HABITUATION OF THE VASOMOTOR COMPONENTS OF THE ORIENTATION REACTION AS A CORRELATE OF STIMULUS RECOGNITION LEARNING

by Anthony J. Gallo

Thesis presented to the School of Education of the University of Ottawa in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Maplewood, New Jersey, 1972

ACKNOWLEDGMENTS

This thesis was prepared under the supervision of Dr. Andre Côté, Faculty of Education of the University of Ottawa. Appreciation is gratefully expressed to him for his help.

The writer is also indebted to Dr. William F. Barry and Dr. Henry Edwards, Faculty of Psychology of the University of Ottawa for their valuable guidance, encouragement, and for the use of the polygraph which was needed in carrying out this study.

CURRICULUM STUDIORUM

Anthony J. Gallo was born February 3, 1932 in Newark, New Jersey. He received the Bachelor of Science degree from Seton Hall University, South Orange, New Jersey, in 1958. He received the Master of Arts degree from New York University, New York, in 1960.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The concept of the orientation reaction was first introduced by Pavlov in 1910. He proposed that this investigatory action is a reflex which brings about the immediate response in man and other organisms to the slightest changes in the world around them. It is widely known that the orientation reaction will eventually habituate upon repeated presentation of the stimulus which is evoking it. A number of models accounting for the elicitation and habituation of this reaction have been produced but the one model which has currently gained the most attention is the model proposed by Sokolov.

In general terms, Sokolov's theory proposes that the orientation reaction is produced by signals of discrepancy which develop when afferent signals are compared with the trace or neuronal model formed in the cortex by an earlier stimulus which has been habituated. After the afferent signals are incorporated into this trace, habituation of the orientation reaction will occur. The moment at which the orientation reaction develops indicates the time at which the differentiation was effected while the cessation of the reaction seems to constitute that point in time at which a neuronal model is formed.

It is assumed that the habituation of the orientation reaction is a kind of stimulus learning. This premise seems to be supported by studies such as those of the Soviet investigators who have found habituation of the orientation reaction to be a prerequisite to both the unconditioned and conditioned stimulus before a stabilized conditioned link can be formed. The simple learning which has taken place in these conditioning experiments may result from the same process that occurs in recognition learning. Both entail the storage and retention of a stimulus in memory or, as Sokolov has proposed, the formation of a neuronal model. This assumption is also based on investigations which reported that high orienting men required fewer trials to learn the paired association task than low orienting men. This may have been due in part to the faster stimulus learning phase of paired-associate learning by the high orienting men since this phase is considered to result from the same process as recognition learning.

Based on the aforementioned observations, it seems reasonable to assume that a relationship may exist between habituation of the orientation reaction to a stimulus and recognition learning. Using Sokolov's ideas to explain this relationship, the question which guides the proposed research is as follows: Is habituation of the orientation reaction a precondition to stimulus recognition learning?

The first chapter contains a review of the literature and an explanation of the orientation reaction and its physiological components. The rationale leading to the formulation of the hypothesis is then presented. The chapter ends with a statement of the experimental hypothesis.

The second chapter contains a description of the sample used in the study, the various instruments used, the experimental procedure, and the methods employed in evaluating the results of the present study.

The results which were obtained in the present study are presented in Chapter Three where they are discussed in terms of the theoretical framework as set forth in Chapter One. Implications for future research are then presented.

CHAPTER I

REVIEW OF THE LITERATURE

In this review of the literature the investigator presents the various research findings and trends which led him to the hypothesis to be tested by the present study. Section A of this chapter contains a discussion of the orientation reaction (OR). Section B presents Sokolov's model of the orientation reaction. Section C deals with the relationship between the orientation reaction and learning. The nature of the expected relationship between Sokolov's model of the orientation reaction and a recognition memory task is discussed in Section D. Section E contains a summary and a statement of the hypothesis.

A. The Orientation Reaction.

Over the years the orientation reaction has been given different names. It has been called the following: the "What is it? reflex"; the orienting response; the investigatory reflex; the focusing reaction; the attitudinal reaction; the orienting reflex; the concentration reflex; and the "What's to be done? reflex". The most common and enduring name for this phenomenon is the orientation reaction.

The OR was first recorded in Pavlov's laboratory in the early years of the twentieth century during conditioning experiments. In the beginning this phenomenon was looked upon by Pavlov's students as an annoyance because the OR interfered with their experiments. Eventually, however, it became a phenomenon of interest in its own right. Pavlov described the OR in this frequently quoted passage:

> It is this reflex which brings about the immediate responses in man and animals to the slightest changes in the world around them, so that they immediatly orientate their appropriate receptor organ in accordance with the perceptible quality in the agent bringing about the change, making full investigation of it. The biological significance of this reflex is obvious. If the animal were not provided with such a reflex its life would hang at every moment by a thread. In man this reflex has been greatly developed with far-reaching results, being represented in its highest form by inquisitiveness--the parent of that scientific method through which we hope one day to come to a true orientation in knowledge of the world around us.[1]

---

1 I. P. Pavlov, Conditioned Reflexes, An Investigation of Physiological Activity of the Cerebral Cortex, London, Oxford University Press, 1927, p. 12.

The OR involves a large number of physiological changes. Lynn states:

> The purpose of these changes, in general terms, is to make the animal more sensitive to incoming stimuli so that it is better equipped to discern what is happening, and to mobilize the body for whatever action may be necessary; for "fight or flight" as Cannon expressed it.[2]

Sokolov reinforces this concept by stating:

> The orienting reflex, which includes some vegetative, somatic, electroencephalographic, and sensory components, is a unitary system, and the role of these components is to increase the discriminatory power of analyzers.[3]

The components of the OR are many and varied. After a comprehensive study Berlyne[4] categorized the components of the OR in the following manner:

Changes in Sense Organs
- a. The pupil of the eye dilates.
- b. There are photochemical changes in the retina lowering the threshold for intensity of light.

---

2 R. Lynn, Attention, Arousal and the Orientation Reaction, Oxford, Pergamon, 1966, p. 2.

3 Eugene Nikolaievich Sokolov, "Neuronal Models and the Orienting Reflex", in M. A. Brazier (Editor), The Central Nervous System and Behavior, New York, J. Moon, 1960, p. 191.

4 D. E. Berlyne, Conflict, Arousal, and Curiosity, New York, McGraw-Hill, 1960, p. 81-82.

Changes in the Skeletal Muscles that Direct Sense Organs

The eyes open wide and turn toward a source of visual stimulation. The animal turns its head toward the source of sound, pricks up its ears and sniffs.

Changes in EEG

The EEG changes toward increased arousal, i.e. faster and lower amplitude activity.

Changes in General Skeletal Musculature

Ongoing reactions are temporarily arrested and general muscle tonus rises, increasing readiness for activity in the skeletal muscles. There is an increase in electromyographic muscular electrical activity.

Vegetative changes

a. The blood vessels in the limbs contract, while those in the head expand.
b. The galvanic skin reaction occurs.
c. In human subjects the heart rate slows.
d. There is a delay in respiration rate followed by increase in amplitude and decrease in frequency.

Sokolov contends that the <u>OR</u> is characterized by two general properties.

> The first is that it is an unspecific reflex and is initiated by any increase, decrease, or qualitative change of a stimulus, independent of the modality of the stimulating agent. The second property is that it is subject to extinction or habituation on repeated presentation. This orienting reflex is a special functional system which can be differentiated from the other two general types of unconditioned reflexes--the adaptive reflex and the defensive reflex. The adaptive reflex is the reflex connected with the direction of a change of stimulus, and the defensive reflex is a general response of the organism when the stimulus is too strong for normal functioning. [...] This reaction, and this is the important point, is produced only by the first few presentations of the stimuli.[5]

---

5 Sokolov, <u>op. cit.</u>, p. 189.

Not all stimuli will evoke an OR. Berlyne[6] has collated a number of characteristics of stimuli which elicit the OR. They include the following:

Intensity
Stimuli of moderate intensity will evoke an OR. High intensity stimuli will evoke stronger reactions such as the startle-defensive reaction.

Color
Colored stimuli are more likely to elicit ORs in human infants than grey stimuli. Adults seem to prefer red and white designs in preference to black and white designs.

Indicating Stimuli
OR responses can become attached to signals through learning. "Listen to this", "Look at what he is doing!" are obvious examples.

Novelty
Stimuli which are new or unfamiliar to an organism tend to elicit an OR.

Surprisingness
Frequently a surprising change in experimental conditions will evoke an OR. Thus an organism which has been trained to find a particular reward such as a banana under a cup will give pronounced ORs when it finds a leaf of lettuce there. A somewhat similar situation arises when stimuli habitually presented in a certain order suddenly occur in a different order.

---

6 Berlyne, op. cit., p. 96-102.

Complexity, Incongruity
The more complex the stimulus, the more likely it will evoke an OR. In adults ORs are readily evoked by incongruous pictures such as that of an animal with a lion's body and an elephant's head.

Conflict
In conditioning situations the organism will first make ORs to the novel situation. The ORs disappear as the conditioning becomes well established and automatic. When discrimination learning is introduced the organism once more makes ORs to both the positive and negative stimuli until the discrimination becomes perfect. Then the ORs once again disappear.

The point at which a stimulus no longer evokes an OR is termed "habituation". Lynn describes this phenomenon in the following way. "When a stimulus is presented again and again the orientation reaction gets progressively weaker and eventually disappears. This is the phenomenon of habituation."[7] According to Sokolov, the phenomenon of habituation takes place with the establishment of a neuronal model of the stimulus item which is evoking the OR. Sokolov's theory is presented in Section D of this chapter.

A number of variables have been studied to determine what effect they may have on the speed of OR habituation. Those variables which seem to affect the rate of OR

---

7 Lynn, op. cit., p. 24.

habituation have been summarized and subdivided by Lynn[8] into two groups: subject variables and stimulus variables. The stimulus variables include the following:

1. Stimulus intensity. Generally low intensity stimuli habituate more rapidly.

2. Duration of the stimulus. Very brief and very long stimuli produce a reaction which habituates quickly.

3. Very brief stimuli may not produce a reaction at all. Stimuli which are of an intermediate duration are the most difficult to habituate.

4. Difficult discriminations. When a subject has to make a positive reaction to one stimulus and a negative reaction to another stimulus and the stimuli are difficult to discriminate, there is a delay in habituation.

5. Time intervals. Shorter intervals between stimuli quickens habituation.

6. Spontaneous recovery. The orientation reaction shows some partial recovery after the elapse of time following habituation. With further habituation, the orientation reaction is completely and permanently habituated.

7. Disinhibition. A strong extraneous stimulus restores the orientation reaction even after habituation has occurred to a stimulus.

8. Generalization. A certain amount of generalization is involved in the habituation of the orientation reaction.

---

8 Lynn, op. cit., p. 26-32.

9. Conditioned (signal) stimuli. Upon repeated presentation a stimulus will normally be habituated. If the stimulus has signal value or has particular significance to the subject, then habituation is greatly prolonged or never occurs.

