease in base level resistance from Trial 1 to Trial 2 and from Trial 9 to Trial 10. Two-tailed $\underline{t}$ tests for correlated samples performed on the difference between the means of these trials (groups and sexes combined) revealed a significant difference in the case of Trial 1 vs. Trial 2 ($\underline{t}$ = 6.81, $\underline{df}$ = 79, $\underline{p}$ < .001), but not in the case of Trial 9 vs. Trial 10.

Analysis of base level resistance data from the test trials, shown in Table 6, revealed two other interactions. For purposes of clarity, these functions have been portrayed separately in Figure 5. The analysis indicates a significant Groups by Trials interaction ($\underline{F}$ = 8.33, $\underline{df}$ = 9/216, $\underline{p}$ <.0005) and a significant Groups by Sex by Trials interaction ($\underline{F}$ = 2.13, $\underline{df}$ = 9/216, $\underline{p}$ <.05).

Experiment II

Figure 6 presents mean GSR magnitudes to the 75 dB habituation

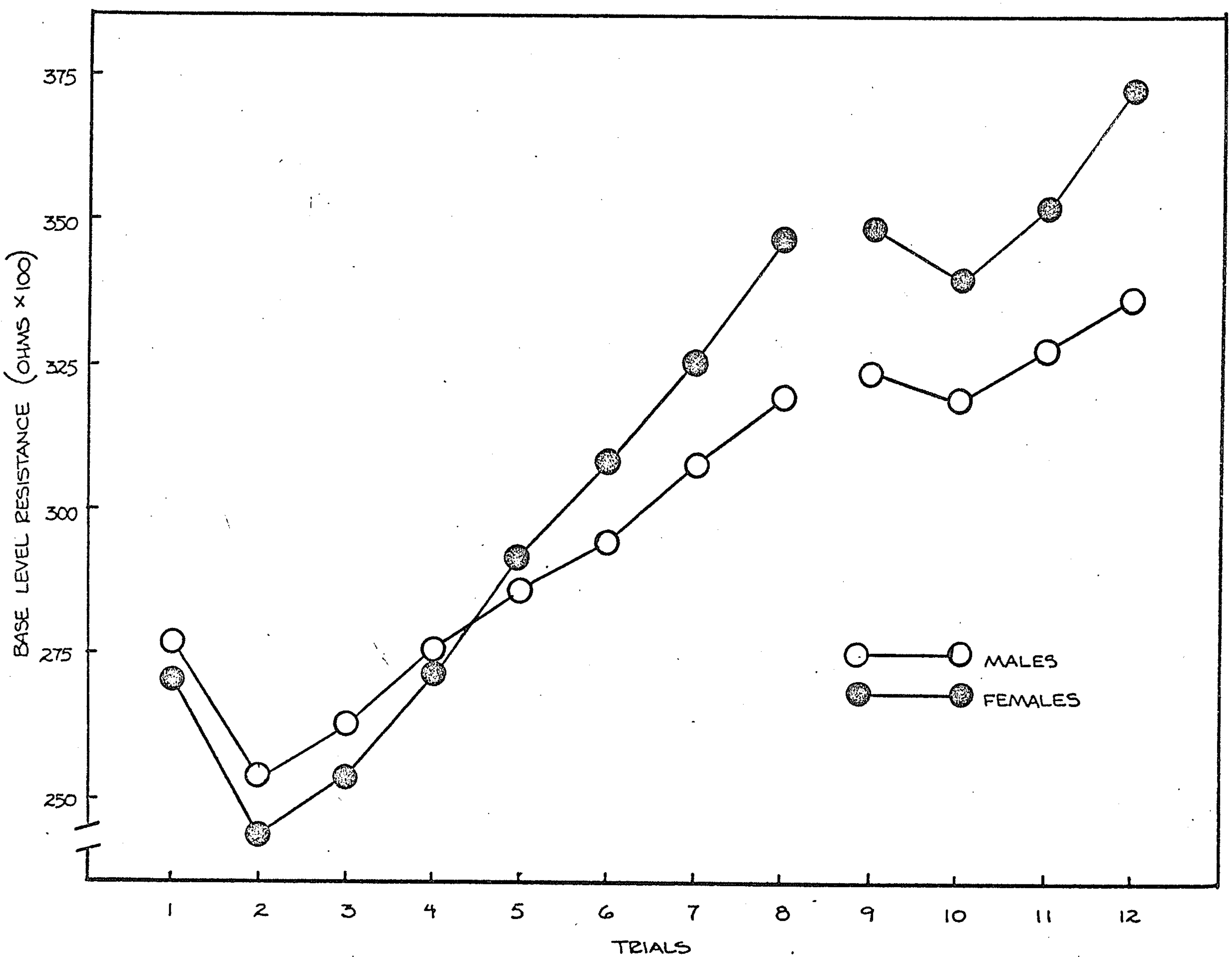

FIG. 4. Base level resistance measures over all trials in Experiment I plotted by sex.

TABLE 5

ANALYSIS OF VARIANCE OF BASE LEVEL RESISTANCE DATA
FOR TRIALS 1 TO 8 IN EXPERIMENT I

Source of Variance	df	SS*	MS	F	p
Total	639	12,829,978			
Between S	79	11,742,304			
Gps	3	143,495	47,832	<1	n.s.
Sex	1	2,937	2,937	<1	n.s.
Gps X Sex	3	346,613	115,537	<1	n.s.
Error (b)	72	11,249,259	156,240		
Within S	560	1,087,674			
Trl	7	465,655	66,522	61.14	$<.0005$
Gps X Trl	21	23,372	1,113	1.02	n.s.
Sex X Trl	7	27,669	3,953	3.63	$<.001$
Gps X Sex X Trl	21	22,751	1,083	<1	n.s.
Error (w)	504	548,227	1,088		

* Note: Multiply figures in this column by 10^4 to obtain actual SS

TABLE 6

ANALYSIS OF VARIANCE OF BASE LEVEL RESISTANCE DATA
FOR TRIALS 9 TO 12 IN EXPERIMENT I

Source of Variance	df	SS*	MS	F	p
Total	319	8,812,341			
Between S	79	8,594,920			
Gps	3	295,700	98,567	<1	n.s.
Sex	1	64,638	64,638	<1	n.s.
Gps X Sex	3	342,940	114,313	1.04	n.s.
Error (b)	72	7,891,642	109,606		
Within S	240	217,421			
Trl	3	22,157	7,386	12.05	<.0005
Gps X Trl	9	45,951	5,106	8.33	<.0005
Sex X Trl	3	5,240	1,747	2.85	<.05
Gps X Sex X Trl	9	11,725	1,303	2.13	<.05
Error (w)	216	132,348	613		

