INDIVIDUAL DIFFERENCES IN SKIN CONDUCTANCE RESPONSE IN RELATION TO IQ SCORES

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INDIVIDUAL DIFFERENCES IN SKIN CONDUCTANCE RESPONSE IN RELATION TO IQ SCORES

An Abstract

Presented to

the Graduate Council of

Austin Peay State University

In Partial Fullfillment

of the Requirements for the Degree

Master of Arts

by

Betty Mads Allen

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ABSTRACT

A two part study investigated the relationship between magnitude of orienting response as indexed by skin conductance response and measured mental functioning as indexed by the Cattell Culture-Fair Intelligence Test. A three factor design with repeated measures on two factors investigated the effect of intelligence, auditory stimulus treatment and trials on SCR.

Forty-five volunteer undergraduate subjects were trained on a stimulus tone, then were given 40 discrimination trials in which they pressed a button at stimulus tone onset and ignored a higher/lower tone.

An eta coefficient yielded a .78 relationship between SCR orienting response and intelligence ($p < .001$). This relationship, however, did not prove to be linear. SCR orienting response seemed a reliable predictor of intelligence at the superior range of intelligence and above.

An analysis of variance with repeated measures on two factors showed that intelligence had a significant main effect on SCR-OR ($p < .05$), imperative and warning tones had a significant effect ($p < .001$) and change occurred across trials ($p < .001$). A significant interaction between intelligence X stimulus X trials showed that the high IQ group tended to maintain a strong response to relevant stimuli, while responding less across trials to irrelevant stimuli; the low IQ group responded nearly as strongly across trials to irrelevant stimuli as to relevant stimuli.

INDIVIDUAL DIFFERENCES IN SKIN CONDUCTANCE RESPONSE IN RELATION TO IQ SCORES

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August 1976

To the Graduate Council:

I am submitting herewith a Thesis written by Betty Eads Allen entitled "Individual Differences in Skin Conductance Response in Relation to IQ Scores." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

Major Professor

We have read this thesis and recommend its acceptance:

Minor Professor

Third Committee Member

Accepted for the Council:

Dean of the Graduate School

LIST OF FIGURES

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Pavlov first observed and described an orienting or "what-is-it" reflex in his laboratory animals. His observation noted the muscular changes involving movements of the eyes, ears, head and trunk which, taken together, gave the animal the power to meet chance dangers (Sokolov, 1963). A pattern of physiological responses elicited by novel stimuli was studied, first by Pavlov (1927) and later by Sokolov (1963). Until 1965 most studies on the orienting response (OR) were done in Russian laboratories. Since that time, British, and then American psychologists, have become increasingly interested in the OR. Subsequent studies done in the west have usually confirmed conclusions of the Russian investigators (Kahneman, 1973).

In Russia, investigators have tended to follow Pavlov and Sokolov in using physiological measures to study the orienting response, this response being seen as a facilitator of learning. In the United States, much of the research on attention tended to deal with the nature of the stimulus eliciting a physical, and therefore measurable, observing response. Developmentalists in the United States have become interested in the physiological measures since such measures within-subjects are presently assumed to remain stable at different ages.

Certain bodily changes have been identified which seem to characterize the OR. These bodily changes include: heightened alertness, pupillary dilation, dilation of blood vessels in the head with constriction of blood vessels in the body, an increase in skin conductance (or decrease in skin resistance), increased tension in skeletal muscles, slowed respiration, and changes in heart rate and brain electrical activity. The OR reflects a change in arousal state which not only directs the organism's attention, but also prepares the organism to deal with the novel stimulus (Beatty, 1975).

Sokolov (1963) has theorized that an OR is elicited by a stimulus until an internal model (neuronal model) is formed which reflects the characteristics of that particular stimulus. Further presentation of the same stimulus will then result in habituation (Sokolov, 1963). According to Hilgard and Bower (1966) habituation is presumably designed to disengage higher brain centers from dealing with stimuli that have ceased to have any significance for it. At the experimental level, according to Lynn (1966), a habituated stimulus can be made into a conditioned stimulus by telling the subject to pay attention to it. This instruction would serve to restore the OR which could be expected to continue over more than a hundred trials. Lynn (1966) further reports that among groups found to be deficient in habituation are those humans with "strong excitatory potentials."

The author had the opportunity of surveying forms which refer children for psychological evaluation in the Clarksville, Tennessee school system. Of children with learning difficulties, teachers almost universally note "short attention span" as a behavorial characteristic. Much has been written about the "hyperactive" child who appears to attend poorly to school work. Less has been written about the attending behavior of average or better learners.

In recent years investigators have become interested in the conditioning of attending behavior in school children (Simpson & Nelson, 1972). This developmental approach to remediation rests upon research which has sought to delineate physiological correlates of attending behavior (Satterfield & Dawson, 1971; Cohen & Douglas, 1972).

This study proposes to investigate the relationship between the OR and individual differences in measured intelligence. Secondly, the effect of intelligence and stimulus difference will be investigated in regard to rate of habituation.