The subject variables include the following:

1. Cortical injury and ablation. Habituation of the orientation reaction is very much prolonged when there has been cerebral cortical destruction. Habituation may be impossible with total ablation.

2. Phylogenetic differences. Organisms which are phylogenetically higher habituate quicker than those phylogenetically lower.

3. Individual differences. Old people suffering from senile dementia, certain schizophrenics, and certain neurotics have difficulty habituating to a stimulus.

B. Sokolov's Model of the Orientation Reaction.

Numerous neurological models of the habituation process of the OR have been proposed and have been divided by Lynn[9] into "one-stage models" and "two-stage models". According to Lynn the one-stage models are those which assume that when a particular group of neurons are repeatedly stimulated an inhibitory process is generated

---

9 Lynn, op. cit., p. 33.

in the neurons which raises their threshold of response and eventually eliminates the response entirely. Because one-stage models cannot fully account for the failure of some stimuli to evoke an OR and cannot account for a habituated stimulus evoking the OR, these models are generally not accepted.

The two-stage models of habituation do account for both the failure of some stimuli to evoke an OR and the phenomenon of evoking the OR to a habituated stimulus. These models embody one stage in which there is an analysing mechanism to determine whether the stimulus necessitates an OR; and then a second stage in which either excitatory or inhibitory mechanisms are activated to either evoke or inhibit the OR. Lynn[10] concludes that the most comprehensive model for the orientation reaction is that advanced by Sokolov. Sokolov's two-stage model of the OR is shown in Figure 1, Page 11 of the current report and it serves as the schema for the rationale underlying the OR and its properties. In general terms the theory proposes that the stimulus analysis takes place in the cortex; after analysis the cortex initiates excitation or inhibition of the OR.

---

10 Lynn, op. cit., p. 14.

More specifically the model in Figure 1, Page 11 indicates that incoming stimuli from the sensory tracts are conveyed to the cerebral cortex for analysis (labeled 1 in the model) and by way of collaterals into the reticular formation (labeled 2 in the model). Stimuli that are perceived as being novel or significant cause the cortex to send down excitatory impulses to the reticular formation for activation (labeled 5 in the model). The concept of a "nervous model" is advanced by Sokolov in developing this part of his model. According to this conception, incoming stimuli leave traces of all their characteristics within the nervous system and especially in the cortex. These traces are the neuronal models. They preserve information about the intensity and duration of the stimulus as well as other more obvious stimulus dimensions. Sokolov[11] describes this concept as follows: "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."

The assumption is made by Sokolov that any incoming stimulus is compared with the neuronal models which exist in the cortex. If the stimulus matches a neuronal model, the

---

11 Sokolov, op. cit., p. 205.

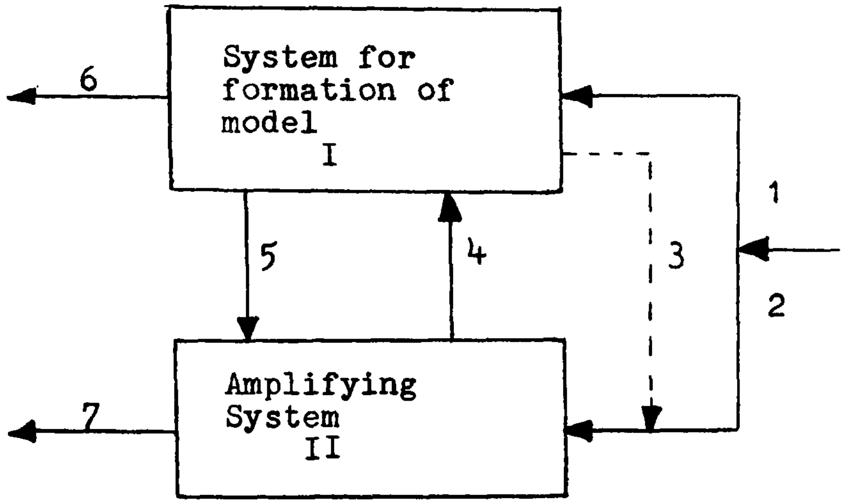


Figure 1. - Sokolov's Schema for the Orienting Reflex. I. Modeling system. II. Amplifying system. 1 = specific pathway from sense organs to cortical level of modeling system; 2 = collateral to reticular formation (represented here as an amplifying device); 3 = negative feedback from modeling system to synaptic connection between collaterals from specific pathway and R.F.; 4 = ascending activating influences from the amplifier (R.F.) upon modeling system (cortex); 5 = pathway from modeling system to amplifying system (this is the pathway through which the impulses signifying concordance are transmitted from the modeling system to the amplifying system); 6 = to the specific responses caused by coincidence between the external stimulation and the neuronal model elaborated in the cortex; and 7 = to the vegetative and somatic components arising from the stimulation of the amplifying system (R.F.).[12]

---

12 Sokolov, <u>op. cit.</u>, p. 216.

orientation reaction is blocked (labeled 3 in the model). The cortex, while not sending down excitatory impulses to the reticular formation, blocks the excitatory non-specific effects that are coming from the afferent collaterals (labeled 2 in the model). If the stimulus does not match an existing nervous model, the <u>OR</u> will occur. The activation of the reticular formation to initiate the <u>OR</u> is brought about by both the excitatory impulses from the cortex (labeled 5 in the model) and the non-specific stimulation by way of the collateral afferents (labeled 2 in the model).

The reticular formation, upon being activated, in turn sends excitatory impulses up to the cortex to heighten cortical arousal (labeled 4 in the model). This is a central component of the <u>OR</u>. The autonomic components of the <u>OR</u> (labeled 7 in the model) occur as a result of reticular activation of the posterior hypothalamus. As a result of both these components, the incoming stimulus is strengthened thus facilitating its analysis by the cortex.

Eventually habituation will occur as a result of repeated presentation of this stimulus. According to Sokolov[13], a neuronal model of the stimulus is eventually established

13 Sokolov, <u>op. cit.</u>, p. 215.

preserving information of all the qualities of that particular stimulus. The cortex, now having an exact model to which the incoming stimulus can be compared, will send down impulses to the afferent collaterals in order to block the non-specific imput which normally helps to elicit an OR. Lynn[14] speculates that this blocking may take place by hyperpolarization of the synaptic connections. Stimulation is able to pass up to the cortex and down again in time for this blocking to take place because of the slower conduction rates in the collaterals due to the short axons and large number of synapses.

Sokolov[15] has scught support for his model at the neuronal level by assuming that a triad of different neurons made up his model: afferent neurons, extrapolatory neurons, and comparator neurons. He assumes that the afferent neurons always respond to a stimulus, even with repeated presentation, while the extrapolatory neurons only begin to respond to a stimulus after repeated stimulation. The following sequence takes place with the repetition of a stimulus:

---

14 Lynn, op. cit., p. 42.

15 E. N. Sokolov, "Higher Nervous Functions: The Orienting Reflex", in V. E. Hall (Editor), Annual Review of Physiology, Vol. 25, 1963, p. 568.

a. The sequence of stimuli are recorded and fixed in the neurons by molecular mechanisms.

b. A sequence of nervous impulses are generated by the neurons in anticipation of the future impulse. This assumption is an attempt to deal with the appearance of an OR to an unexpected stimulus, i.e. a stimulus which is not in the proper sequence such as with the findings of Unger.[16]

The purpose of the comparator neurons is to compare the signals from the afferent and extrapolatory neurons. If there is a mismatching of the two signals due to the novelty of the stimulus, the comparator neurons will then initiate the OR. The activation of the comparator neurons gives rise to local EEG desynchronization. With repeated presentation of the stimulus the signals from the afferent and extrapolatory neurons come to match, the comparator neurons will not be activated, and the local EEG desynchronization will cease. This then is habituation.

Lynn[17] has provided a summary of the neurophysiological evidence in the literature for the existence of these three types of neurons and he concludes that these studies go some way in increasing confidence in the theory of the nervous model.

---

16 S. M. Unger, "Habituation of the Vasoconstrictive Orienting Reaction", in Journal of Experimental Psychology, Vol. 67, January 1964, p. 11-18.

17 Lynn, op. cit., p. 45.

C. The Relationship Between the Orientation Reaction and Learning.

The purpose of this section is to review studies which seem to support the assumptions that habituation of the OR is a kind of stimulus learning and that this stimulus learning may be viewed as a kind of recognition learning. The second purpose of this section is to review those studies which assume that the OR may be used as a predictor of learning and performance.

The Soviet investigators have learned with some difficulty that habituation of the OR is a necessary prerequisite to both the unconditioned and conditioned stimulus before a stabilized conditioned link can be formed. It would appear therefore that both the unconditioned and conditioned stimuli produce ORs by virtue of their novelty. According to Sokolov's theory a neuronal model must be established for each of these stimuli. When these two habituated stimuli are paired, the OR will return. The combination of the two stimuli has novelty and therefore the OR returns. It would seem that another neuronal model must be encoded in order to handle this new combination. These assumptions appear to be supported by Sokolov[18] who reported a correlation

---

18 Sokolov, "Neuronal Models and the Orienting Reflex", op. cit., p. 223-226.

between habituation of the OR and the stabilization of conditioned responses in classical conditioning experiments.

Other studies which seem to support Sokolov's neuronal model of the OR have been reported. Kintsch[19] studied the magnitude of the GSR as a measure of strength of the orienting response during paired-associate learning. The momentary resistance changes which occurred whenever an item was presented were recorded. In Experiment I the subjects learned to associate nonsense syllables with the response 1 and 2. The learning data was described by a two-state Markov model. He reported that the GSR increased in magnitude up to the trial of the last error. After that the response began to habituate. Similar results were obtained for response latencies. Experiment II was a conventional paired-associate task with nonsense syllables as responses. A three-state Markov model was used to describe the learning data. The GSR was again correlated with the states of the model. It tended to increase in the initial state, remained at its peak during intermediate trials, and habituated as soon as learning was completed. Kintsch concluded that the fact that the OR is stronger in the intermediate state than

---

19 Walter Kintsch, "Habituation of the GSR Component of the Orienting Reflex during Paired-Associate Learning before and after Learning Has Taken Place", in Journal of Mathematical Psychology, Vol. 2, 1965, p. 330-341.

at the very beginning of learning agrees well with the interpretation of the first stage of the learning process as stimulus encoding. As long as an item is completely new, a moderate OR is evoked. This reflex reaches maximum strength after the subject already knows something about the item but recall is either still incomplete or unreliable. In terms of Sokolov's neuronal model, one could say that a neural representation has been built up but does not yet coincide perfectly with all the parameters of the source of stimulation. After an item enters the learning stage habituation develops.

Several investigations which seem to be in general agreement with these findings are summarized as follows. In studies dealing with verbal learning Brown[20] and Obrist[21] reported that the GSR follows closely the order of learning in a serial list. Finesmith[22] reported a peak of the GSR on the trial of the first success in paired-associate learning.