* Note: Multiply figures in this column by 10^4 to obtain actual SS

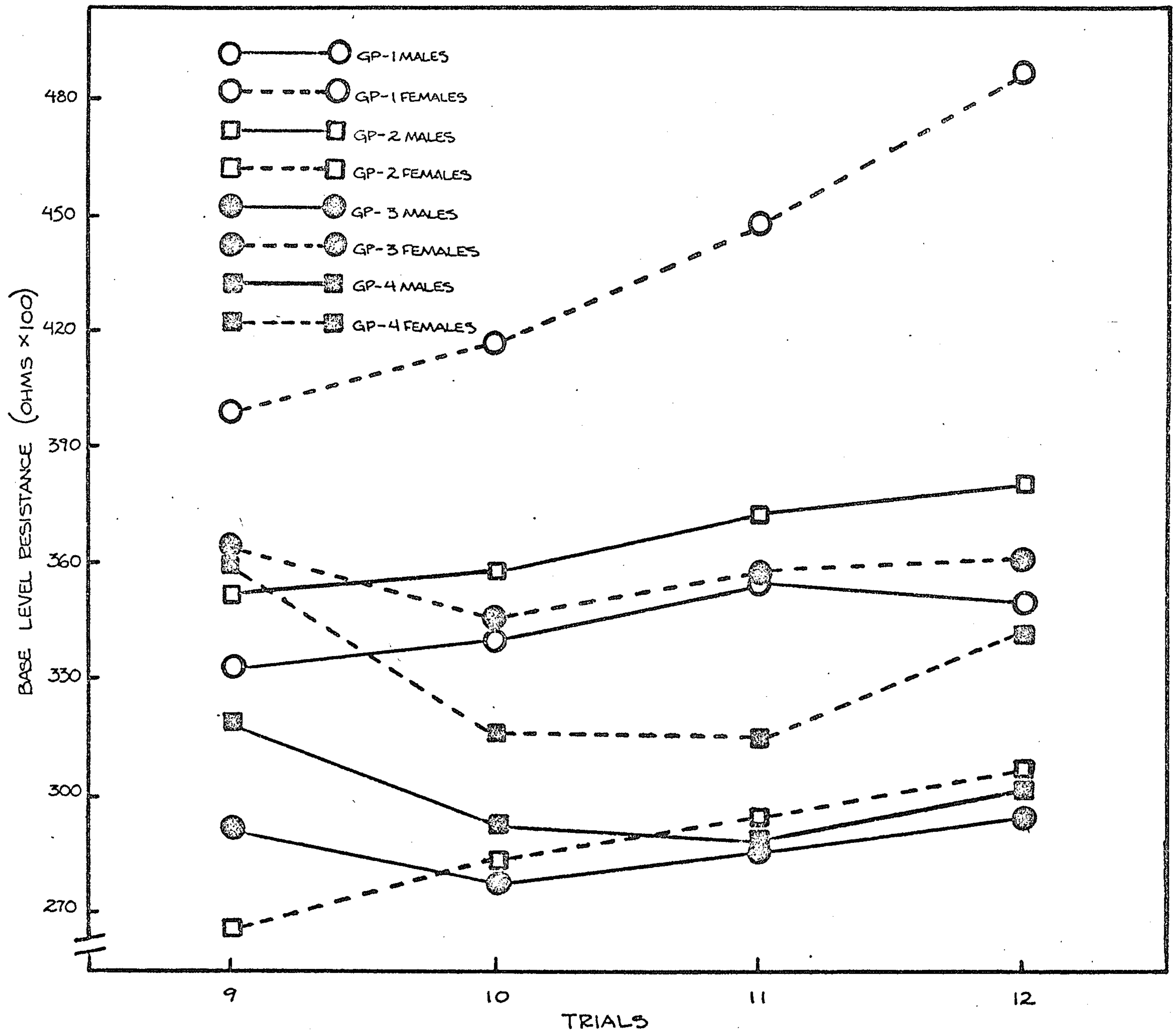

FIG. 5. Base level resistance measures on test trials in Experiment I showing Groups by Sex by Trials interaction.

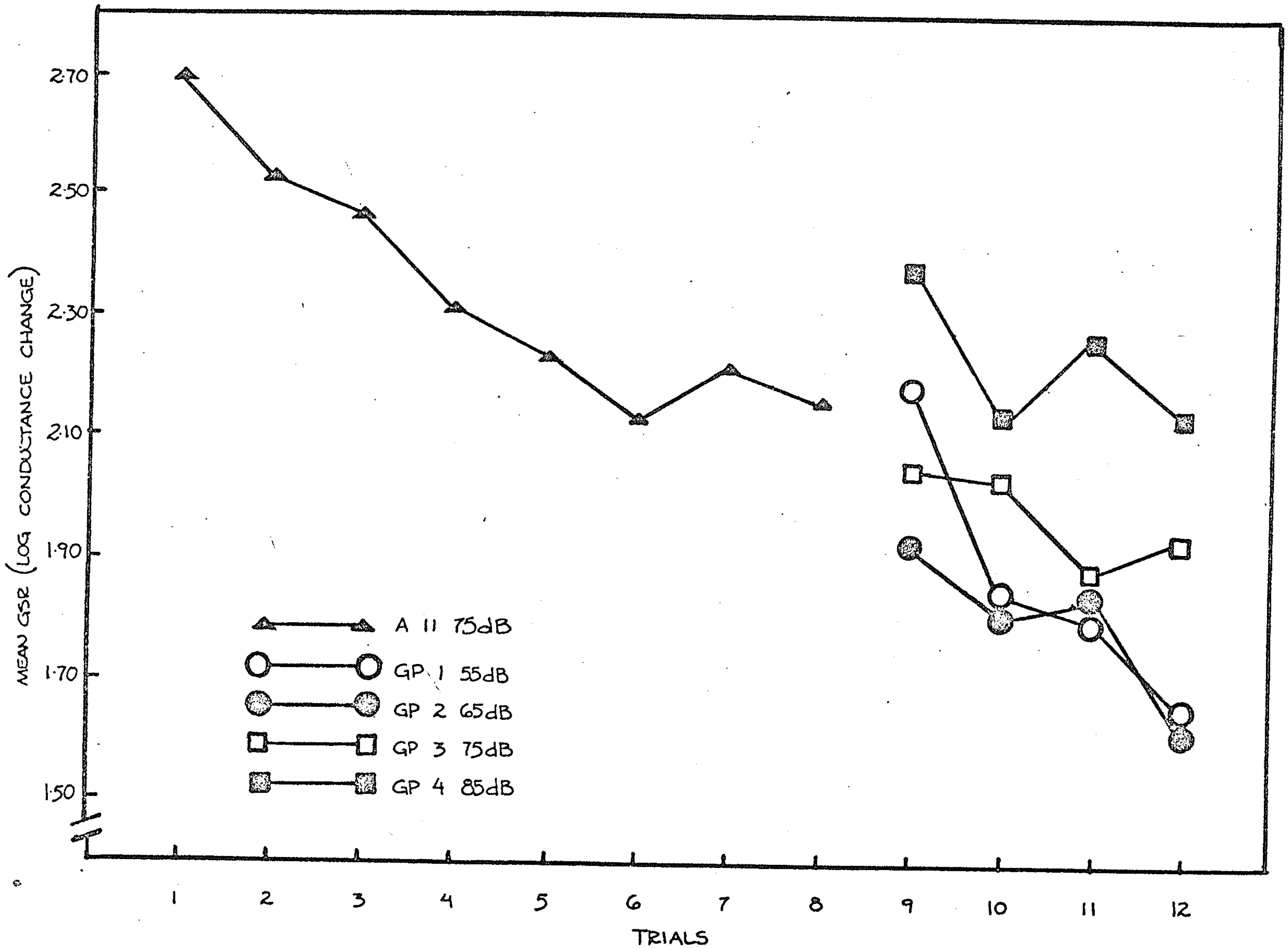

FIG. 6. Magnitude of the GSR to the habituation stimulus (Trials 1 to 8) and to the test stimuli (Trials 9 to 12) in Experiment II.

stimulus. A Groups by Sex by Trials ANOVA of these responses is shown in Table 7. Only the Trials effect was significant (F = 23.12, df = 7/504, p <.0005). Again, this indicates that the GSR decreased reliably with stimulus repetition. A significant Trials effect was also found for the test phase (Trials 9 to 12) of the experiment (F = 5.68, df = 3/216, p <.001). As indicated in Table 8, this was the only significant effect found during the test trial phase of the experiment.