CHAPTER II

REVIEW OF LITERATURE

In studying skin conductance response (SCR) habituation, both characteristics of the stimulus and tonic state of the subject must be considered. In regard to qualities of the stimulus, the following studies elucidate two dimensions of stimulus properties.

Biddle and Glenn (1974) studied SCR habituation of retarded and non-retarded adults to simple and complex visual stimuli. The main effects for group (level of mental functioning) and complexity were not significant, however, there was a significant interaction for group and complexity. Retarded subjects were found to habituate at a slower rate than did non-retarded subjects. Habituation of retarded subjects tended to be slower with the complex stimulus than with the simple stimulus. In the case of a simple stimulus, results of this study are in agreement with previous studies, in that no habituation differences between retarded and non-retarded persons was found.

Coles, Bosdian and Isaacson (1972) studied SCR and heart rate habituation to signal and nonsignal stimuli. Following Lynn's (1966) position that a neutral stimulus may become a signal stimulus by instructing the subject to attend to it, Coles, et al (1972) set up an experimental design in which some subjects were to count the number of tone presentations (a passive task), while other subjects were to actively respond to tones. Results showed that the active group showed greater magnitude of SCR responses than the passive group. Responses to signal stimuli were significantly larger than those to ignored stimuli. Responses tended to increase significantly in magnitude during the session.

While the Coles et al study utilized a simple stimulus, instructions to the subjects to attend and respond, changed the properties of the stimulus. Under such experimental conditions, Coles et al suggests that these stimuli be referred to as imperative and warning stimuli.

The following studies are reviewed to demonstrate some of the current findings on within subject effects on orienting response and habituation. A study by Zeiner and Schell (1971) investigated individual differences in orienting, conditionability and skin conductance. Results of this study support earlier findings that subjects high on OR magnitude condition better to an inocuous stimulus than do subjects low on OR magnitude. The authors suggest that differences in response magnitude to an inocuous stimulus might well be due to differences in attention as earlier postulated by Maltzman (1967).

Coles and Gale (1971) designed a study to determine the value of measures of physiological activity as predictors of performance in a vigilance task. Subjects were tested for physiological reactivity in a resting state, and later were exposed to an auditory vigilance task. Results showed that none of the measures of physiological activity taken under resting conditions were significantly correlated with overall detections. The physiological measures included EEG potentials, heart rate and skin conductance. Of all the physiological measures, only some of the measures of electrodermal responsiveness were significantly correlated with overall detections. These were latency of the first SCR, habituation, and total SCR's.

The results were interpreted as follows: the shorter the latency of the GSR to the first stimulus, the slower the habituation, and the more responses to stimuli, the greater the overall detection efficiency. Coles & Gale (1971) conclude that some aspects of electrodermal activity (latency of first SCR, habituation, and total SCR's) are good predictors of overall performance in a vigilance task.

Variables influencing the tonic state (resting state) of the subject have been found to effect SCR habituation. For example, Maltzman, Smith, Kantor and Mandell (1971) studied the effects of stress on habituation of the orienting reflex. Using both skin conductance and vasomotor changes as indexes or OR, the investigators presented both visual and auditory stimuli to two groups of subjects. One subject group was assumed to be stressed to some degree by an upcoming oral examination which followed their experimental session. Actual tonic state of the individuals was measured by what the authors designated as pulse width, and varied in a manner which appeared to reflect different levels of arousal. Results indicated that habituation of measures of the OR to inocuous stimuli is not determined by parameters of the stimuli alone, but is also influenced by the tonic state of the individual. The conclusion is that habituation is a consequence of characteristics of the stimuli and is slowed in subjects more highly aroused.

In a study utilizing male hospital employees as "normals" and male psychiatric patients who had been diagnosed "anxiety neurosis," Hart

(1974) used heart rate and skin conductance as measure of OR. An auditory stimulus was employed and responses were analyzed under two experimental conditions, signal and nonsignal. Although differences between anxious and normal subjects were highly significant, no overall differences in habituation between anxious and normal subjects was found. The author cites previous studies which failed to differentiate anxious subjects from normals using skin conductance base levels as indices of arousal.

Gatchel and Gaas (1976) studied effects of arousal level on both short-and long-term habituation of the OR using an auditory stimulus, with skin conductance as an index of OR. Employing volunteer female undergraduate college students as subjects, the authors threatened shock to manipulate arousal levels in one experimental group, and no threat of shock in the other group. Results showed that the threatened group showed significantly higher skin conductance levels on both short- and long-term habituation than the non-threatened group. The authors suggest that the higher level of physiological arousal may interfere with the sonsolidation process that prompts habituation. These results support the earlier Maltzman findings.

Carroll and Pokora (1976) also used threatened shock to manipulate arousal level in one of two experimental groups of college students, using skin conductance as an index of OR. Results showed that the habituation level of the two groups varied significantly across time with threatened subjects habituating less. The authors concluded that threat of an impending electric shock retards the rate of SCR habituation to simple auditory stimulus. These findings were also in accord with the Maltzman study.