---

20 C. H. Brown, "The Relation of Magnitude of Galvanic Skin Responses and Resistance Levels to the Rate of Learning", in Journal of Experimental Psychology, Vol. 20, 1937, p. 262-278.

21 W. E. Obrist, "Skin Resistance and Electro-encephalographic Changes Associated with Learning", in Summaries of Doctoral Dissertations, Northwestern University, Vol. 7, 1950, p. 607-610.

22 S. Finesmith, unpublished doctoral dissertation presented to the University of Buffalo, 1959, cited by H. O. Mowrer, Learning Theory and the Symbolic Process, New York, Wiley, 1960, p. 169.

Thompson and Obrist[23] reported that when syllables are first being anticipated correctly, changes in the electrocortical activity reached a maximum. A study conducted by Scull and Kantor[24] employed a four category concept identification task in which continuous recordings of the GSR were obtained. They found that the magnitude of the GSR increased up to the point at which the criterion of 100% correct concept identification occurred at which point the GSR dropped precipitously.

In a study by Zimny[25] the effects of stimulus order and novelty upon habituation and dishabituation of the GSR component of the OR were investigated. It was reported that the factor of novelty, but not of order, differentially affected the return of the OR to the first test stimulus. He concluded that the neuronal model generated by the succession of the same stimulus contained parameters of the specific stimulus, so that introduction of the test stimulus

---

23 L. W. Thompson and W. D. Obrist, "EEG Correlates of Verbal Learning and Overlearning", Electroencephalography and Clinical Neurophysiology, Vol. 16, 1964, p. 332-342.

24 John Scull and William Kantor, unpublished report cited by Irving Maltzman and Mary P. Mandell, "The Orienting Reflex as a Predictor of Learning and Performance", in Journal of Experimental Research in Personality, Vol. 3, 1968, p. 104.

25 George H. Zimny, Gene F. Pawlick, and David P. Saur, "Effects of Stimulus Order and Novelty on Orienting Responses", in Psychophysiology, Vol. 6, No. 2, 1969, p. 166-173.

produced a pronounced discrepancy between the model and the test stimulus, resulting in pronounced dishabituation or return of the OR.

Lovibond[26] studied the hypothesis that rate of habituation of the OR to multiple stimulus sequences is a negative function of the uncertainty in the stimulus series. The response measure was change of skin conductance to a stimulus of light. Mean conductance change scores of the various groups involved in the study were closely related to the degree of uncertainty in the stimulus series. The investigator concluded that the results are consistent with Sokolov's neuronal model theory of the OR, and offered further support for the view that human information processing involves a form of probability analysis similar to that postulated by information theory.

Other studies have demonstrated that the neuronal model seems to be placed in the cerebral cortex and incorporates the different parameters of the stimulus as proposed by Sokolov. Evidence of this concept finds its roots in the very physiological process upon which the OR is based. It

---

26 S. H. Lovibond, "Habituation of the Orienting Response to Multiple Stimulus Sequences", in Psychophysiology, Vol. 5, No. 4, 1969, p. 435-439.

has long been known that habit formation and learning in higher forms of animal life is directly correlated to cortical development. As the evolutionary process brought about the expansion of the cerebral cortex, the animal came to habituate more quickly. The importance of the cortex to habituation is further seen in those experiments which have found that decortication abolishes or severely impairs habituation and partial decortication retards habituation according to extent.

According to Lynn[27], the most important evidence for placing the analyzing mechanism in the cerebral cortex is the subtlety of the discrimination which the nervous system is able to make between familiar and novel stimuli. Some of these subtle discriminations include the differentiation between stimuli differing only in duration or in "semantic habituation". If a subject is habituated to a whole group of words of similar meaning and if a word of a different meaning is presented to the subject, he will once again give an OR. This seems to be powerful evidence for the cognitive activity of the OR. Other types of fine discrimination can occur as in selective habituation to patterns and sequences of stimuli, so that if only one stimulus of a sequence of different stimuli which has already been habituated is

---

27 Lynn, op. cit., p. 44.

presented the individual will evoke an OR. Lynn states that only animals with a well-developed cortex are capable of these discriminations and the discriminations are lost after cortical damage.

It would appear from the previous mentioned studies that habituation of the OR is a kind of stimulus learning. Bernbach[28] assumes that recognition learning requires the storage and retention of a stimulus in memory. He also assumes that the storage and retention of stimulus tags (internal representation) is the basis for performance in the recognition-memory task. That is, when an item is presented for a recognition test it is compared with the tags that are stored in memory, and on the basis of this comparison a decision is made to say either "old" or "new". In general, subjects will respond "old" when an item is presented for which a tag is available in memory. Thus a failure to recognize (to call "old") an old item indicates that the stimulus tag stored on its prior presentation(s) is no longer available. Based on the aforementioned assumptions, it seems reasonable to assume that the stimulus learning that

---

28 H. A. Bernbach, "Stimulus Learning and Recognition in Paired-Associate Learning", in Journal of Experimental Psychology, Vol. 75, 1967, p. 513-519.

takes place during habituation is similar to the process that is evidenced by recognition learning. A few of the studies entailed the use of paired-associate learning. The relationship of recognition learning to paired-associate learning will be described in a subsequent section of the present study.

Soviet investigators view the *OR* as possessing a duality of function. First they see it as a reaction which facilitates perceptual sensitivity. This is particularly evident in the work of Sokolov[29,30]. He reports many studies of the type in which the arousal of an *OR* to a tone resulted in an increase in sensitivity to visual stimuli. Secondly they see it as having an effect on the learning process. Elicitation of *ORs* by stimuli facilitates their conditioning. This concept has been expanded by recent studies which now consider the *OR* with its objective measures and related principles as a major empirical factor for predicting the course of learning.

---

29 Sokolov, "Neuronal Models and the Orienting Reflex", *op. cit.*, p. 187-276.

30 E. N. Sokolov, *Perception and the Conditioned Reflex*, New York, Macmillan, 1963, p. 104.

Maltzman and Mandell[31] have summarized the unpublished results of a number of experiments which support this concept. They state that those studies have

> ...demonstrated that individual differences in physiological measures of the orienting reflex predicted between response systems. For example, individual differences in the GSR measure of the OR predicted individual differences in semantic conditioning of alpha blocking, and differentiated between "aware" and "unaware" Ss in the experiment. It was also found that a GSR measure of the OR induced by verbal reinforcement differentiated "aware" from "unaware" Ss in an operant verbal conditioning task.

Maltzman and Raskin[32] in reporting the findings of several experiments conclude that those subjects with relatively large ORs as compared with those subjects with relatively small ORs show better semantic conditioning of autonomic responses, more readily verbalize the experimental contingencies, are superior in paired-associate learning, and show greater differential responsivity to signals. They have concluded that the conception of the OR and its related principles have much to recommend them as means of assessing the effectiveness of stimuli and their reinforcement value for the individual organism. They also conclude that the

---

31 Irving Maltzman and Mary P. Mandell, "The Orienting Reflex as a Predictor of Learning and Performance", in Journal of Experimental Research in Personality, Vol. 3, 1968, p. 99-106.

32 Irving Maltzman and David C. Raskin, "Effects of Individual Differences in the Orienting Reflex on Conditioning and Complex Processes", in Journal of Experimental Research in Personality, Vol. 1, 1965, p. 1-16.

<u>OR</u> provides a powerful tool for the analysis of many "perceptual" problems, conditions at the moment of stimulus reception that influence subsequent behavior. Among the studies discussed by Maltzman and Raskin there are two investigations that are especially pertinent to the present project--the studies of Belloni[33] and that of Nies[34]. The findings of both of these investigators are described in the following paragraphs.

On the basis of the assumption that the <u>OR</u> is related to discriminative ability, Belloni[35] classified her subjects as high and low orienters on the basis of the magnitude of the <u>OR</u> to the first word heard in a semantic conditioning experiment. She found that the High Orienting men were reliably superior to Low Orienting men in terms of response speed on a difficult list and also required reliably fewer trials to reach the criterion. Thus, at least for men, she demonstrated that the GSR measure of the <u>OR</u> is reliably related to paired-associate performance.

---

33 Marigold L. Belloni, <u>The Relationship of the Orienting Reaction and Manifest Anxiety to Paired-Associates Learning</u>, unpublished doctoral dissertation presented to the University of California, Los Angeles, 1964, ii-137 p.

34 Richard Nies, <u>Orienting Response and Drive as Distinguishable Concepts in Learning Performance</u>, unpublished doctoral dissertation presented to the University of California, Los Angeles, 1964, v-82 p.

35 Belloni, <u>loc. cit.</u>

In a somewhat similar study Nies[36] categorized his subjects as high and low orienters on the basis of their OR to a burst of 90 db noise. He reported that High OR subjects were superior to the Low OR subjects in all phases of paired associate performance on the two lists. The High OR group was reliably superior to the Low OR group for the trials-to-criterion measure for the difficult list.

The findings of Belloni and Nies on paired associate learning would seem to indicate a relationship between the OR and recognition learning since according to Kintsch[37] before a subject can retrieve the appropriate response in a paired-associate test he must be able to recognize the stimulus term. The studies of Bernbach[38] and Martin[39,40] have shown that recognition of the stimulus term is a necessary condition for the establishment of a stimulus-response connection. The

---

36 Nies, loc. cit.

37 Walter Kintsch, Learning, Memory and Conceptual Processes, New York, Wiley, 1970, p. 285.

38 H. A. Bernbach, "Stimulus Learning and Recognition in Paired-Associate Learning", in Journal of Experimental Psychology, Vol. 75, 1967, p. 513-519.

39 E. Martin, "Relation Between Stimulus Recognition and Paired-Associate Learning", in Journal of Experimental Psychology, Vol. 74, 1967, p. 500-505.

40 E. Martin, "Stimulus Recognition in Aural Paired-Associate Learning", in Journal of Verbal Learning and Verbal Behavior, Vol. 6, 1967, p. 272-276.

findings of these studies have reported that it does not matter how often the subject already has given a correct recall response to a particular item on previous trials. If he fails to recognize it, recall performance on that trial is at the chance level. Since the high OR subjects performed better than the low OR subjects on paired associate learning, it seems reasonable to assume that this may be due in part to the faster stimulus-recognition learning that took place.

Luria[41] further reinforces the relationship of the OR to learning by contending that the well-known defects in attention and poor learning of mental defectives are a result of poor orientation. These subjects frequently do not give ORs to low and medium intensity stimuli. However, they will give ORs to intense stimuli. These reactions are usually powerful and difficult to extinguish. It is assumed that these characteristics are attributed to defects of cortical functioning. The cortex does not facilitate an OR to low or medium strength stimuli. These reactions when they do appear are weak and habituate in one or two trials. Direct stimulation of the reticular formation by intense stimuli activates an OR and the cortex fails in its habituation function. The

---

41 A. R. Luria, The Mentally Retarded Child, Oxford, Pergamon, 1963, p. 97-108.

habituation of the mentally defective child is not like the habituation of the normal child.