The gradient of generalization of habituation is shown in Figure 7. The data are again shown as difference scores (Trial 9 minus Trial 8) in order to correct for differential levels of habituation. A one-way ANOVA was performed on these difference scores and a significant Stimulus Intensity effect was found (F = 3.02, df = 3/76, p <.025) as shown in Table 9. The mean difference in GSR for Group III (the group that did not experience stimulus change) was compared with the mean difference for each of the other groups. Two-tailed t tests for independent samples were carried out and it was found that Groups I and II did not differ significantly from Group III. However, the mean of Group IV was found to be significantly different from the mean of Group III (t = 2.489, df = 38, p <.025).

Base level resistance for the habituation and test phases of the experiment are shown by sex in Figure 8. An ANOVA of these results (Table 10) reveals a significant Trials effect (F = 26.11, df = 7/504, p <.0005), and a significant Sex by Trials interaction (F = 3.38, df = 7/504, p <.005) during the habituation phase. Again from Figure 8, a decrease in base level resistance is found from Trial 1 to Trial 2 but

TABLE 7

ANALYSIS OF VARIANCE OF LOG CONDUCTANCE CHANGE DATA FOR TRIALS 1 TO 8 IN EXPERIMENT II

Source of Variance	df	SS	MS	F	p
Total	639	220.58			
Between S	79	120.93			
Gps	3	1.65	.55	<1	n.s.
Sex	1	2.03	2.03	1.30	n.s.
Gps X Sex	3	4.45	1.48	<1	n.s.
Error (b)	72	112.80	1.57		
Within S	560	99.65			
Trl	7	22.96	3.28	23.12	$<.0005$
Gps X Trl	21	2.09	.10	<1	n.s.
Sex X Trl	7	1.13	.16	1.14	n.s.
Gps X Sex X Trl	21	1.94	.09	<1	n.s.
Error (w)	504	71.52	.14		

TABLE 8

ANALYSIS OF VARIANCE OF LOG CONDUCTANCE CHANGE DATA FOR TRIALS 9 TO 12 IN EXPERIMENT II

Source of Variance	df	SS	MS	F	p
Total	319	187.98			
Between S	79	134.05			
Gps	3	8.40	2.80	1.67	n.s.
Sex	1	.45	.45	<1	n.s.
Gps X Sex	3	4.10	1.37	<1	n.s.
Error (b)	72	121.10	1.68		
Within S	240	53.93			
Trl	3	3.74	1.25	5.68	$<.001$
Gps X Trl	9	1.56	.17	<1	n.s.
Sex X Trl	3	.97	.32	1.45	n.s.
Gps X Sex X Trl	9	.56	.06	<1	n.s.
Error (w)	216	47.10	.22		

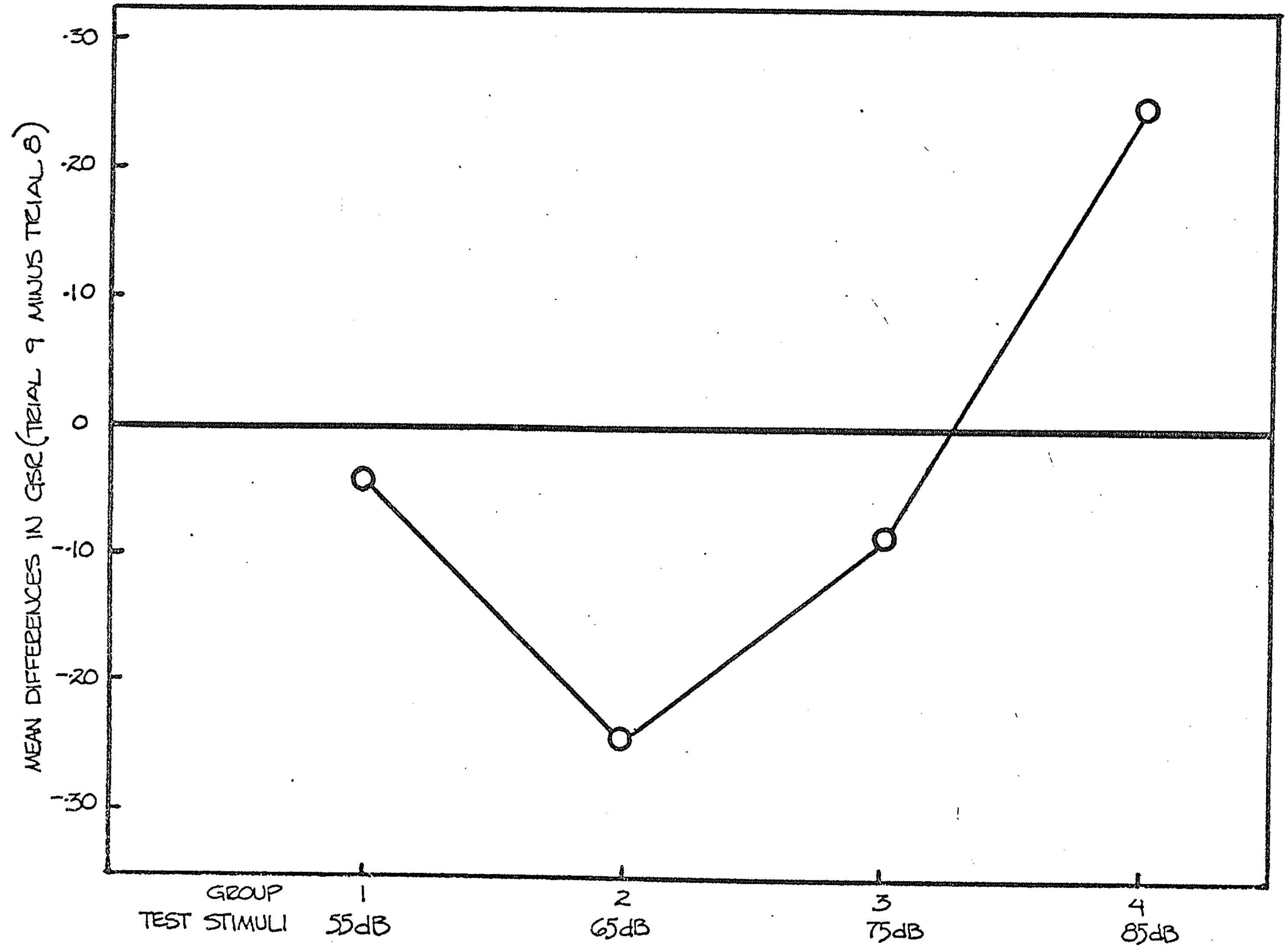

FIG. 7. Gradient of responses to test stimuli of varying intensities in Experiment II.