A study by Crider and Augenbraun (1975) tested the hypothesis that individual differences in SCR habituation reflect characteristic rates of attentional decrement. Subjects were selected for extremes of SCR habituation, fast or slow habituation, and were tested with an auditory vigilance task. Results confirmed the previous reports of Coles and Gale (1971), and Siddle and Glenn (1972) of a relationship between SCR habituation speed and performance in an auditory vigilance task. The authors suggest however, that analysis of their data shows that individual differences in arousal state. Thus, they believe that SCR habituation speed may be found to be correlated with measures of physiological activity that are generally regarded as arousal indices.

Thus, while the Hart (1974) study failed to differentiate subjects clinically diagnosed as anxious from normals on habituation, the other studies cited support the Maltzman findings that level of arousal affects rate of habituation, with more highly aroused subjects showing a slower rate of habituation.

Coles, Gale and Kline (1971) investigated the personality dimensions of extraversion-introversion and neuroticism in relation to SCR habituation. In a factorial design, six experimental groups were exposed to an auditory stimulus. Results indicated that both main effects, neuroticism and extraversion, failed to reach significance. However, high neurotic subjects took longer to habituate than low neurotic subjects. In a final conclusion, reminiscent of Hart's findings, the authors point out that their date shows that the behavioral distinctions between extraversion and neuroticism obtained by Eysenck in non-physiological contexts, are not reflected in SCR measures.

However, Coles et al (1971) posit an activation continuum, positively correlated with neuroticism and negatively with extraversion. They believe its behavorial counterpart is anxiety and its physiological counterpart includes "some" SCR measures. The authors point out that this hypothesized continuum is not compatible with the views of Eysenck (1967) whose theory they are testing.

Much attention in the field of education has been given to the hyperkinetic child. The following two studies review the relationship between physiological reactivity and the hyperkinetic child.

Satterfield and Dawson (1971) studied skin conductance in 12 hyperkinetic children and in 12 matched controls. Although the authors predicted high SCR's for hyperkinetic children, based on the view that high SCR level is an index of high excitation, mean SCR values for normal children was found to be significantly higher during 2 periods of time monitored. As a group, the hyperkinetic subjects had a significantly lower median SCR level than that of normal subjects. Hyperkinetic subjects also showed smaller magnitude of specific SCR's. Also noted was a high degree of inter-subject variability among the hyperkinetic subjects. It is conjectured that the low level of SCR reactivity in hyperkinetic children may be due to a lowered excitability of the mid-brain recticular activating system.

Cohen and Douglas (1972) studied characteristics of SCR-CR to signal and nonsignal auditory stimuli in hyperactive and normal children. Twenty children judged to be hyperactive by a number of criteria, and 20 matched normal children were required to listen to nonsignal stimuli and to make an active response to signal stimuli on a delayed reaction time task. Results showed that hyperactives and controls did not differ with regard to SCR during resting conditions or during presentation of nonsignal or signal stimuli. However, only controls exhibited a significant increase in basal conductance as a function of the increase in task demands from the nonsignal to the signal presentation periods. Although hyperactives took fewer trials to habituate than normals in the signal situation, the authors conclude the difference could only be considered as a trend. When subjects were asked to sit passively and attend to repetitive tone stimuli, the OR and its habituation was similar for normal and hyperactive children. Only when an active response to signal stimuli was required did the two groups differ; controls exhibited larger and tended to show more persistent OR's than hyperactives. At the behavioral level, the performance of controls was clearly more efficient than that of hyperactives, which suggests that in normal children the warning signal had the intended effect of alerting the subject and preparing him to respond to the reaction signal.

The preceding studies relate skin conductance change to simple responses, such as discriminating tones and pressing buttons. One recent study relates SCR-OR to a complex performance variable. Zeiner (1974) studied individual differences in orienting response magnitude related to performance in academic work. Using a weak neutral light stimulus, undergraduate subjects took part in an SCR discrimination conditioning experiment. Magnitude of SCR-OR was correlated with four year grade point averages in college courses. A 2X2 factorial anaylsis of variance was performed on the acquisition data. In line with earlier findings (Zeiner & Schell, 1971), the high OR group gave significantly larger responses to CS's than did the low OR group. There was a trend toward greater discrimination conditioning in the high OR group when compared against the low OR group.

A similar 2X2 factorial analysis of variance was performed on the extinction trial data. The high OR group significantly maintained its superiority in responding over the low OR group.

Zeiner's data indicates a trend for high OR subjects to condition better than low OR subjects. The significant correlation between a physiological index of orienting response and the complex performance variable of grade point average in college extends the correlates of attending behavior and suggests several further lines of research. Zeiner suggests one logical extension of his study to be a correlational study relating SCR orienting to measured mental functioning. Of the several physiological measures of orienting response studied in the literature, it should be noted that Sokolov considers SCR to be the most sensitive indicator of changes in the environment and habituation to these changes (Sokolov, 1963).