Another characteristic of the OR in mentally defective children is that the OR cannot be prolonged by verbal instruction as it can be with normal subjects. Instructing normal subjects to pay attention to the stimulus greatly extends the number of ORs given to it.

According to Luria[42] a close relationship exists between these imperfections in the functioning of the OR and the learning difficulties of the mentally defective. He proposes three distinct kinds of defects. The first defect exhibited by the mentally defective child entails the lack of attention given to the novel stimuli because of the failure to produce an OR to them. Since according to Sokolov the ORs are essential for the formation of conditioned reactions, this will lead to a failure of learning. This first defect is exemplified in experiments where a neutral stimulus precedes the instruction--"press the bulb". The normal child makes an OR to the neutral stimulus and is conditioned to it (i.e. he presses the bulb on presentation of the stimulus) after two or three trials. This does not occur with the mentally defective child. He does not give an OR and is thus not

---

42 Ibid.

conditioned. In this respect he resembles a normal subject who has first been habituated to the stimulus.

The second defect relates to the distractibility of the mentally defective children. These children continue to show ORs to intense irrelevant stimuli whereas with the normal child who is absorbed in some kind of task, these irrelevant stimuli do not evoke ORs. The third defect involves the failure of verbal conditioning. This defect makes it impossible to direct the attention of the mentally defective child by verbal instruction. This defect is exemplified in the following situation: When the instruction "Count the stimuli" is given, the mentally defective child does not produce continued ORs to the stimuli as it does in the normal child. This defect obviously will lead to great difficulty in learning in the classroom. This does not mean that the mentally defective child cannot be taught a reaction. Sometimes the reaction is taught for only a brief period, but the learning quickly breaks down. The following is given as an example of this difficulty. It is possible to teach discrimination of two metronome beat rates, so that the subject reacts to one and not to the other. The mentally defective child will cease to give ORs to the two stimuli after a few trials and at the same time the correct reaction breaks down. Normal subjects continue to elicit ORs until the motor response becomes stablized and "automatic".

D. The Nature of the Expected Relationship Between Sokolov's Model of the Orientation Reaction and a Recognition Memory Task.

According to McCormack[43] there are five basic designs used in recognition memory studies. He explains these paradigms as follows.

> The first of these, and that most commonly employed, involves the presentation of a set of items (targets) followed by a second presentation of this set intermingled with items from another set (distractors) which are being presented for the first time. When targets and distractors are presented concurrently, the subject (S) is required to make a decision with respect to each item as to whether it is old or new. Occasionally S is required to supplement each decision with a statement indicating his degree of confidence. A second paradigm involves an initial presentation of the target set followed by several series of items where, in each case, the target appears along with one or more distractors, with S being required to make a forced-choice decision. A third paradigm, originally employed by Shepard and Techtsoonian (1961), involves a continuous presentation of items, some presented once and others twice, and following the appearance of each, S is required to make an old-new decision. The remaining two paradigms are used by investigators concerned with short-term recognition memory. For the first of these, a series of targets is presented followed by a single item which is either a target or a distractor, with S being required to say whether the item was or was not a member of the target set. The second short-term recognition memory paradigm involves the presentation of a single target, followed by some retention interval activity at the termination of which S says "old" or "new" in the presence of a single target or distractor.

---

43 P. D. McCormack, "Recognition Memory: How Complex a Retrieval System?", in Canadian Journal of Psychology, Vol. 26, 1972, p. 19-41.

The two types of recognition studies that would employ these designs are item recognition or class recognition. In item recognition, or individual recognition, target and distractor items belong to the same set of homogeneous items. In class recognition the targets and distractors come from different sets. It seems obvious that if the target items are nonsense syllables and the distractors are three letter digits on the recognition test the subject will perform on a completely different basis than if both the targets and the distractors are nonsense syllables. Kintsch[44] states that in all recognition tests the similarity between the learning items and the distractor items is a very powerful variable and that in recognition tests it is often possible to recognize an item correctly on the basis of some remembered detail. If the learning material is poorly integrated, part-recognition may be quite effective depending upon the confusability of the distractor items used in the experiment.

In view of the aforementioned facts it would seem that the more closely related the distractors are to the target, as in the present study, the more difficult becomes

---

44 Kintsch, Learning, Memory and Conceptual Processes, op. cit., p. 221.

the learning task. Very similar distractors and target would tend to eliminate the use of part-recognition by the subject. What appears to be involved is a complex mechanism in the central divisions of analyzers which reflect the external world. Sokolov's two-stage model of the _OR_ would appear to be related to that conception. The essence of the model is that the _OR_ does not occur as a direct result of incoming excitation, but rather is produced by signals of discrepancy which develop when afferent signals are compared with the trace formed in the cortex by an earlier stimulus which has been habituated. According to Sokolov[45], this trace constitutes the neuronal model which simultaneously registers the intensity, duration, location in space, dimensions, qualitative features, and rhythm of the stimuli. It seems to follow that since the _OR_ is produced by discrepancy, its cessation as indicated by habituation, constitutes that point in time at which a neuronal model is completely formed. If we equate this process with stimulus recognition learning, it may then be assumed that habituation is a precondition to stimulus recognition learning where the target and distractors are extremely similar.

---

45 E. N. Sokolov, "The Modeling Properties of the Nervous System", in Michael Cole and Irving Maltzman (Editors), _A Handbook of Contemporary Soviet Psychology_, New York, Basic Books, 1969, p. 702.

E. Summary and Hypothesis.

The purpose of this chapter has been to present a review of the literature which led the author to the present project and the formulation of his hypothesis.

In Section A of this chapter the nature and properties of the OR were presented. Section B presented Sokolov's Model of the OR. This neurophysiological model accounts for both the elicitation and habituation of the OR. Section C reviewed the relationship between the OR and learning. Based on Sokolov's theory of the OR, one relationship that was assumed to exist between the OR and learning was that habituation of the OR is a kind of stimulus learning. The findings of a number of investigations supported this assumption. Other studies dealing with the discrimination of stimuli further demonstrated the amount of information that had been encoded in the cerebral cortex (i.e. the subtlety of the discriminations). It was concluded by the present investigator that the stimulus learning in the formation of a neuronal model which occurs during habituation may result from the same process that occurs in recognition learning since both entail the storage and retention of a stimulus in memory. Another relationship that is assumed to exist between the OR and learning is that the OR may be used as a predictor of learning and performance. Several findings seem to confirm this position. Two of these studies were assumed by the investigator to further show that the OR is related to recognition learning. The studies and contentions of other investigators were offered as possible evidence for the relationship of the OR to learning. Section D presented the nature of the expected relationship between Sokolov's model of the OR and a recognition memory task. Based on Sokolov's theory, it was assumed that in a recognition memory task where the target and distractors are extremely similar, OR habituation is a precondition to stimulus recognition learning.

In its null form, the hypothesis is: OR habituation is not a precondition to stimulus recognition learning and therefore the Habituation Scores from the Habituation Task and the Learning Scores from the Learning Task will not show a significant correlation.

CHAPTER II

EXPERIMENTAL DESIGN

The various aspects involved in conducting the experiment to test the hypothesis proposed in the preceding chapter are described under the following subdivisions:

A. The Subjects of the Experiment.
B. The Tools of the Experiment.
C. The Experimental Procedure.
D. The Methods Employed in Evaluating the Results of the Experiment.

A. The Subjects of the Experiment.

A total of sixty male volunteers from undergraduate classes at Seton Hall University, South Orange, New Jersey, served as subjects in the experiment. The average age of the subjects was twenty-one years eight months with a standard deviation of 2.9 years. One hundred and thirty-six additional volunteers were not used in the experiment for the following reasons: (1) they did not fall within the fifth and sixth stens on the _IPAT Anxiety Scale Questionnaire_, which was one of the requirements of being a subject in the experiment; (2) the measurement of the vasomotor components of the _OR_ was unattainable on them.

Subjects were recruited by inviting students of psychology classes to participate in an experiment that would take approximately seventy-five minutes of their time. The investigator personally went to the classes and addressed the students. The professors left the classrooms when this was being done in order that the students would not feel coerced into volunteering. The students were assured by the investigator that no noxious stimuli would be used and that their individual performance results would be kept confidential.

B. The Tools of the Experiment.

The following instruments were used in the experiment:

1. The IPAT Anxiety Scale Questionnaire.
2. A Polygraph and Two Photoelectric Plethysmograph Transducers.
3. Recognition Slides (Habituation Slides; Learning Slides).
4. Projectors; Screens; Timer; Tape Recorder; Score Sheet.

1. The IPAT Anxiety Scale Questionnaire (Self Analysis Form)[1]. -- This questionnaire scale (hereafter referred to as the IPAT) was used to measure psychometrically the anxiety level of the subjects. A copy of the IPAT is found in Appendix 1.

---

1 R. B. Cattell and I. H. Scheier, IPAT Anxiety Scale Questionnaire (Self Analysis Form), Champaign, Illinois, Institute for Personality and Ability Testing, 1963.

The test was used in this investigation as a control measure because of various studies which have essentially the same finding regarding the role of anxiety in relation to the rate of OR habituation. Jackson[2] reported that there was a significant correlation between the anxiety level as measured by the IPAT and speed of habituation. He concluded that the less anxious subjects habituated faster than the higher anxious subjects. Koepke and Pribram[3] in a similar investigation studied the relationship between anxiety level as measured by the Taylor Anxiety Scale and rate of OR habituation. They interpreted the results of their investigation as indicating that anxiety is significantly related to speed of OR habituation in that the higher the anxiety, the longer it takes for habituation of the vasoconstriction response. Because of the claimed relationship between levels of anxiety and rate of OR habituation and because the rate of OR habituation is such an important factor in the present study, the investigator accounted for different basal anxiety levels by using only

---

2 Barrie T. Jackson, Cardiovascular Responses During Habituation and Attention as Measures of Anxiety, unpublished doctoral thesis presented to the Faculty of Psychology and Education of the University of Ottawa, Ontario, 1967, v-52 p.

3 Jean E. Koepke and Karl H. Pribram, "Habituation of the Vasoconstriction Response as a Function of Stimulus Duration and Anxiety," in Journal of Comparative and Physiological Psychology, Vol. 64, No. 3, 1967, p. 502-504.

those Ss who fell within the fifth and sixth stens of the IPAT. It is maintained that this procedure provided a reasonable control for the anxiety factor.

The IPAT is administered either individually or to large groups and it is scored by using a standard key. The IPAT Handbook includes tables for the conversion of total anxiety raw scores to stens and percentiles; therefore anyone administering the IPAT could agree on the anxiety level which characterizes a given examinee.

Cohen[4] reports that reliability coefficients for the total anxiety score range from .80 to .93. He also states that evidence for the test's validity is varied and impressive. He concludes that for a quick measure of anxiety level the IPAT has no peer.