TABLE 9

ANALYSIS OF VARIANCE OF LOG CONDUCTANCE CHANGE DIFFERENCE SCORES DATA (TRIAL 9 MINUS TRIAL 8) IN EXPERIMENT II

Source of Variance	df	SS	MS	F	p
Total	79	23.46			
Test Stimulus Intensity	3	2.50	.83	3.02	$<.05$
Error	76	20.96	.28		

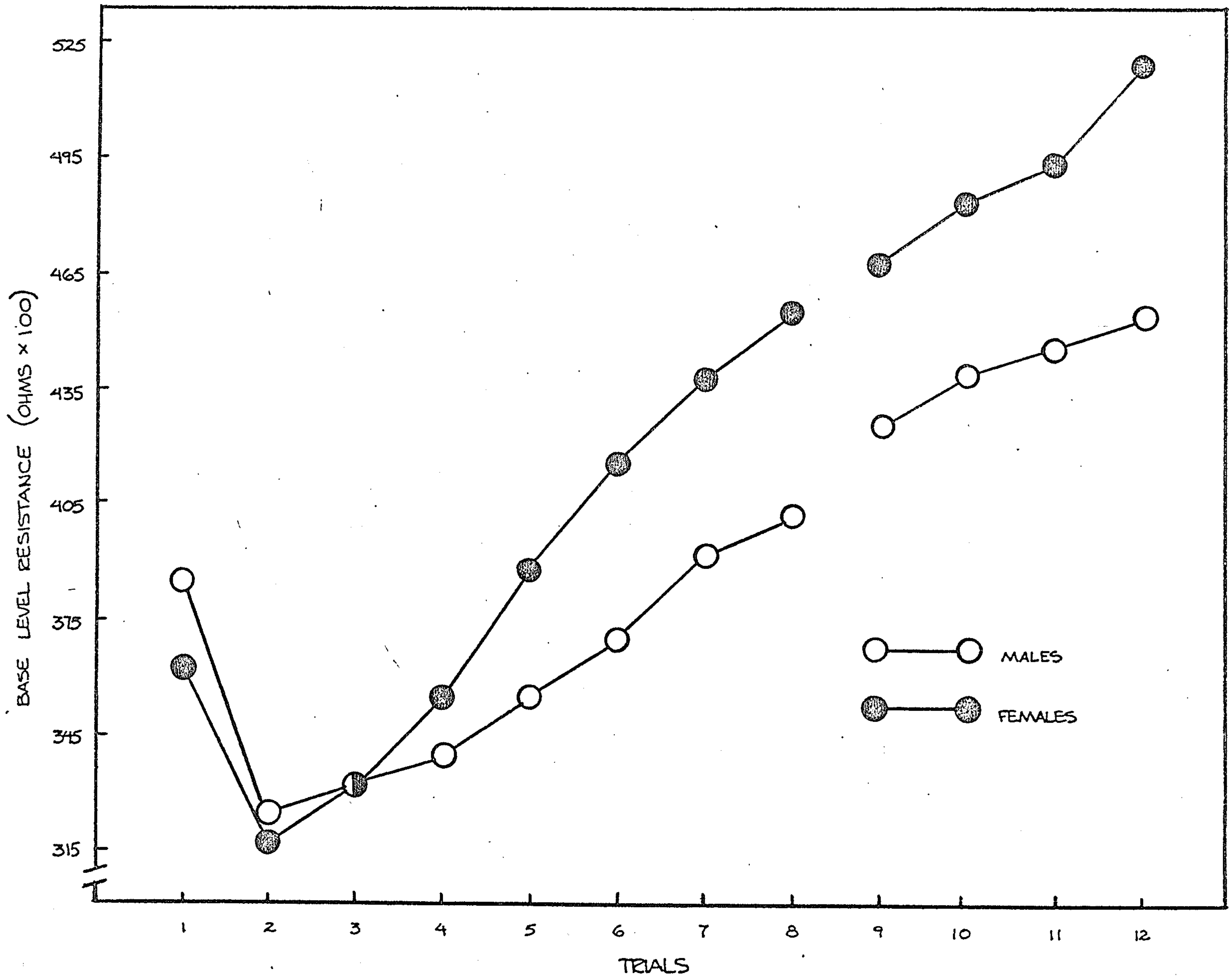

FIG. 8. Base level resistance over all trials in Experiment II plotted by sex.

TABLE 10

ANALYSIS OF VARIANCE OF BASE LEVEL RESISTANCE DATA
FOR TRIALS 1 TO 8 IN EXPERIMENT II

Source of Variance	df	SS*	MS	F	p
Total	639	22,369,416			
Between S	79	19,073,744			
Gps	3	791,390	263,797	1.04	n.s.
Sex	1	62,726	62,726	<1	n.s.
Gps X Sex	3	23,628	7,876	<1	n.s.
Error (b)	72	18,196,000	252,722		
Within S	560	3,322,672			
Trl	7	823,766	117,682	26.11	<.0005
Gps X Trl	21	69,234	3,297	<1	n.s.
Sex X Trl	7	106,582	15,226	3.38	<.005
Gps X Sex X Trl	21	51,743	2,464	<1	n.s.
Error (w)	504	2,271,337	4,507		

* Note: Multiply figures in this column by 10^4 to obtain actual SS

no decrease in resistance is found between Trial 9 and Trial 10. A two-tailed *t* test for correlated samples performed on the differences between the means of Trial 1 and Trial 2 (groups and sexes combined) indicated that this decrease in resistance was significant ($t = 3.96$, $df = 79$, $p < .001$). During the test phase, in addition to a significant Trials effect ($F = 15.28$, $df = 3/216$, $p < .0005$), Table 11 also reveals a significant Groups by Trials interaction ($F = 2.34$, $df = 9/216$, $p < .025$). Again, in order to avoid confusion, this interaction is presented separately in Figure 9.

TABLE 11

ANALYSIS OF VARIANCE OF BASE LEVEL RESISTANCE DATA FOR TRIALS 9 TO 12 IN EXPERIMENT II

Source of Variance	df	SS*	MS	F	p
Total	319	19,220,000			
Between S	79	18,797,504			
Gps	3	992,382	330,794	1.37	n.s.
Sex	1	193,798	193,798	<1	n.s.
Gps X Sex	3	226,361	75,454	<1	n.s.
Error (b)	72	17,384,963	241,458		
Within S	240	422,496			
Trl	3	64,528	21,509	15.28	$<.0005$
Gps X Trl	9	29,704	3,300	2.34	$<.025$
Sex X Trl	3	7,059	2,353	1.67	n.s.
Gps X Sex X Trl	9	17,109	1,901	1.35	n.s.
Error (w)	216	304,096	1,408		