CHAPTER III

RESEARCH DESIGN

This research is a two part study. The first part, involving 6 acquisition trials is a correlational study probing the relationship between magnitude of orienting response as indexed by skin conductance change and measured mental functioning as indexed by scores derived from the Cattell Culture-Fair Intelligence Test.

Part two of the study is a three factor design with repeated measures on two factors (Bruning, 1968), evaluating the effect of IQ, stimulus and trials on habituation as shown below. The twenty discrimination trials on each stimulus were treated as four blocks of five trials each.

To probe the relationship between IQ and magnitude of OR the following null hypotheses (H_o) were tested for significance at the .05 alpha level.

H_o1 There is no statistically significant initial difference in magnitude of orienting response in relation to IQ.

H_o2 There is no statistically significant relationship between IQ and SCR orienting response.

To investigate how IQ, stimulus and trials effect habituation, the following hypotheses were tested for significance at the .05 alpha level.

H_o3 There is no statistically significant difference in the SCR orienting response elicited by imperative and warning stimuli.

H_o4 There is no statistically significant difference in rate of habituation to imperative and warning stimuli.

CHAPTER IV

METHOD

Subjects

Fifty-nine volunteer subjects, 38 females and 21 males were recruited from freshman, sophomore and junior level Psychology courses at Austin Peay State University. Subjects ranged in classification from freshmen to graduating seniors. Points on course work were applied in return for participation in the study.

Apparatus

A skin conductance change measurement was obtained by using a constant voltage transducer, imposed on the volar surfaces of the first and third fingers of the left hand. Thirty-five of the subjects used silver impregnated cloth electrodes and 24 of the subjects used stainless steel electrodes, both electrodes applied in the same manner.

All recordings were made by an Offner R-A chart recorder, with the paper moving at 2.5 millimeters (mm) per second. The output of the constant voltage transducer was recorded on one channel of the Offner chart recorder, with output adjusted so that a change of one micromho of skin conductance change resulted in a pen deflection of 3 mm on the chart paper. Stimulus presentation was recorded on a second channel of the chart recorder.

Tones of 500 and 1000 hz at approximately 70 db were generated by an Ambco Screening Audiometer, model 1122. Tones were of 1 sec. duration presented at 25-45 sec. inter-stimulus intervals. Length of inter-stimulus intervals was randomly assigned to trials.

Procedure

Subjects reported individually and were seated in a comfortable straight chair within a separate booth in a partially sound-proof room. Participants were given a verbal explanation of the procedure. Skin surfaces were prepared for the conductance measure by washing, and then electrode paste was applied to enhance conductance.

Subjects listened to taped instructions and tone presentations over head phones. They were trained over 6 trials to recognize a stimulus tone. Following the training tones, subjects were instructed to listen for the stimulus tone and ignore a higher/lower tone. Forty-five of the subjects responded to the lower of 2 tones and 14 responded to the higher tone. In response to the stimulus tone, subjects were instructed to press a button held in the right hand. This response was recorded on a third channel of the chart recorder. At the completion of the discrimination trials, subjects were instructed to move to an adjoining room where they self-administered Part 1 of the Cattell Culture-Fair Intelligence Test, Scale 2, according to taped instructions.

According to Buros Mental Measurement Yearbook (1959), this measure of mental functioning has a high saturation on general ability, and is relatively independent of school achievement, social advantages and various other environmental influences. Full test correlations with Stanford-Binet range from .56 to .85.

Of the 59 records obtained, 8 could not be used due to procedural problems in measuring SCR. Five subjects' records were not used, because conversation with these subjects, indicated that their IQ scores were likely underestimations of their intelligence. Of the 46 remaining subjects, one was randomly dropped in order to facilitate analysis of the data by equalization of group size.

Millimeters of Skin conductance change were measured from a basal SCR at stimulus onset to the greatest peak within a 10 second interval following stimulus presentation. These millimeters of SCR change were converted to micromhos. Square root of the change in skin conductance, recorded in micromhos was used to compute appropriate analysis of variance.

In order to investigate the relationship between IQ and magnitude of SCR orienting response, an eta coefficient was used to test hypotheses $H_0 1$ and $H_0 2$. A three factor analysis of variance with repeated measures on one factor was used to investigate the effects of IQ and stimulus on trials.

To test $H_0 3$ and $H_0 4$, a three factor analysis of variance with repeated measures on two factors was used. This design was chosen to separate the effects of intelligence and stimulus on rate of habituation, as well as the effects of the interactions of these variables.

CHAPTER V

RESULTS

Cattell tests were hand scored and yielded an IQ range for subjects from 86 to 158. Mean IQ score for males was 109.82 and mean score for females was 106.75. Overall mean score was 107.89.

Since the data on training did not prove to be linear, an eta coefficient was computed to show the relationship between IQ scores and magnitude of orienting response as indexed by skin conductance change. This relationship was shown to be .78 ($p < .001$).