2. Polygraph and Two Photoelectric Plethysmograph Transducers. -- The vasomotor components of the OR were measured by use of the Lafayette Model D Polygraph[5] (7603-2A) together with two modified Lafayette E-4 Photoelectric Plethysmograph Transducers. These transducers are manufactured to be AC coupled. Since they have a resistor and

---

4 Jacob Cohen, "The IPAT Anxiety Scale Questionnaire", in The Sixth Mental Measurements Yearbook, O. K. Buros, Editor, Highland Park, New Jersey, Gryphon Press, 1965, p. 255-256.

5 Lafayette Instrument Company, Lafayette, Indiana.

capacitor built into the transducer which blocks low frequency variations in blood level, the resistor and capacitor were removed so that the transducer was DC coupled, thus ensuring that all variations in blood level were transmitted to the polygraph.

These transducers have a built-in light source. Variations in the volume of blood in the capillaries cause changes in light transmission which is picked up by a sensitive photoconductor. These changes produce corresponding baseline and wave amplitude changes which are recorded on the polygraph chart.

The paper drive of the polygraph was set at six inches per minute. The gain dial on the polygraph was set at two.

An event marker was used in conjunction with the polygraph and was wired to a slide projector. This was done to record on the polygraph chart exactly when the stimulus was presented to the subject and the length of time that the stimulus was shown. In this way, anyone reading the polygraph charts would know whether the baseline or wave amplitude of the subject was affected by the stimulus.

3. Recognition Slides (Habituation Slides; Learning Slides). -- The recognition slides consisted of two different types of slides: Habituation Slides and Learning Slides.

They will be described separately. The negatives of the slides were used in the experiment because it was felt that if the positives of the slides were used there would be no way of determining whether the lighted background of the slide appearing on the screen was evoking the OR or whether it was being evoked by the stimulus on the slide. When the negatives of the slides were used, only white lined figures and letters appeared on the screen. The background of the slide appearing on the screen was not lighted and thus if an OR was evoked, it could be attributed to the stimulus.

(a) Habituation Slides. -- Two Habituation Slides were used in this project: Habituation Slide A and Habituation Slide B. Each slide had on it a different incongruent animal figure. These figures were conceived and illustrated by the investigator. According to Lynn[6], incongruent figures should readily evoke an OR in adults. Different three letter nonsense syllables were printed beneath the figures in capital letters. The nonsense syllables used were randomly selected from Glaze's[7] 47%

---

6 R. Lynn, Attention, Arousal and the Orientation Reaction, Oxford, Pergamon Press, 1966 p. 12.

7 J. Arthur Glaze, "The Association Value of Non-Sense Syllables", in Journal of Genetic Psychology, Vol. 35, 1928, p. 264.

association value nonsense syllables. The nonsense syllables selected were then randomly paired with the incongruent figures. On Habituation Slide A there was a drawing of an animal which had the head of a squid and the body of a sheep. The nonsense syllable GEY appeared beneath the figure. On Habituation Slide B there was the drawing of an animal which had the head of a rooster and the body of a horse. The nonsense syllable WAZ appeared beneath this figure. Copies of these two slides are in Appendix 2.

(b) Learning Slides. -- The Learning Slides consisted of the following:

Learning Slide A which was an exact copy of Habituation Slide A; Learning Slide B which was an exact copy of Habituation Slide B.

Learning Test Slides Group A. -- This group consisted of ten slides, one of which was exactly the same as Learning Slide A. The other nine slides in the group were similar but not identical to Learning Slide A. Examples of some of the changes made include: changing one letter of the three letter nonsense syllable (i.e. GEP instead of GEY); changing one part of the incongruent figure (i.e. a flexed leg instead of a leg in an extended position).

Learning Test Slides Group B. -- This group also consisted of ten slides one of which was exactly the same as Learning Slide B. Here again the other nine slides in the group were similar but not identical to Learning Slide B (i.e. WAW instead of WAZ; an extended leg instead of a leg in a flexed position). For each slide that was changed in Learning Test Slides Group A, a similar change was made on a slide in Learning Test Slides Group B. This was done in order to insure alternate form reliability between the two groups of Learning Test Slides.

To determine the degree of reliability between Learning Test Slides Group A and Learning Test Slides Group B, the experimenter recruited twenty male undergraduate students from Seton Hall University. Ten students were first tested individually on Learning Test Slides Group A and one week later they were tested individually on Learning Test Slides Group B. The remaining ten students were first tested individually on Learning Test Slides Group B and one week later they were tested individually on Learning Test Slides Group A. The coefficient of correlation obtained was .91.

The order of showing the ten Learning Test Slides in Group A and Group B was arrived at in the following way. The ten slides in Group A were randomly numbered one to ten. Ten cards were numbered one to ten and they were dropped into a box which was then shaken. The order in which the numbers were drawn randomly from the box determined the order in which the ten slides were shown in the actual testing situation (i.e. the number four was drawn first--therefore the slide numbered four was shown first; the number two was drawn next--therefore the slide numbered two was the second slide shown, etc.). This procedure was repeated until the investigator had established twenty random orders of presentation for the ten testing slides involved. These twenty orders of presentation appear in Appendix 3.

Since each slide in Learning Test Slides Group A had a comparable slide in Learning Test Slides Group B, each slide in Group B was given the same number as its comparable slide in Group A. The same twenty orders of presentation arrived at for the ten slides in Group A were used in showing the slides in Group B.

4. Projectors; Screens; Timer; Tape Recorder; Score Sheet. --

(a) Projectors. -- Two slide projectors and two portable screens were used in the experiment. The slide projector used for the Habituation Task was an Argus 200 while the slide projector used for the Learning Task was a Kodak Carousel 800 Automatic Slide Projector. Different models were used because only one slide was shown in the Habituation Task and a carousel type projector was not needed.

The Argus slide projector was wired to the event marker of the polygraph and had a single pole, single throw, silent switch which was manually operated. This type of switch was used because it makes no noise when it is in operation and therefore it could not be responsible for evoking an <u>OR</u> in the subject. The switch was wired in such a way that at the exact time that the slide was projected on the screen, the event marker recorded this event on the polygraph chart.

(b) Timer. -- A Coxco Municator Programming Cassette Tape Recorder (Series X) was used in conjunction with the Learning Task because it works well with a Kodak Carousel Automatic Slide Projector. The programmer was set to advance slides at three second intervals and was plugged into the Kodak projector.

(c) Tape Recorder. - A Bell and Howell Tape Recorder (Model 785) was used in taping the Habituation Task and the Learning Task instructions for the subjects. These instructions appear in Appendix 4 and Appendix 5.

(d) Score Sheet for the Learning Task. -- A score sheet showing the twenty orders of presentation of the testing slides (previously discussed) was used by the experimenter. When the subject made a choice as to what he felt was the correct slide, it was recorded on this sheet. A copy is found in Appendix 3.

C. The Experimental Procedure.

The experiment was conducted in the psychology building of Seton Hall University, South Orange, New Jersey, with two laboratory rooms being used by the investigator--one for the Habituation Task and one for the Learning Task. Both rooms have automatic temperature controls (uniformly set for $72^{o} \pm 2^{o}$ Fahrenheit), acoustical ceilings, and indirect ceiling lighting. In both rooms the subject was seated in an arm chair four and one half feet away from the screen with the projector behind him and on his right side. The projected image appearing on the screen was approximately 14" by 20". In the room used for the Habituation Task, the polygraph was placed on a table which was eight feet long. The polygraph was on the right side of and just behind the subject who rested his right arm on the tabletop which was at about heart level.

The subject had two tasks to perform: the Habituation Task and the Learning Task. There were alternate forms of the Habituation Task (Habituation Task A and Habituation Task B) and of the Learning Task (Learning Task A and Learning Task B). The slide used in Habituation Task A was exactly the same as the slide used in Learning Task A. The slide used in Habituation Task B was exactly the same as the slide used in Learning Task B. The volunteers were randomly distributed into one of four groups: Habituation Task A, Habituation Task B, Learning Task A, Learning Task B. Those subjects who completed the Habituation Task first proceeded to the alternate form Learning Task (i.e. Habituation Task A subjects proceeded to Learning Task B; Habituation Task B subjects proceeded to Learning Task A). Those subjects who completed the Learning Task first proceeded to the alternate form Habituation Task (i.e. Learning Task A subjects proceeded to Habituation Task B; Learning Task B subjects proceeded to Habituation Task A). As a result, there was a counter-balancing for the two sets of slides and the task performance. Each subject had two scores--a Habituation Score which indicated when he habituated to the stimulus and a Learning Score which indicated when he learned the stimulus.

Assignment of Volunteers into Groups. -- Separate cards each having the name of one of the 196 volunteers were prepared and dropped into a box. The numbers one through 196 were printed on separate cards which were then dropped into a second box. After the boxes were shaken, a volunteer drew a name from the first box and a number from the second box. The name with its corresponding number was recorded and the cards were set aside with this procedure continuing until each volunteer was assigned a number.

The cards with the numbers one through 196 were again dropped into a box and shaken. The following list was used in distributing the volunteers:

a. Habituation Task A Subjects.
b. Habituation Task B Subjects.
c. Learning Task A Subjects.
d. Learning Task B Subjects.
e. Habituation Task A Subjects, etc.

The first number drawn from the box was assigned as a Habituation Task A volunteer; the second number was assigned as a Habituation Task B volunteer; the third number was assigned as a Learning Task A volunteer; the fourth number was assigned as a Learning Task B volunteer; the fifth number was assigned as a Habituation Task A volunteer. This sequence was used over and over again until all 196 volunteers were placed in a task. As a result of this random distribution, there were forty-nine volunteers assigned to each task.

Procedure Used in the Habituation Task. -- The experimenter first worked with the Habituation Task A volunteers. When the volunteer arrived he was given the IPAT which was immediately scored by the investigator. The raw score was converted into a sten score. If the volunteer's score did not lie in the fifth or sixth sten, he was ruled out as a subject. If his score did lie in the fifth or sixth sten, the investigator proceeded to give him Habituation Task A. This consisted in doing the following: The tape recorded instructions (a copy of which is found in Appendix 4) were played back. The Photoelectric Plethysmograph Transducers were attached to the volunteer--one on the distal volar pad of his right middle finger and the other on the medial line of the forehead. A black cloth sleeve was fitted over the volunteer's right middle finger and a black cloth cap was loosely fitted over his forehead and head. This was done to prevent any outside light from interfering with the recordings.

Once the volunteer's cephalic and digital vasomotor baseline recordings were established on the polygraph chart, the experimenter presented the stimulus, Habituation Slide A, for a duration of three seconds. There was a thirty second interval between each showing of the slide which was shown a total of twenty-five times in this manner. The experimenter did not stop showing the slide after he felt that the subject had habituated. Another judge would read the charts and to stop at such an arbitrary point might influence the second judge's readings.

If the subject failed to evoke an OR during these twenty-five presentations, he was ruled out as a subject. If, however, he did evoke an OR during the twenty-five presentations, the experimenter proceeded to give him Learning Task B in the room set up for that part of the experiment.