* Note: Multiply figures in this column by 10^4 to obtain actual SS

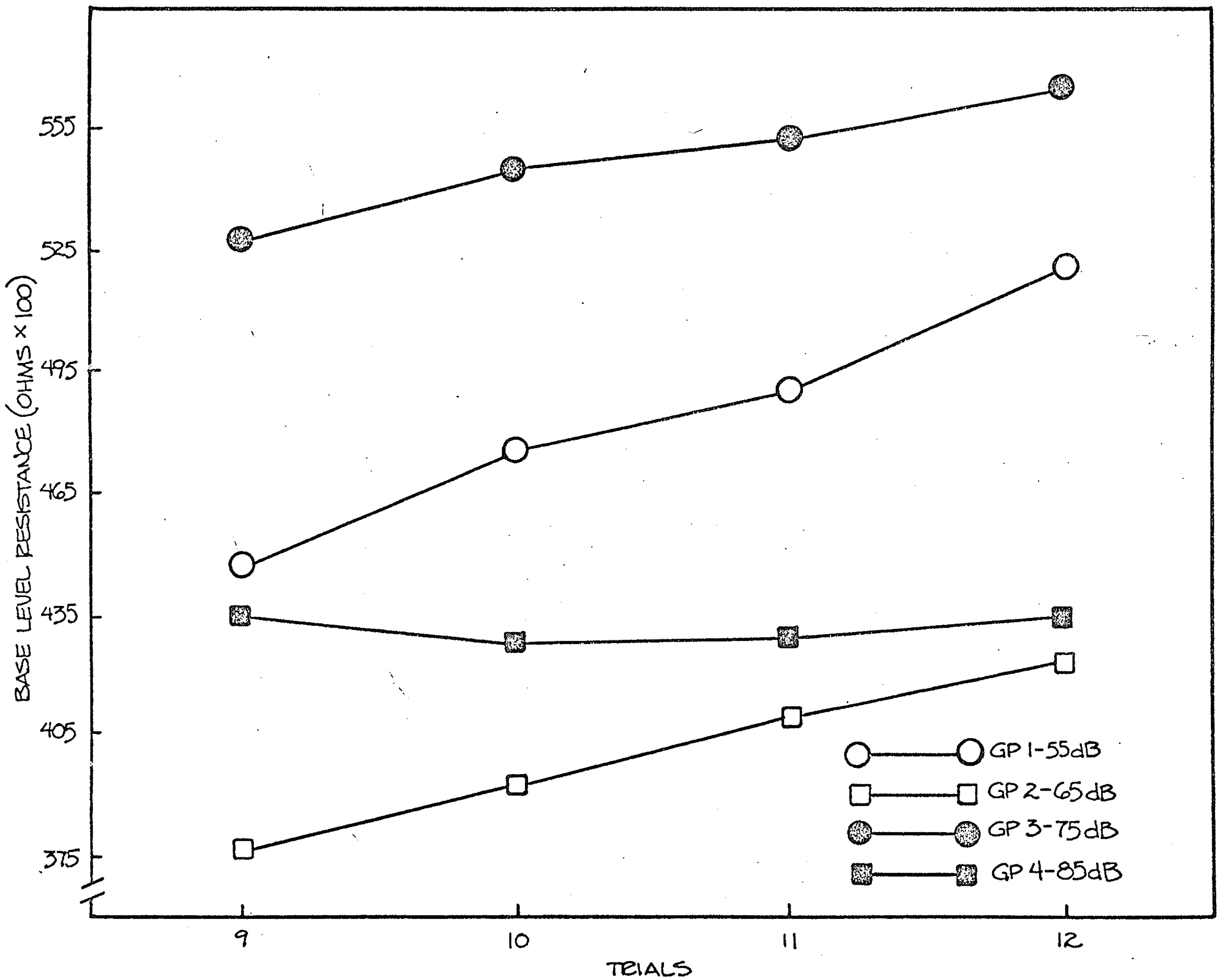

FIG. 9. Base level resistance on test trials in Experiment II showing Groups by Trials interaction.

CHAPTER IV

DISCUSSION

Experiment I

The reliable decrease in GSR magnitude across habituation trials shown in Figure 1 indicated that habituation took place. The demonstration of such an effect is, of course, essential in a study of habituation. When sex was considered as a factor, differential and interacting gradients of habituation were found. An examination of Figure 2 reveals that females were initially more reactive than males, but as habituation progressed, this difference in reactivity appeared to decrease and, in fact, became insignificant through Trials 6, 7, and 8.

In the GSR magnitudes to the test stimuli plotted in Figure 1, it is noted that the groups are ordered in terms of stimulus intensity with the greatest response being evoked by the highest intensity stimulus and progressively smaller responses being elicited as stimulus intensity decreases. Although the overall groups effect was significant, t tests on the mean difference scores of the groups indicated that Group IV, the group that experienced a 20 dB increase in stimulus intensity, was the only group that differed significantly from Group II, the group for which stimulus intensity did not change from habituation to testing. No significant difference was found for either a 10 dB increase in intensity or a 10 dB decrease. While there is no statistical reason to assume that these results are due to anything other than chance, it is interesting to note that these differences are, in fact, in opposite directions. On the basis of Sokolov's theory, it would have been expected that Groups I and III would differ from Group II by approximately the same response magnitude and that these differences would have been in the same direction.

The Trials effect was also significant over the test trials and this suggests that, although there was an initial disruption of the habituation process when a new stimulus was presented, habituation to the new stimulus took place fairly rapidly thereafter. This process can be seen rather clearly in Figure 1. The Groups by Sex by Trials interaction that took place during the test trials is displayed in Figure 2. A close inspection of these functions fails to reveal any consistent pattern, however.

Although an indication of the shape of the gradient of generalization of habituation can be seen in both Figures 1 and 2, this gradient is most distinctly displayed in Figure 3. The data points are plotted from mean difference scores (Trial 9 minus Trial 8). Even when this correction has been made for differential habituation, however, Group IV was still the only group that differed significantly from Group II. That is, a 20 dB increase in stimulus intensity was necessary before the GSR could be re-evoked. Although here again there is no statistical reason to assume that the results are due to anything other than chance, it is interesting to note that a 10 dB increase in stimulus intensity brought about an increased response on Trial 9, while a 10 dB decrease in intensity brought about a slight reduction in mean response. As noted previously, Sokolov's theory would predict that a reduction in stimulus intensity would re-arouse the GSR as much as an increase in intensity since, theoretically, both are equally novel. These results, then, would appear to support the SID-SG position rather than Sokolov's theory. In the introductory portion of this paper, it was suggested that the SID-SG position would predict that the gradient of generalization to decreases in stimulus intensity would be relatively flat. This prediction seems to hold for a 10 dB decrease at least, although there are certain difficulties involved in making such an assertion from negative evidence. This point will be considered more fully in later discussion.

Analysis of base level resistance data revealed that after an initial lowering of resistance following presentation of the first stimulus, resistances increased reliably over trials. The significant Sex by Trials interaction during habituation is illustrated in Figure 4. This suggests that the base resistance of the males was slightly higher than the females with this trend being reversed by Trial 5.