Table II summarizes the results of an analysis of variance with repeated measures which investigated the effects of measured intelligence and trials on magnitude of orienting response. This analysis shows that level of intelligence had a significant effect on magnitude of orienting response ($p < .001$). The first and second null hypotheses were therefore rejected. Beyond this, there was a strong interaction between level of intelligence and the change occuring across trials ($p < .001$).

The significant F for groups was probed by using a Duncan Multiple Range Test, an a posteori test, to see where differences occurred among groups. As can be seen in Figure I, group 1, the low IQ group, differed in their responses across the trials from the others ($p < .01$). Group 3, average IQ group also differed from the others ($p < .01$). Group 5, the high IQ group, differed significantly ($p < .01$) in magnitude of orienting response from all the others.

It should be noted that Group 3, (average IQ) and 5 (high IQ) seemed to be responding less by trial 5, but made a strong response to trial 6. This strong response may reflect an error in taping the instructions which caused the experimenter's instructions for the discrimination trials to intervene in the recording interval following presentation of training tone 6. Thus these groups may have oriented to the experimenter's instructions rather than to the tone alone.

Table III summarizes the results of an analysis of variance with repeated measures on two factors which investigated the effects of IQ level, warning and imperative stimulus tones and change across trials. Groups or level of intelligence made a significant difference in responding to discrimination tones ($p < .05$). There was a significant difference in orienting response to imperative and warning tones ($p < .001$); therefore $H_0 3$ can be rejected.

Further, there was significant change across trials ($p < .001$); therefore $H_0 4$ can be rejected. Figures 2 and 3 show mean change among groups across trials. The imperative stimulus required a discrimination plus active responding in terms of pressing a button. As in the training trials, Group 5 (high IQ group) shows a higher level of orienting response without a trend toward habituation to the Imperative stimulus; indeed their responding is slightly increasing at the end of 40 trials. Group 2, the low average IQ group again is showing a lower magnitude of OR than other groups although their response was on the increase at the end of 40 trials.

Group 1, the low IQ group, although showing a larger magnitude of OR at the beginning of the discrimination trials, did begin a steady tendency to habituate to the imperative stimulus following the second block of trials. Group 3, the average IQ group, tended to steadily habituate across trials. Group 4, the high average IQ group, also tended to steadily habituate across trials.

Figure 3 charts the change among groups to the warning tones. Group 1, Group 3, Group 4, and Group 5 all tended to habituate in linear fashion to the warning stimulus. Group 2 (low average IQ) group did not habituate in linear fashion, but instead followed their pattern of responding to the imperative stimulus by increasing their responding across trials following block 2.

There was a strong interaction among IQ, stimulus and trials ($p < .001$). Group 1, the low IQ group, neared their level of responding to the imperative stimulus witn their responses to the warning stimulus. Group 5, the high IQ group, shows a strengthening tendency across trials to discriminate between tones, responding less to warning tones and more to imperative tones.

CHAPTER VI

DISCUSSION

The relationship between magnitude of CR and measured intelligence at higher levels of intelligence seems from these date to be a strong one. If the orienting response is seen as a facilitator of learning, or as the first step in learning, then common sense might suggest a strong relationship between the OR and measured mental functioning. The relationship demonstrated by these data provides a logical extension of Zeiner's (1974) findings.

As seen in this data, however, the relationship did not prove to be strong at lower levels of intelligence. People of lower levels of intelligence showed a weaker relationship with CR. The low IQ group (here, this group is defined as 86-94) showed a surprisingly high and varied CR across trials. One explanation for the variance in responding may lie in Hull's postulate concerning oscillation around stimulus threshholds. Hull posited an inhibitory potential associated with reaction potentials which oscillates around the stimulus threshhold. If the low IQ group is assumed to have a higher stimulus threshhold, then some reaction to stimulus may occur, while another reaction to the same stimulus may be inhibited (Hilgard & Bower, 1966).

Group 5 (the higher IQ group) with the largest magnitude of CR and group 4 (high average IQ group) with the second largest magnitude of CR, argue for a strong relationship between magnitude of CR and measured intelligence at this level. Thus it appears that one predictor of measured intelligence in the superior range and above is magnitude of CR as indexed by SCR. Below the superior range of intelligence, prediction by SCR-OR would likely be unreliable.

The results of analysis of the discrimination trials supports Coles et al (1972) in that the imperative stimulus was associated with larger magnitude CR's which did not habituate in any of the five groups, as Lynn (1966) postulates.

The tendency of the low IQ group to orient nearly as strongly to warning stimuli across trials, while the high IQ group tended to discriminate between warning and imperative tones across trials presents an interesting phenomenon. One interpretation might be that while the low IQ group continues to respond to irrelevant stimuli, the high IQ group attends with continuing intensity to the relevant stimuli, and begins to ignore the irrelevant stimuli. The implication is that the high IQ group attend much more efficiently than the low IQ group, and thereby enhance learning.