The exact procedure described above was used for the volunteers who had been assigned to Habituation Task B with the following exceptions: (a) Habituation Slide B was used instead of Habituation Slide A; (b) if the volunteer showed an OR, he then proceeded to Learning Task A.

Procedure Used in the Learning Tasks. -- In Learning Task B the subjects were given tape recorded instructions which are to be found in Appendix 5. Learning Slide B was shown first to the subject for three seconds. A blank negative slide was then shown for three seconds to separate the slide to be learned from the testing group slides. Each slide in the testing group was presented for three seconds according to the orders of presentation established earlier and shown in Appendix 3. As these slides were presented to the subject, the investigator checked off the numbers on the score sheet. When the subject made his selection, the investigator recorded whether the subject was correct or not. A blank negative slide was then presented to separate the testing slides from the learning slide and also to warn the subject that the learning slide would be shown next. This procedure continued until the subject chose the correct slide three consecutive times. The same procedure was used for Learning Task A with the exception that Learning Test Slides Group A were used.

The volunteers who had first been assigned to Learning Task A followed the exact procedure as stated above for Learning Task A and then proceeded to Habituation Task B. The volunteers who had been assigned to Learning Task B followed the same procedure with the exception that these subjects then proceeded to Habituation Task A.

D. The Methods Employed in Evaluating the Results of the Experiment.

The methods employed by the investigator in evaluating the Habituation Task Results, the Learning Task Results, and testing the null hypothesis are presented in this section.

An interjudge reliability test was used to verify the investigator's interpretation of the polygraph charts which were recorded during the Habituation Task. First the investigator read the polygraph charts which were obtained in the Habituation Task. The experimenter recorded the readings for each subject on a separate sheet. The polygraph charts were then given to the judge who had been instructed by the investigator as to the criteria to use in reading these charts. To insure that the judge understood the application of these criteria, the experimenter worked with the judge in reading two of the charts. The judge was instructed to record his readings for each of the subjects in a manner similar to that used by the experimenter. The degree of relationship between the investigator's readings of the polygraph charts and the judge's readings of these charts was arrived at by calculation of the Pearson coefficient of correlation by use of the following formula[8]:

$$r_{XY} = \frac{N\Sigma x'y' - \Sigma x' \Sigma y'}{\sqrt{N\Sigma x'^2 - (\Sigma x')^2}\sqrt{N\Sigma y'^2 - (\Sigma y')^2}}$$

In reading the polygraph charts both the investigator and the judge employed the following criteria. The Habituation Score was defined as the total number of trials which were necessary to reach habituation from the onset of the first stimulus. Habituation of the OR was defined as three consecutive failures on the part of the subject to evoke an OR to the Habituation Slide. An OR was defined as the simultaneous, cephalic vasodilation and digital vasoconstriction within the intertrial interval (30 seconds from the onset of one stimulus to the onset of the next stimulus). Vasodilation was defined as the downward movement of the baseline at least 0.1 inch. Vasoconstriction was defined as the upward movement of the baseline at least 0.1 inch. The Startle Defensive Reaction was defined as simultaneous vasoconstriction of both the cephalic and digital blood vessels. The Adaptive Reaction was defined as simultaneous vasodilation of both the

---

8 Lawrence T. Dayhaw, Manuel de Statistique, Ottawa, Canada, Editions de l'Universite d'Ottawa, 1963, p. 126.

cephalic and digital blood vessels. As previously mentioned, learning was defined as the correct choice of the slide by the subject three consecutive times. The Learning Score was defined as the total number of trials which were necessary to reach this criterion.

Before determining the degree of relationship between the Learning Score and the Habituation Score, justification for collapsing the data across the counterbalanced orders was made based on homogeneity as demonstrated by the following t-test of means[9] and F-test of variance[10]:

$$t = \frac{M_1 - M_2}{\sqrt{\left(\frac{\sum x_1^2 + \sum x_2^2}{N_1 + N_2 - 2}\right)\left(\frac{N_1 + N_2}{N_1 N_2}\right)}} \quad \text{with } N_1 + N_2 - 2 \text{ d/f.}$$

$$F = \frac{\text{larger variance}}{\text{smaller variance}}$$

It was hypothesized that no significant difference in means or in variances existed between those subjects who were first given the Learning Task as compared to those subjects who were first given the Habituation Task. The criterion tested for in both of these groups was learning and habituation.

---

9 J. P. Guilford, Fundamental Statistics in Psychology and Education, New York, McGraw-Hill, 1956, p. 220.

10 Ibid., p. 224.

To further justify the combination of groups the investigator determined whether a significant difference in correlations existed between the same two groups described in the preceding paragraph by use of the Fisher's Z Transformation[11] which is as follows:

$$SD_z = \sqrt{S_{z_1}{}^2 + S_{z_2}{}^2}$$

$$SD_z = \sqrt{\left(\frac{1}{\sqrt{N_1 - 3}}\right)^2 + \left(\frac{1}{\sqrt{N_2 - 3}}\right)^2}$$

$$\tilde{Z} = \frac{Z_1 - Z_2}{SD_z}$$

It was hypothesized that there would be no significant difference between these two correlation coefficients.

The degree of relationship between the Habituation Score and the Learning Score was arrived at by calculation of the Pearson coefficient of correlation by use of the

---

11 N. M. Downie and R. W. Heath, Basic Statistical Methods, New York, Harper & Row, 1959, p. 145.

following formula[12]:

$$r_{XY} = \frac{N \sum x'y' - \sum x' \sum y'}{\sqrt{N \sum x'^2 - (\sum x')^2}\ \sqrt{N \sum y'^2 - (\sum y')^2}}$$

The significance of the obtained coefficient of correlation between the Habituation Score and the Learning Score was assessed by use of the following test[13]:

$$F_r = \frac{r^2_{XY}}{(1 - r^2_{XY}) / (N - 2)}$$ with N-2 degrees of freedom.

The F_r assesses the significance of a coefficient of correlation between two variables when it is hypothesized that a zero relationship exists between the variables as stated in the null hypothesis. Significance was sought at the 5% level.

In order that the coefficient of correlation be valid, it is necessary that all zero order coefficients be computed from data in which the regression is linear. In order to avoid any doubts as to linearity, the investigator

---

12 Dayhaw, loc. cit.

13 Lawrence T. Dayhaw, The Dayhaw Correlation Chart, Ottawa, Canada, University of Ottawa Press, 1956.

employed the following formulae in testing for linearity[14].

$$\eta^2_{YX} = \frac{N\,(A) - (\Sigma\, y')^2}{N\,\Sigma\, y'^2 - (\Sigma\, y')^2}$$

$$F_{\eta_{yx}} = \frac{\eta^2_{YX} \,/\, (k_x - 1)}{(1 - \eta^2_{YX}) \,/\, (N - k_x)}$$

$$F_{(Lin)} = \frac{(\eta^2_{YX} - r^2_{XY}) \,/\, (k_x - 2)}{(1 - \eta^2_{YX}) \,/\, (N - k_x)}$$

Summarizing statistics were also computed. These included calculation of various means, standard deviations, and correlations of the groups involved in the study. They appear in Table II of Appendix 6.

The purpose of this chapter has been to describe the subjects, the tools, the experimental procedure, and the methods employed in evaluating the results of the experiment. In the chapter that follows the investigator will present the results of the experiment and discuss these findings.

---

14 Dayhaw, The Dayhaw Correlation Chart, op. cit.

CHAPTER III

PRESENTATION AND DISCUSSION OF RESULTS

This chapter includes the presentation and discussion of the results of this experiment. In interpreting the results, the investigator has attempted to put forth the implications of the findings and to offer possible areas for future research.

A. Presentation of Results.

In this section the null hypothesis as presented in Chapter One is repeated and the statistical results obtained from the investigation are set forth.

As the investigator mentioned in Chapter Two, a verification was made of his interpretation of the polygraph charts by having a judge reread and score these charts. A Pearson coefficient of correlation between the investigator's scores and the judge's scores was calculated; it was found to be .96.

As indicated in Chapter Two, the combination of the groups was justified on the basis of homogeneity shown by a t-test of means and an F-test of variance. Hypothesizing that no difference in means or in variances existed, this null hypothesis was accepted on the basis of the table which appears on the following page.

	N	Means L-H	Means H-L	t	p(t)	Sig.	F	p(F)	Sig.
Learning	30	13.40	12.70	0.499	>.10	Not Sig.	1.099	>.05	Not sig.
Habituation	30	14.76	14.56	0.129	>.10	Not Sig.	1.459	>.05	Not Sig.

In further justifying the combination of groups Fisher's Z Transformation yielded a result of 0.188. Since this was less than 1.96 (required in order to have significance >.05), it was not significant and therefore the hypothesis that there would be no significant difference between the two correlation coefficents was accepted.

In the null form the hypothesis states that OR habituation is not a precondition to stimulus recognition learning and therefore the Habituation Scores from the Habituation Task and the Learning Scores from the Learning Task will not show a significant correlation.

In order to test this hypothesis the Pearson product-moment coefficient of correlation was calculated between the scores obtained in the OR Habituation Task and the scores obtained in the Learning Task. It was found to be .493.

The F_r test yielded a value of 18.6 which is significant beyond the .001 level of probability.

The results of the tests for linearity were as follows:

$$\eta^2_{YX} = 0.662$$

$$F_{\eta_{yx}} = 3.98 \quad (P = .001)$$

$$F_{(Lin)} = 1.96$$

Since the calculated value of $F_{(Lin)}$ (1.96) was less than the table value, linearity existed. Therefore it was possible to use the Pearson coefficient of correlation.

As the investigator mentioned in the previous chapter, a number of summarizing statistics were computed for each separate group, the combined groups, and the total group. These statistics appear in Appendix 6 (Table II). While each separate group showed a moderate correlation, only two were significant at the 0.05 level. Both combined groups showed a significant correlation.

In view of these statistical findings, the null hypothesis of this study must be rejected. It appears reasonable to conclude therefore that OR habituation seems to be a precondition to stimulus recognition learning in the manner described by Sokolov.

B. Discussion of Results.

The correlation coefficient of 0.49 obtained between the Learning Scores and the Habituation Scores, while indicating a moderate degree of relationship, was not as high as one might have anticipated by virtue of the theoretical premise upon which the experiment was based. A clue to the variation between the assumed and the actual degree of correlation may be found in the immediate feedback brought into play during the Learning Task. A similar occurrence was impossible during the Habituation Task by the very nature of the operation. It was noted during the Learning Task that a subject might select the wrong slide three consecutive times. However, cognizant of prior instructions given, the subject came to the realization that the continuation of the task beyond this point was indicative of an error in selection. Other clues were thus sought in an effort to identify the correct slide. In contrast, a slide was presented twenty-five times during the Habituation Task. Once the subject had orientated to it, the assumption was made that he had learned it. There was no feedback to use as a check.