The decrease in base resistance found between Trials 1 and 2 (illustrated in Figure 4) is understandable. Base resistance level measurement for Trial 1 is taken just before the first stimulus is presented. Typically, the first stimulus elicits a large GSR and the subject usually remains in a heightened state of arousal (i.e., base level resistance decreases sharply and remains lowered for some time) until the next stimulus is presented. After this initial arousal, subsequent repetitions of the same stimulus do not ordinarily cause a similar increase in arousal. Although the difference between base levels on Trials 9 and 10 was not significant, this change is similarly comprehensible. When base level resistance for Trial 9 is being measured, the subject is unaware that there will be a change in the stimulus. When the new stimulus is presented, the heightened arousal that results usually carries over to the time during which the base level resistance is being measured for Trial 10.

Figure 5 illustrates the Groups by Trials and Groups by Sex by Trials interactions that took place during the test trials. A careful examination of gradients obtained failed to disclose any uniform pattern.

Experiment II

Figure 6 illustrates the reliable decrease in GSR magnitudes that occurred over Trials 1 to 8 indicating that habituation took place. Differential habituation due to sex was not found in this experiment. The only significant effect in the test phase was the Trials effect. This suggests that, after the initial disruption of habituation occasioned by stimulus change, subjects tend to habituate rapidly to the new stimulus. This process may be seen rather clearly in Figure 6. Although the data have been plotted by groups over the test trial phase of the experiment for illustrative purposes, it should be noted that the Groups effect was not statistically significant.

It will be recalled that, when difference scores were used to correct for differential habituation, a significant overall effect due to stimulus intensity was found. This would suggest that differential generalization of habituation did take place contrary to the indications of the analysis of the uncorrected data. As Figure 7 illustrates, a 10 dB increase in stimulus intensity brought about a significant increase in GSR magnitude while, for a 10 dB decrease in intensity, there was no corresponding statistically significant increase in response magnitude. Even a 20 dB decrease in stimulus intensity did not produce either a significant increase or decrease in GSR magnitude. Sokolov's theory would again have predicted that the 10 dB decrease in stimulus intensity should re-arouse the GSR at least as much as the 10 dB increase in intensity. The 20 dB decrease in intensity should have re-evoked the GSR to an even greater extent than the 10 dB increase. Re-arousal of the GSR along the intensity continuum, therefore, did not seem to be affected as much by stimulus dissimilarity as by stimulus intensity dynamism effects. While the results obtained here are explicable in terms of the stimulus intensity dynamism theory put forward earlier in this paper, Sokolov's theory would have difficulty handling these data.

Statistical analysis and visual inspection of the data plotted in Figure 8 revealed that base level resistances increased reliably over Trials after an initial decrease following presentation of the first stimulus. The significant Sex by Trials interaction that took place during the habituation trials again indicated that the males were initially slightly higher in base level resistance, though this trend reversed itself by Trial 3.

As discussed previously, the lowering of resistance from Trial 1 to Trial 2 seen in Figure 8 is understandable in terms of the arousal that accompanies presentation of the first stimulus. Oddly enough, this increase in arousal was not found following Trial 9, even though it might be expected to result from the unforeseen change in stimulus intensity.

The significant Groups by Trials interaction found during the test trials and illustrated in Figure 9 is not readily apparent on visual inspection. Interaction is customarily defined as any significant departure from parallelism of plotted functions. It will be noted that this criterion is met by the fact that the Group IV function appears to have essentially a zero slope while all the other functions seem to have an upward slope. This would seem to suggest that, when a higher intensity stimulus is presented after habituation to a given stimulus, base level resistance ceases to increase for a number of trials. On the other hand, when the stimulus remains unchanged or when a lower intensity stimulus is presented, base level resistance appears simply to continue to increase.

General Discussion

Habituation of the GSR to a white noise stimulus was reliably obtained in both experiments. In Experiment I, there was a significant Sex effect and Sex by Trials interaction during habituation which did not appear in Experiment II. This would seem to suggest that these effects may be somewhat ephemeral. A possible reason for this difference in findings is the fact that in one case the subjects were habituated to a 65 dB stimulus, while in the other, they were habituated to a 75 dB stimulus, although this adds little in the way of explanation. The Groups by Trials, Sex by Trials and Groups by Sex by Trials interactions found during the test trials in the first experiment were not found in the second experiment and a similar reason for this failure to observe them could be advanced. As mentioned earlier, the complex interactions in the test phase of Experiment I are not decipherable in terms of any consistent pattern.

The main purpose of this study was to examine the direction of the gradients of generalization of habituation to increases and decreases in stimulus intensity. In Experiment I, it was noted that there was a reliable increase in responsiveness for a 20 dB increase in intensity but not for a 10 dB increase. The failure to obtain a significant increase in GSR magnitude for a 10 dB increase in intensity is rather difficult to explain, particularly in view of the fact that it was observed in Experiment II and in the James and Hughes (1969) study for a much smaller increase in intensity. This inability to demonstrate an increase in GSR for an increase in stimulus intensity could possibly be due to extreme variability obscuring the effect due to stimulus intensity change. In spite of this one unsuccessful attempt to find a significant positive relationship between stimulus intensity and response strength, it is probably justifiable to conclude that, under ideal conditions, an increase in stimulus intensity will bring about a corresponding re-arousal of the OR. As noted in the introductory section of this paper, such a finding is congruent with both SID effect and Sokolov's theory.

In the two experiments reported here, a consistent body of evidence, though negative, has been amassed for the effect of decreases in stimulus intensity on generalization of habituation of the GSR. In Experiment I, it was found that a 10 dB decrease in stimulus intensity produced a slight but nonsignificant decrease in GSR magnitude. If Sokolov's theory were true, then one would expect to find an increase in response to a decrease in intensity. In fact, such an increase in responsiveness is a necessary consequence of this theory. The failure to find this increase in response, therefore, suggests that Sokolov's theory does not hold. However, it is possible that other factors could account for the failure to observe an increase in response such as extreme variability in the data, so that any conclusions arrived at by this line of reasoning are perhaps less certain than those arrived at by more conventional methods. Further evidence of this nature was provided by Experiment II. In this study, neither a 10 dB decrease in stimulus intensity nor a 20 dB decrease was sufficient to re-arouse the GSR. James and Hughes (1969) also found that decreases in stimulus intensity failed to produce a re-arousal of the GSR. Kimmel (1960), however, found that the GSR was re-evoked by a 30 dB decrease in stimulus intensity. Kimmel's study differed from the others cited here, though, in that the decrease in stimulus intensity was 10 dB greater than in any of the other studies. In addition, there were important procedural differences. A classical conditioning paradigm was employed which meant that on the first extinction (test) trial, there were two changes in the stimulus complex: omission of the UCS and change in stimulus intensity. Subjects were pre-exposed to the extinction stimulus as well. Thus, although Kimmel's results are not in agreement with the findings of the present study, there are enough methodological differences to make a comparison tenuous.

The evidence from the habituation studies seem to suggest that Sokolov's theory does not hold for decreases in stimulus intensity. The facts are, however, compatible with the SID-SG position. The gradient obtained was, in fact, essentially flat and this is what had been predicted on the basis of the possible interaction between SID and SG. Further support for this position comes from Mednick and Freedman's (1960) review of conditioned stimulus generalization studies which varied intensities of sound. Examination of the results of these studies led the authors to conclude that responses to generalized stimuli are a joint function of SG and stimulus intensity. Considered together, the available evidence appears to suggest that generalization of habituation of the GSR to stimuli of varying intensities can better be predicted in terms of an interaction between SG and SID rather than in terms of stimulus dissimilarity. Stein's (1966) theory, based on the conditioning of inhibition to the repeatedly presented stimulus, is also capable of handling the data, but the SID-SG position provides a more direct explanation of the results.