A practical application of this study suggests that lower IQ children may attend to irrelevant stimuli in the classroom, thereby learning inefficiently. The possibility of conditioning attending behavior at the physiological level might be investigated. Conditioning children to attend to letters, groups of letters, words and numbers may prove to be useful.

Common sense suggests that personality variables other than those already researched may enter in to the magnitude of CR. More can be understood about this facilitator of learning when more of these variables are delineated. One such variable may be need for achievement, since conversation various subjects in this study, expressed different levels of motivation to achieve.

The correlation between a verbal measure of IQ and SCR-OR may prove to be of interest. Clearly defining seperate IQ groups may shed more light on the relationship between IQ and SCR-OR, since IQ groups in this study overlapped at some points. One study could be designed to investigate IQ as assessed by a measure such as WISC-R or WAIS in clearly defined and seperated groups and need for achievement to SCR-OR.

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TABLE I

SUBJECT GROUPS — TREATMENT: Imperative Stimulus

SUBJECT GROUPS	Block 1	Block 2	Block 3	Block 4
Low IQ	N=9	N=9	N=9	N=9
Low Average IQ	N=9	N=9	N=9	N=9
Average IQ	N=9	N=9	N=9	N=9
High Average IQ	N=9	N=9	N=9	N=9
High IQ	N=9	N=9	N=9	N=9

SUBJECT GROUPS — TREATMENT: Warning Stimulus

SUBJECT GROUPS	Block 1	Block 2	Block 3	Block 4
Low IQ	N=9	N=9	N=9	N=9
Low Average IQ	N=9	N=9	N=9	N=9
Average IQ	N=9	N=9	N=9	N=9
High Average IQ	N=9	N=9	N=9	N=9
High IQ	N=9	N=9	N=9	N=9

TABLE II

ANALYSIS OF VARIANCE: TRAINING TRIALS

Source	SS	df	MS	F
Between Subjects	48.10	44	1.09	
Intelligence	17.97	4	4.49	5.99
Residual	30.13	40	.75	
Within Subjects	30.92	225	.14	
Trials	.87	5	.17	5.67
Intelligence X Trials	23.68	20	1.18	39.33
Residual	6.37	200	0.03	
Total	79.02	269		

TABLE III

ANALYSIS OF VARIANCE: DISCRIMINATION TRIALS

Source	SS	df	MS	F
Between Subjects	64.34	44		
Intelligence (A)	14.02	4	3.51	2.79
Residual	50.32	.40	1.26	
Within Subjects	18.05	315		
Stimulus (B)	1.36	1	1.36	18.09
Trials (C)	2.58	3	.86	13.48
AXB	.07	4	.02	.22
AXC	.48	12	.04	.62
BXC	.05	3	.02	1.3
AXBXC	1.49	12	.12	10.79
Residual	12.02	280		
Total	82.39	359		