In endeavoring to interpret the results of the experiment as they pertain to the relationship between

Habituation Scores and Learning Scores and in extending these results beyond conditioning to a learning process involving visual recognition and a certain amount of immediate memory, one finds herein a defense of the Sokolovian model. A recapitulation of this model demonstrates that novel stimuli arrive at the cortex via the specific pathways from the sense organs. It is in the cortex that the properties of the stimulus are analyzed and compared to a pre-existing model. If the properties of the incoming stimulus cannot be matched to a pre-existing neuronal model, the cortex will send excitatory impulses down to the reticular formation to activate it. This activation of the reticular formation brings about the central and autonomic components of the OR. Habituation to the novel stimulus occurs only when a neuronal model of the stimulus item has been established in the cortex. In Sokolov's own words -- "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."[1]

---

1 Eugene Nikolaievich Sokolov, "Neuronal Models and the Orienting Reflex", in M. A. Brazier (Editor), The Central Nervous System and Behavior, New York, J. Moon, 1960, p. 205.

The Russians have taken the view that OR habituation is a prerequisite to conditioning. Several studies confirm this position.[2,3,4] The present investigation appears to extend this assumption one step beyond conditioning and sees OR habituation as a prerequisite to a cognitive function -- a learning function, which in the present study consisted of a stimulus recognition learning task.

There are however other alternative interpretations of these findings that should be considered. For example, Quirion[5] concluded that subjects scoring high on the Extraversion Scale of the *Eysenck Personality Inventory* required

---

2 P. K. Anokhin, "The Role of the Orienting Exploratory Reaction in the Formation of the Conditioned Reflex", in L. G. Voronin *et al.* (Editors), *Orienting Reflex and Exploratory Behavior*, Washington, American Institute of Biological Sciences, 1965, p. 3-16.

3 O. S. Vinogradova, "On the Dynamics of the Orienting Reflex in the Course of a Conditioned Connection", in L. G. Voronin *et al.* (Editors), *Orienting Reflex and Exploratory Behavior*, Washington, American Institute of Biological Sciences, 1965, p. 52.

4 E. I. Lebedinskaya, "Interaction of a Conditioned Reflex and a Conditioned Motor Reflex During the Development of a Temporary Connection Between Two Neutral Stimuli", in L. G. Voronin *et al.* (Editors), *Orienting Reflex and Exploratory Behavior*, Washington, American Institute of Biological Sciences, 1965, p. 111.

5 Norman F. Quirion, *Extraversion, Neuroticism and Habituation of the Orienting Reaction*, unpublished doctoral thesis presented to the Faculty of Psychology of the University of Ottawa, Ontario, 1970, p. 51.

a greater number of stimulus repetitions for OR habituation to occur than subjects with low scores on the Extraversion Scale. The significant correlation that was obtained in the present study might have occurred due to the fact that a great many of the subjects participating in the present experiment were introverts and good memorizers or extraverts and poor memorizers.

Another view that should be considered is that the finding obtained in the present study seems to apply only to a recognition task in which the target and distractors are very similar. As the investigator mentioned earlier, part-recognition may be used by the subjects if the targets and distractors are not very similar. In part-recognition a complete neuronal model of the item does not seem necessary and thus habituation of the OR is not an essential pre-condition.

An interesting study for future investigation which seems to follow from the finding of the present study would be to determine if and how much of the neuronal model can be recalled. The investigator found no studies in the literature which dealt with the recall of the neuronal model. It is assumed by the investigator that recognition and recall are two separate processes. Kintsch seems to support this assumption when he visualizes recognition as being "...a matter of checking the familiarity or response strength of an item, but that recall involves an additional process of search, or retrieval."[6]

This approach to the learning process may provide future investigators with a tool by which they can tap the amount of modeling that has gone on in a person's frame of experience. This may be possible even with children. With this physiological prognostigator one could estimate the amount of experential enrichment in an individual. For example, in an experiment one could dichotomize children empirically as impoverished children versus enriched children. The investigator could then select a number of stimuli common to the culture which would provide an instrument of measurement by which he could predict that children brought up in high or upper middle class homes with a wide variety of experiences and stimulus complexities would habituate more readily to such stimuli. Conversely, deprived children by virtue of the impoverishment in neuronal models would take much longer to habituate.

---

6 W. Kintsch, "Models for Free Recall and Recognition", in D. A. Norman (Editor), Models of Human Memory, New York, Academic, 1970 p. 333.

In hypothesizing still further on the implications of the present investigation, one might consider the field of programmed learning. Something akin to a memory drum or programmed instruction could be used. Generally, these programs repeat themselves until the individual responds behaviorly in the correct fashion. The individual then goes on to further steps. The present investigation might be extended to programmed learning in the following manner. An individual would be hooked up with a computed assisted program and would be subjected to a continuing barrage of repetitive material from the program until such time as the OR is no longer elicited. In other words, the program would be run primarily on the basis of the individual's physiological responses rather than the physical selection of a correct response. The implications are enormous when extended to the concept of testing the handicapped who are unable to respond physically or the very young who find it difficult to follow specific instructions.

Still another area of future research that might be touched upon in the field of learning would be to determine on the basis of OR habituation to what extent an individual can actually recall material that has presumably been learned. This investigation was concerned with recognition learning which is but one facet in the total field of learning. It is not known how long the retention of recognition learning endures in time. It may be presumed that if this type of learning went solely into immediate memory and were not encoded into long term memory, there would shortly be a reinstatement of the ORs for materials to which the individual had previously habituated. Research of this type may provide a new approach in determining what is encoded into permanent memory as opposed to what is encoded into transitory or immediate memory.

Somewhat related to the above are the ideas of proactive versus retroactive inhibition -- particularly as regards the paired association sort of experiment. One may speculate in the following manner. If an individual has learned to associate a particular stimulus with a specific response and has done so for a series of them, what would happen if one altered the situation by varying the linkages between the various stimuli and responses? From established learning theories it would appear that relearning the series at this particular point in time would be fraught with difficulties because one would have to contend with all kinds of interferences from previously established associations. If one were to present them in pairs, would the OR now reappear and would the time required for habituation be extended? It would seem that research of this nature might provide further evidence of the relationship between the OR and learning because now the elements would not have novelty but the linkage would.

OR habituation may even be extended beyond simple learning into cognitive development. Jeffrey theorizes as follows:

> Certain changes in stimulation produce a pattern of physiological responses (orienting reflex) that is presumed to sharpen perception, i.e., focus attention on that cue or subset of cues that is most salient. When the orienting reflex habituates to a particular cue of a complex stimulus, a 2nd and previously less salient cue may now elicit an orienting reflex and attention will then become selective for that cue. Given certain conditions, serial habituation of the orienting reflex to several cues of a stimulus complex will produce a chain of attending responses. With repeated presentation of the stimulus complex, this chain will become a single well-integrated mediating event (schema) that may be used to explain higher-level problem-solving behavior.[7]

The writer is not familiar with any studies that have dealt with estimating the stability of a belief or an attitude. For example, if one were to ask an individual if he believed in God, he might respond positively or negatively. It would seem that there is no way of estimating the objective value of the statement. One can estimate the stability

---

7 W. E. Jeffrey, "The Orienting Reflex and Attention in Cognitive Development", in Psychological Review, Vol. 75, No. 4, 1968, p. 323-334.

of the response which is different from the objective validity of the belief or attitude. With the OR, for example, if an investigator were to show a subject stimuli with content in relation to very obtuse things (i.e. belief in the afterlife), he might be afforded, via habituation or non-habituation, a more direct instrument of measurement to determine whether or not an individual has modeled his beliefs in a stable, ongoing fashion or whether there still exists a problem which needs to be resolved.

The question arises in the mind of the investigator as to why so many subjects have to be rejected because of their failure to elicit an OR. Perhaps a fruitful area of research might be to compare non OR producers to OR producers in the area of learning. It seems reasonable to assume that learning must be going on despite the absence of ORs.

The area of the OR abounds in many other topics for further investigation such as studying it in relation to the following: hemisphere dominance; hemispheric lesions; and intelligence.

It is the hope of the investigator that the present study will provide some modicum of information aiding future researchers to understand the complexities of the orientation reaction and its implications in the learning process.

SUMMARY AND CONCLUSIONS

This study was designed to investigate the relationship between habituation of the orientation reaction (OR) and stimulus recognition learning.

The hypothesis tested stated that OR habituation is not a precondition to stimulus recognition learning and therefore the Habituation Scores from the Habituation Task and the Learning Scores from the Learning Task would not show a significant correlation.

Sixty male volunteers from undergraduate classes at Seton Hall University, South Orange, New Jersey, served as subjects. Their average age was twenty-one years and eight months and they had scored in the fifth or sixth sten of the IPAT Anxiety Scale Questionnaire.

The experimental design consisted of two tasks which were given in counterbalanced order. The stimulus item used in both the Habituation Task and the Learning Task was a drawing of an incongruent animal paired with a three letter nonsense syllable of 47% Glaze association value. In both tasks the subjects were instructed to learn the details of the figure and pair this figure with the nonsense syllable presented with it. In the Habituation Task, Photoelectric Plethysmograph Transducers were attached to the subject and to the polygraph in order that the vasomotor components of the OR could be recorded.

The Pearson coefficient of correlation between the scores of the Learning Task and the scores of the Habituation Task was 0.493. The null hypothesis was rejected because the F_r test applied to the data demonstrated that the relationship was statistically significant.

The result of this study was interpreted as supporting Sokolov's model -- habituation of the OR seems to be a pre-condition to the establishment of a neuronal model. It was concluded that the area of the orientation reaction abounds with topics for future research and a number of possible projects in the areas of education and psychology were suggested.

BIBLIOGRAPHY

Belloni, Marigold L., The Relationship of the Orienting Reaction and Manifest Anxiety to Paired-Associates Learning, unpublished doctoral thesis presented to the University of California, Los Angeles, 1964, ii-137 p.

This was an important study for its contributions to the theoretical framework of the present study. It reported the significant finding that High OR Ss more rapidly and accurately discriminate stimuli than do Low OR Ss in paired associate learning.

Berlyne, D. E., Conflict, Arousal, and Curiosity, New York, McGraw-Hill, 1960, vii-350 p.

This book contains a valuable section on many aspects of the orientation reaction. It was this work that helped in the present study to differentiate the orientation reaction from the defensive reaction based on the vasomotor components.

Bernbach, H. A., "Stimulus Learning and Recognition in Paired-Associate Learning", in Journal of Experimental Psychology, Vol. 75, 1967, p. 513-519.

The results of this study showed that stimulus recognition learning is prerequisite to association learning. This finding was significant to the present study.

Jackson, Barrie T., Cardiovascular Responses During Habituation and Attention as Measures of Anxiety, unpublished doctoral thesis presented to the Faculty of Psychology, University of Ottawa, Ontario, 1967, v-52 p.