Base level resistance data over habituation trials shows a consistent pattern over the two experiments. In both studies, it was found that, while males began with a higher mean resistance level than females, as habituation progressed this trend reversed itself. A reliable lowering of base level resistance following presentation of the first stimulus also occurred in each experiment with a subsequent reliable increase in resistance over trials. This seems to suggest that, while males were slightly more aroused by the experimental situation, the females eventually became more aroused than males once stimulus presentation began. During the test trials, a Groups by Trials interaction was common to both experiments. Analysis of this interaction in Experiment I is obscured by other interactions. A straightforward explanation of the relationship observed in Experiment II has already been advanced. Sex by Trials and Groups by Sex by Trials interactions were obtained in Experiment I that did not appear in Experiment II. A parsimonious explanation of the failure to observe these relationships in both studies would be the fact that different habituation stimulus intensities were used. It is doubtful, however, that an effect that would be so sensitive to stimulus intensity could be considered reliable.

A summary of the findings of these two experiments will be found in the final section of this paper, along with a number of conclusions that might be drawn from the evidence presented.

Limitations of the Present Study and Suggestions for Future Research

One of the most valuable assets to a study of this nature is the provision of an effectively sound-shielded enclosure for the subject. A sound attenuating chamber such as that used by audiometrists would likely be ideal. In the absence of such facilities, it is still possible to carry out this kind of research, but the lack of adequate soundproofing does create a problem. The greatest difficulty is that of limitation of the range of stimulus intensities which can be employed. While other factors impose an upper limit on stimulus intensity (high intensity stimuli may elicit a defensive reflex rather than an orienting reflex), the ambient noise level of the experimental space imposes a lower limit. For this reason, the range of stimulus intensities was necessarily limited. A further problem created by inadequate sound shielding is the intrusion of extraneous stimuli. An unprogrammed stimulus might be unnoticed by the experimenter and yet might enhance the GSR on that particular trial to an unknown extent. Other factors such as room temperature and humidity may or may not exert any influence on the GSR (Montagu and Coles, 1966), but it would seem prudent to control these variables nevertheless. Such control could probably be more easily achieved in an audiometric booth.

In the two experiments reported here, all subjects in each were habituated to a certain stimulus and then tested to a stimulus that was higher, lower, or of the same intensity as the habituated stimulus. As Bernstein (1969) pointed out, the problem with this kind of design is the fact that the effects of direction of change and of absolute intensity are necessarily confounded. This problem may fairly easily be circumvented, when the amount of increase and decrease in stimulus intensity is equal, by habituating one group to a low intensity stimulus and one to a high intensity stimulus and then testing both to a stimulus midway between the two. However, in the present experiment, the problem is not as easily solved.

It will be recalled that sex main effects and interactions were found to influence both log conductance change and base level resistance. As Maltzman (1967) pointed out, factorially designed experiments employing male and female experimenters as well as male and female subjects are necessary "in order to determine whether the sex difference is a main effect, an interaction with the experimenter, or both (p. 107)."

Other procedural refinements such as tape recording the stimuli (Uno and Grings, 1965) could possibly provide more uniform stimulus quality across subjects. Of course, the list of ways in which any study may be improved is probably limited only by the imagination.

The present studies seem to suggest that further research in the area is required and that it should prove fruitful. As mentioned above, given more ideal conditions, a wider range of stimuli could be employed. With stricter control over procedural, subject and experimenter variables, the extreme variability in the data that is often found in experiments with the GSR should be greatly reduced.

CHAPTER V

SUMMARY AND CONCLUSIONS

The present study was undertaken in order to determine the shape of the gradients of generalization of habituation of the GSR to test stimuli of higher and lower intensity than the habituation stimulus. Stimulus dissimilarity theory (Sokolov, 1960, 1963a, 1963b, 1965) predicts that equivalent increases and decreases in intensity should re-evoke the GSR to an equivalent extent. The SID--SG position, on the other hand, predicts that while increases in stimulus intensity will re-evoke the GSR, decreases in stimulus intensity will not. A review of the literature on GSR conditioning studies and GSR habituation experiments revealed some disagreement among the empirical findings. Thus, the two experiments reported in this paper were performed in the hope of clarifying the situation.

From the data obtained, the following conclusions (some admittedly more tenuous than others) may be advanced:

(1) It would appear that, with repeated presentation of a stimulus, the GSR component of the OR reliably decreases or habituates. While various interactions are sometimes found, they do not appear with sufficient consistency to be considered reliable effects.

(2) Disruption of the habituation process occasioned by the unexpected presentation of a new stimulus is only temporary. On repeated presentation, the GSR to the new stimulus is rather rapidly habituated. Interactions of variables during test trials do not appear

with sufficient regularity to warrant the formulation of further conclusions.

(3) Generally, it would seem that increases in stimulus intensity cause the GSR to be re-evoked, producing an upward sloping gradient of generalization of habituation to stimuli of higher intensity.

(4) The evidence appears to indicate that decreases in stimulus intensity do not cause the GSR to be re-evoked, suggesting that the gradient of generalization of habituation of the GSR to lower intensity stimuli is relatively flat. This is contrary to Sokolov's stimulus dissimilarity theory but tends to support a theory based on stimulus intensity dynamism.

(5) After an initial decrease following the presentation of the first stimulus, base level resistance increases steadily over habituation trials. Stimulus repetition appears to interact reliably with sex, suggesting that a shift in levels of arousal of males and females is produced as habituation progresses.

(6) When an unexpected change in stimulus intensity is made, interruption of the continuous increase in base level resistance may or may not take place. Occurrence of the phenomenon may be related to the intensity of the habituation stimulus.

(7) Consistent effects of other variables on base level resistance during the test trials were not indicated.

The main purpose of this study was to determine the slope of the gradients of generalization of habituation of the GSR to increases and decreases in stimulus intensity. In summary, the evidence suggests that the gradient of generalization to higher intensity stimuli slopes upward while the gradient of generalization to lower intensity stimuli appears to be flat. Further research, conducted in a more rigorous fashion and in a more highly controlled experimental space, should ultimately determine whether the present findings reflect the actual relationship.

REFERENCES

Bass, M. J., & Hull, C. L. The irradiation of a tactile conditioned reflex in man. Journal of Comparative Psychology, 1934, 17, 47-65.

Beecroft, R. S. Classical Conditioning. Coleta, Calif.: Psychonomic Press, 1966.

Bernstein, A. S. The orienting response and direction of stimulus change. Psychonomic Science, 1968, 12, 127-128.

Brown, J. S., Bilodeau, E. A., & Baron, M. R. Bidirectional gradients in the strength of a generalized voluntary response to stimuli on a visual spatial dimension. Journal of Experimental Psychology, 1951, 41, 52-61.

Burstein, K. R., Epstein, S., & Smith, B. Primary stimulus generalization of the GSR as a function of objective and subjective definition of the stimulus dimension. Journal of Experimental Psychology, 1967, 74, 124-131.