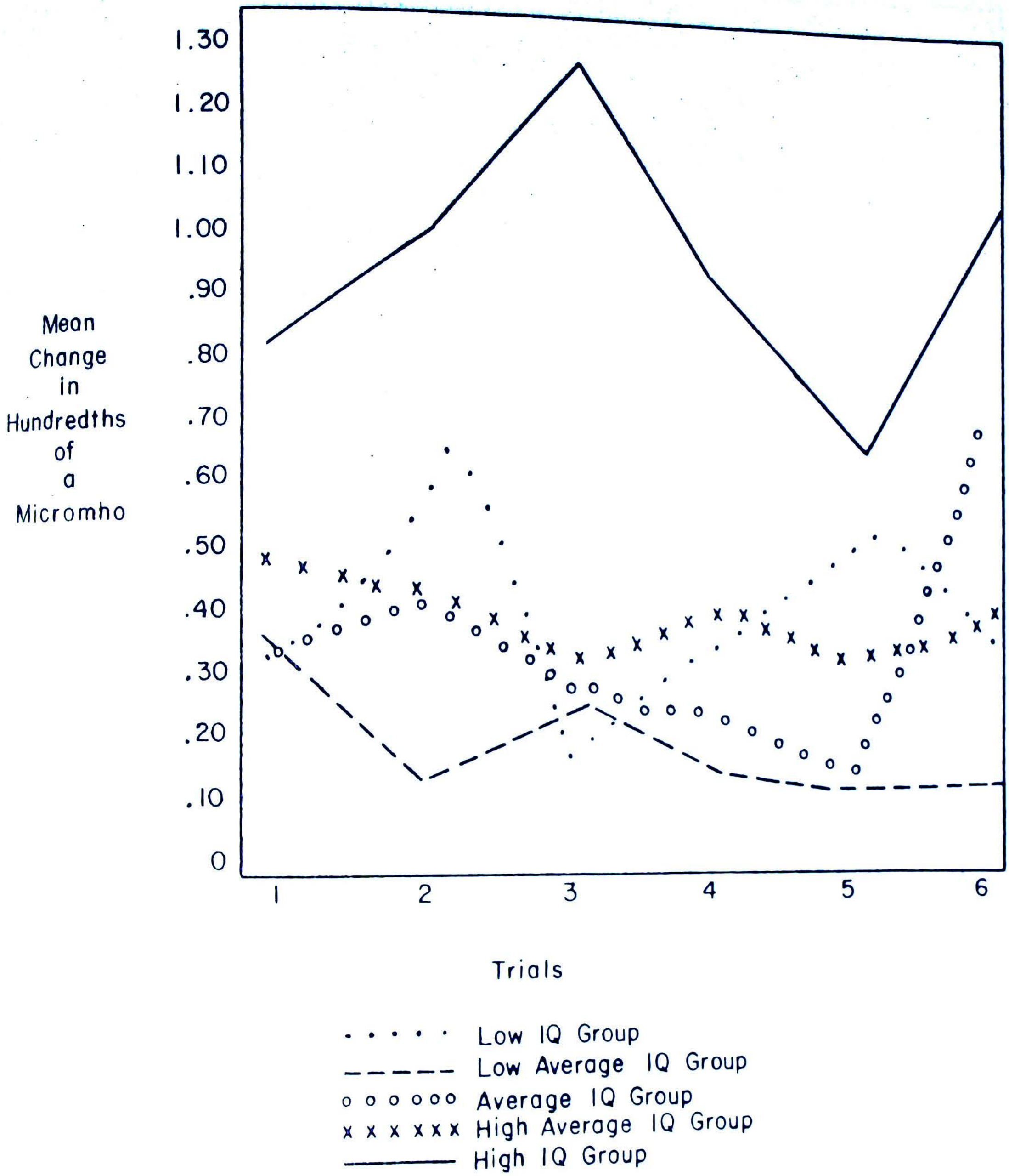

Figure 1

Mean Change Among Groups Across Training Trials

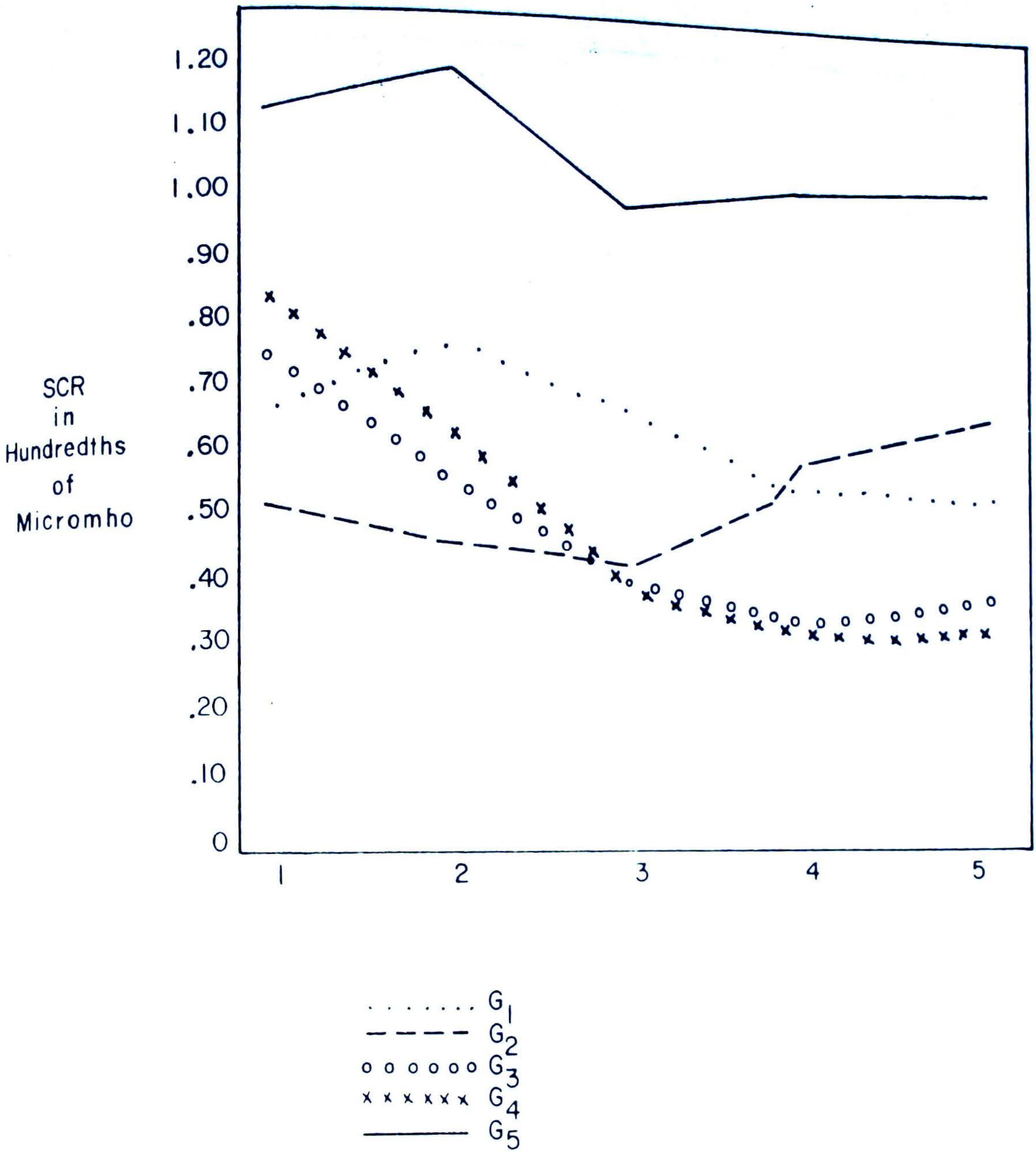

Figure 2

Mean Change to the Imperative Stimulus Across Discrimination Trials

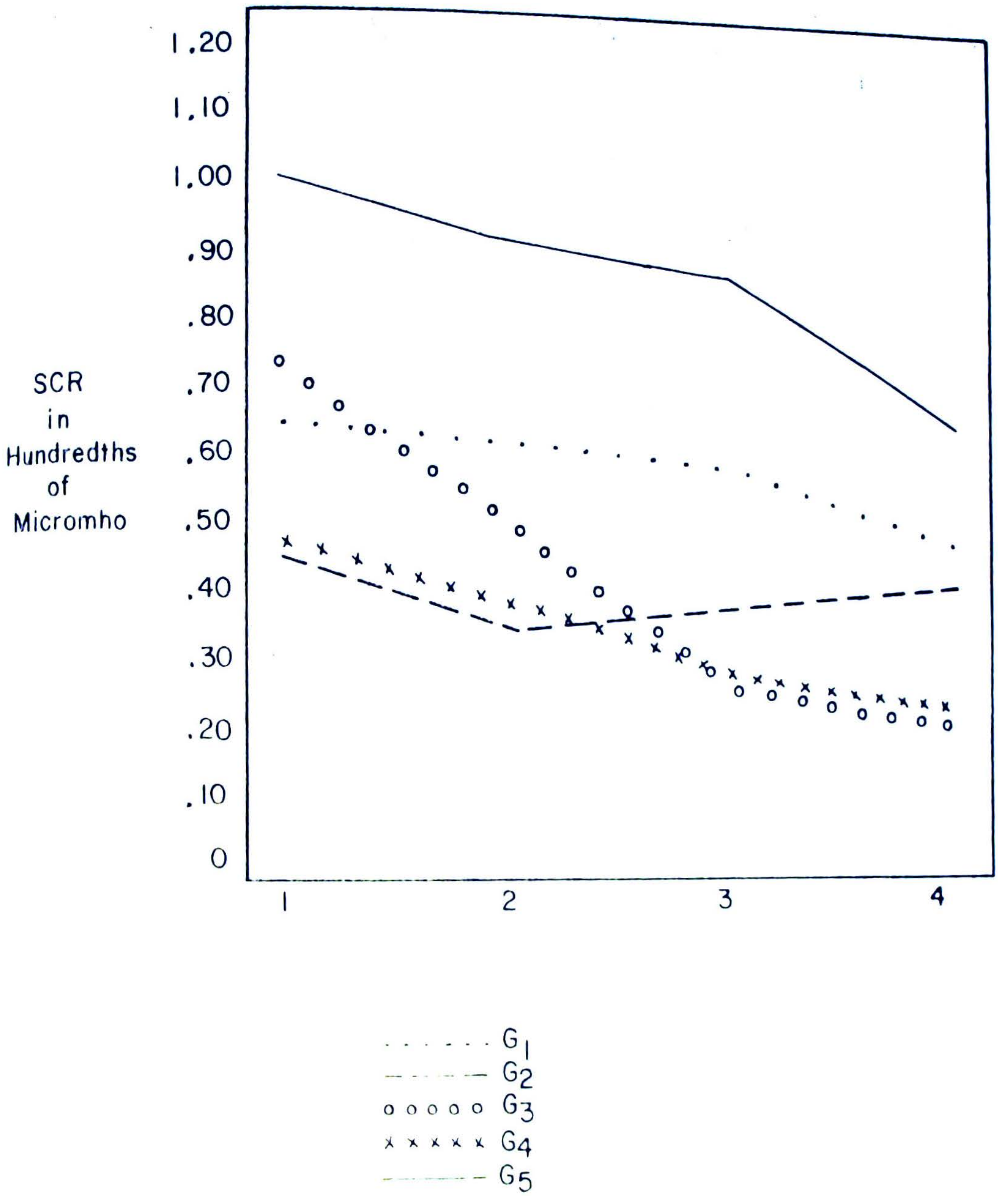

Figure 3

Mean Change to the Warning Stimulus Across Discrimination Trials