Coombs, C. H. Adaptation of the galvanic response to auditory stimuli. Journal of Experimental Psychology, 1938, 22, 244-268.

Corman, C. D. Stimulus generalization of habituation of the galvanic skin response. Journal of Experimental Psychology, 1967, 74, 236-240.

Epstein, S., & Burstein, K. R. A replication of Hovland's study of generalization to frequencies of tone. Journal of Experimental Psychology, 1966, 72, 782-784.

Gormezano, I. Classical conditioning. In J. B. Sidowski (Ed.), Experimental Methods and Instrumentation in Psychology. New York: McGraw-Hill, 1966. Pp. 385-420.

Grant, D. A., & Dittmer, D. G. An experimental investigation of Pavlov's cortical irradiation hypothesis. Journal of Experimental Psychology, 1940, 26, 299-310.

Grant, D. A., & Schiller, J. J. Generalization of the conditioned galvanic skin response to visual stimuli. Journal of Experimental Psychology, 1953, 46, 309-313.

Grastyan, E. The significance of the earliest manifestations of conditioning in the mechanisms of learning. In A. Fessard et al. (Eds.), Brain Mechanisms and Learning. Oxford: Blackwell, 1961. Pp. 243-263.

Gray, J. A. Stimulus intensity dynamism. Psychological Bulletin, 1965, 63, 180-196.

Grice, G. R., & Saltz, E. The generalization of an instrumental response to stimuli varying in the size dimension. Journal of Experimental Psychology, 1950, 40, 702-708.

Guttman, N., & Kalish, H. I. Discriminability and stimulus generalization. Journal of Experimental Psychology, 1956, 51, 79-88.

Haggard, E. A. On the application of analysis of variance to GSR data: I. The selection of an appropriate measure. Journal of Experimental Psychology, 1949, 39, 378-392.

Hall, J. F., & Prokasy, W. F. Stimulus generalization to absolutely discriminable tones. Perceptual and Motor Skills, 1961, 12, 175-178.

Hanson, B. R. The semantic generalization of habituation of the galvanic skin response. Unpublished master's thesis, University of Manitoba, 1968.

Hovland, C. I. The generalization of conditioned responses: I. The sensory generalization of conditioned responses with varying frequencies of tone. Journal of General Psychology, 1937, 17, 125-148. (a) Cited by R. S. Beecroft, Classical Conditioning. Goleta, Calif.: Psychonomic Press, 1966. P. 111.

Hovland, C. I. The generalization of conditioned responses: II. The sensory generalization of conditioned responses with varying intensities of tone. Journal of Genetic Psychology, 1937, 51, 271-291. (b)

Hull, C. L. Stimulus intensity dynamism (V) and stimulus generalization. Psychological Review, 1949, 56, 67-76.

James, J. P., & Hughes, G. R. Generalization of habituation of the GSR to white noise of varying intensities. Psychonomic Science, 1969, 14, 163-164.

Jennings, H. S. Behavior of the Lower Organisms. New York: Macmillan, 1906.

Kimmel, H. D. The relationship between direction and amount of stimulus change and amount of perceptual disparity response. Journal of Experimental Psychology, 1960, 59, 68-72.

Kling, J. W. Generalization of extinction of an instrumental response to stimuli varying in the size dimension. Journal of Experimental Psychology, 1952, 44, 339-346.

Konorski, J. Conditioned Reflexes and Neuron Organization. London: Cambridge University Press, 1948.

Lang, P. J., Geer, J., & Hnatiow, M. Semantic generalization of conditioned autonomic responses. Journal of Experimental Psychology, 1963, 65, 552-558.

Littman, R. A. Conditioned generalization of the galvanic skin response to tones. Journal of Experimental Psychology, 1949, 39, 868-882.

Lynn, R. Attention, Arousal and the Orientation Reaction. London: Pergamon Press, 1966.

Maltzman, I. Individual differences in "attention": the orienting reflex. In R. M. Gagne (Ed.), Learning and Individual Differences. Columbus, Ohio: Merrill, 1967. Pp. 94-112.

Mednick, S. A., & Freedman, J. L. Stimulus generalization. Psychological Bulletin, 1960, 57, 169-200.

Montagu, J. D., & Coles, E. M. Mechanism and measurement of the galvanic skin response. Psychological Bulletin, 1966, 65, 261-279.

Pavlov, I. P. Conditioned Reflexes. (Trans. by G. V. Anrep) London: Oxford University Press, 1927. (Republished: New York: Dover, 1960.)

Porter, J. M., Jr. Adaptation of the galvanic skin response. Journal of Experimental Psychology, 1938, 23, 553-557.

Sharpless, S., & Jasper, H. Habituation of the arousal reaction. Brain, 1956, 79, 655-680.

Sidowski, J. B., & Smith, M. J. Basic instrumentation. In J. B. Sidowski (Ed.), Experimental Methods and Instrumentation in Psychology. New York: McGraw-Hill, 1966. Pp. 33-114.

Slivinske, A. J., & Hall, J. F. The discriminability of tones used to test stimulus generalization. American Journal of Psychology, 1960, 73, 581-586.

Sokolov, E. N. Neuronal models and the orienting reflex. In M.A.B. Brazier (Ed.), The Central Nervous System and Behavior. New York: Josiah Macy, Jr. Foundation, 1960. Pp. 187-276.

Sokolov, E. N. Perception and the Conditioned Reflex. New York: Macmillan, 1963. (a)

Sokolov, E. N. Higher nervous functions: the orienting reflex. Annual Review of Physiology, 1963, 25, 545-580. (b)

Sokolov, E. N. The orienting reflex, its structure and mechanisms. In L. G. Voronin, A. N. Leontiev, A. R. Luria, E. N. Sokolov & O. S. Vinogradova (Eds.), Orienting Reflex and Exploratory Behavior. Baltimore: Garamond/Pridemark Press, 1965. Pp. 141-151.

Stein, L. Habituation and stimulus novelty: a model based on classical conditioning. Psychological Review, 1966, 73, 352-356.

Thorpe, W. H. Learning and Instinct in Animals. London: Methuen, 1956.

Uno, T., & Grings, W. W. Autonomic components of orienting behavior. Psychophysiology, 1965, 1, 311-321.

Van Olst, E. H., & Orlebeke, J. F. The role of the orienting reflex in the generalization of a conditioned GSR. Canadian Journal of Psychology, 1965, 19, 56-60.

Wickens, D. D., Schroder, H. M., & Snide, J. D. Primary stimulus generalization of the GSR under two conditions. Journal of Experimental Psychology, 1954, 47, 52-56.

Williams, J. A. Novelty, GSR, and stimulus generalization. Canadian Journal of Psychology, 1963, 17, 52-61.

Zimny, G. H., & Schwabe, L. W. Stimulus change and habituation of the orienting response. Psychophysiology, 1966, 2(2), 103-115.

APPENDIX

APPENDIX A

INSTRUCTIONS TO SUBJECTS

The purpose of this experiment is to measure physiological responses to auditory stimuli. From time to time, a sound will be presented in the earphones for a brief period. All you are required to do is to sit still and listen. You are to remain alert, but you must sit very still and you must especially avoid moving the hand to which the electrodes are attached. No shock will be given.