This doctoral thesis reported a significant correlation between rate of habituation and quantified levels of anxiety. This finding was used in the experimental design as a control measure. This thesis was also used as a reference on the nature and properties of the orientation reaction.

Kintsch, Walter, "Habituation of the GSR Component of the Orienting Reflex during Paired-Associate Learning before and after Learning Has Taken Place", in Journal of Mathematical Psychology, Vol. 2, 1965, p. 330-341.

The findings of this study were important in supporting one of the assumptions used in the theoretical framework of the present project. It gives support to Sokolov's model of the orientation reaction.

Lynn, R., Attention, Arousal and the Orientation Reaction, Oxford, Pergamon Press, 1966, viii-115 p.

This book offers one of the few English attempts at reviewing the literature of the orientation reaction. All areas of this reaction are covered along with a number of theories for this phenomenon and its habituation.

Maltzman, Irving and David C. Raskin, "Effects of Individual Differences in the Orienting Reflex on Conditioning and Complex Processes", in Journal of Experimental Research in Personality, Vol. 1, 1965, p. 1-16.

This article summarized and reviewed several studies which supported the assumption that the orientation reaction is related to learning. The conclusions of this review were incorporated into the theoretical framework of the present study.

Martin, E., "Relation Between Stimulus Recognition and Paired-Associate Learning", in Journal of Experimental Psychology, Vol. 74, 1967, p. 500-505.

The finding of this investigation indicated that associated responses are contingent upon stimulus recognition, but that stimulus recognition does not depend upon the existence of associated responses. This study was used in the present project to show a relationship between the orientation reaction and recognition learning.

Nies, Richard, Orienting Response and Drive as Distinguishable Concepts in Learning Performance, unpublished doctoral dissertation presented to the University of California, Los Angeles, 1964, v-82 p.

This doctoral thesis reported the significant finding that large orientation reaction subjects were superior to small orientation reaction subjects in all phases of paired associate performance. This finding was used in support of some of the assumptions that were made in the present project.

Quirion, Norman F., Extraversion, Neuroticism and Habituation of the Orienting Reaction, unpublished doctoral thesis presented to the Faculty of Psychology, University of Ottawa, Ontario, 1970, vii-76 p.

This doctoral thesis was consulted frequently as a basic reference on the nature and properties of the orientation reaction. It is this reference that was used in the present study in defining vasodilation, vasoconstriction, and habituation.

Razran, G., "The Observable Unconscious and the Inferable Conscious in Current Soviet Psychophysiology: Interoceptive Conditioning, Semantic Conditioning, and the Orienting Reflex", in Psychological Review, Vol. 68, 1961, p. 109-119.

The references for this brief review of the orientation reaction are almost exclusively Russian. This article defined the orientation reaction in such a way as to distinguish it from other autonomic responses.

Sokolov, Eugene Nikolaievich, "Neuronal Models and the Orienting Reflex", in M. A. Brazier, (Editor), The Central Nervous System and Behavior, New York, J. Moon, 1960, p. 187-276.

This was the most frequently consulted source for the present study. It presents the "neuronal model" which was used in explaining the nature and properties of the orientation reaction.

--------, "Higher Nervous Functions: The Orienting Reflex", in Annual Review of Physiology, Vol. 25, 1963, p. 545-580.

Sokolov presents a detailed neurophysiological presentation of the orientation reaction. The article deals mainly with the central components of the orientation reaction.

--------, Perception and the Conditioned Reflex, New York, Macmillan, 1963, v-309 p.

The central theme of this book is the reflex mechanisms which provide feedback in perception. These reflex mechanisms, of which the orienting reaction is an important part, are treated under both signal and non-signal modes of operation.

--------, "The Modeling Properties of the Nervous System", in Michael Cole and Irving Maltzman (Editors), A Handbook of Contemporary Soviet Psychology, New York, Basic Books, p. 671-704.

This article deals with the various modeling properties of the nervous system. It presents supporting evidence for Sokolov's theory of the orientation reaction. This article was consulted frequently as a basic reference on the nature and properties of the orientation reaction.

APPENDIX 1

THE IPAT ANXIETY SCALE QUESTIONNAIRE (SELF ANALYSIS FORM)

SELF ANALYSIS FORM

NAME ____ TODAY'S DATE ____________________
First Middle Last

SEX ____________ AGE ____________ OTHER FACTS ____________________________________
(Write M or F) (Nearest Year) (Address, Occupation, etc., as instructed)

CONFIDENTIAL

Inside this booklet you will find forty questions, dealing with difficulties that most people experience at one time or another. It will help a lot in self-understanding if you check Yes, No, etc., to each, frankly and truthfully, to describe any problems you may have.

Start with the two simple examples just below, for practice. As you see, each inquiry is actually put in the form of a sentence. By putting a cross, X, in *one* of the three boxes on the right you show how it applies to you. Make your marks now.

	Yes	Occasionally	No
1. I enjoy walking	☐	☐	☐

A middle box is provided for when you cannot definitely say Yes or No. But use it as little as possible.

	A	In between	B
2. I would rather spend an evening: (A) talking to people, (B) at a movie	☐	☐	☐

About half the items inside end in A and B choices like this. B is always on the right. Remember, use the "In between" or "Uncertain" box only if you cannot possibly decide on A or B.

Now:

1. Make sure you have put your name, and whatever else the examiner asks, in the place at the top of this page.
2. Never pass over an item but give some answer to every single one. Your answers will be entirely confidential.
3. Do not spend time pondering. Answer each immediately, the way you want to at this moment (not last week, or usually). You may have answered questions like this before; but answer them as you feel *now*.

Most people finish in five minutes; some, in ten. Hand in this form as soon as you are through with it, unless told to do otherwise. As soon as the examiner signals or tells you to, turn the page and begin.

STOP HERE—WAIT FOR SIGNAL

 Printed in U. S. A. Published by the Institute for Personality and Ability Testing, 1602-04 Coronado Drive, Champaign, Illinois.

An-tb-7AA

1957-63 EDITION

A

Do not write in this column

1.	I find that my interests, in people and amusements, tend to change fairly rapidly	True ☐	In between ☐	False ☐
2.	If people think poorly of me I can still go on quite serenely in my own mind	True ☐	In between ☐	False ☐
3.	I like to wait till I am sure that what I am saying is correct, before I put forward an argument	Yes ☐	In between ☐	No ☐
4.	I am inclined to let my actions get swayed by feelings of jealousy	Sometimes ☐	Seldom ☐	Never ☐
5.	If I had my life to live over again I would: (A) plan very differently, (B) want it the same	A ☐	In between ☐	B ☐
6.	I admire my parents in all important matters	Yes ☐	In between ☐	No ☐
7.	I find it hard to "take 'no' for an answer", even when I know what I ask is impossible	True ☐	In between ☐	False ☐
8.	I doubt the honesty of people who are more friendly than I would naturally expect them to be	True ☐	In between ☐	False ☐
9.	In demanding and enforcing obedience my parents (or guardians) were: (A) always very reasonable, (B) often unreasonable	A ☐	In between ☐	B ☐
10.	I need my friends more than they seem to need me	Rarely ☐	Sometimes ☐	Often ☐
11.	I feel sure that I could "pull myself together" to deal with an emergency	Always ☐	Often ☐	Seldom ☐
12.	As a child I was afraid of the dark	Often ☐	Sometimes ☐	Never ☐
13.	People sometimes tell me that I show my excitement in voice and manner too obviously	Yes ☐	Uncertain ☐	No ☐
14.	If people take advantage of my friendliness I: (A) soon forget and forgive, (B) resent it and hold it against them	A ☐	In between ☐	B ☐
15.	I find myself upset rather than helped by the kind of personal criticism that many people make	Often ☐	Occasionally ☐	Never ☐
16.	Often I get angry with people too quickly	True ☐	In between ☐	False ☐
17.	I feel restless as if I want something but do not know what	Very rarely ☐	Sometimes ☐	Often ☐
18.	I sometimes doubt whether people I am talking to are really interested in what I am saying	True ☐	In between ☐	False ☐
19.	I have always been free from any vague feelings of ill-health, such as obscure pains, digestive upsets, awareness of heart action, etc.	True ☐	Uncertain ☐	False ☐
20.	In discussion with some people, I get so annoyed that I can hardly trust myself to speak	Sometimes ☐	Rarely ☐	Never ☐

CONTINUE ON NEXT PAGE.

A Score

B

Do not write in this column

21. Through getting tense I use up more energy than most people in getting things done	True ☐	Uncertain ☐	False ☐
22. I make a point of not being absent-minded or forgetful of details	True ☐	Uncertain ☐	False ☐
23. However difficult and unpleasant the obstacles, I always stick to my original intentions	Yes ☐	In between ☐	No ☐
24. I tend to get over-excited and "rattled" in upsetting situations	Yes ☐	In between ☐	No ☐
25. I occasionally have vivid dreams that disturb my sleep	Yes ☐	In between ☐	No ☐
26. I always have enough energy when faced with difficulties	Yes ☐	In between ☐	No ☐
27. I sometimes feel compelled to count things for no particular purpose	True ☐	Uncertain ☐	False ☐
28. Most people are a little queer mentally, though they do not like to admit it	True ☐	Uncertain ☐	False ☐
29. If I make an awkward social mistake I can soon forget it	Yes ☐	In between ☐	No ☐
30. I feel grouchy and just do not want to see people: (A) occasionally, (B) rather often	A ☐	In between ☐	B ☐
31. I am brought almost to tears by having things go wrong	Never ☐	Very rarely ☐	Sometimes ☐
32. In the midst of social groups I am nevertheless sometimes overcome by feelings of loneliness and worthlessness	Yes ☐	In between ☐	No ☐
33. I wake in the night and, through worry, have some difficulty in sleeping again	Often ☐	Sometimes ☐	Never ☐
34. My spirits generally stay high no matter how many troubles I meet	Yes ☐	In between ☐	No ☐
35. I sometimes get feelings of guilt or remorse over quite small matters	Yes ☐	In between ☐	No ☐
36. My nerves get on edge so that certain sounds, e.g., a screechy hinge, are unbearable and give me the shivers	Often ☐	Sometimes ☐	Never ☐
37. If something badly upsets me I generally calm down again quite quickly	True ☐	Uncertain ☐	False ☐
38. I tend to tremble or perspire when I think of a difficult task ahead	Yes ☐	In between ☐	No ☐
39. I usually fall asleep quickly, in a few minutes, when I go to bed	Yes ☐	In between ☐	No ☐
40. I sometimes get in a state of tension or turmoil as I think over my recent concerns and interests	True ☐	Uncertain ☐	False ☐

STOP HERE. BE SURE YOU HAVE ANSWERED EVERY QUESTION.

B Score

Name________ Sex____ Age____ Date______ Examiner______

Raw Scores:	A Score (Covert, indir.)______ (p. 2 score) B Score (Overt, manifest, sympt.)______ (p. 3 score). $Q_3(-)$____, C(−)____, L ____, O____, Q_4____. Overt-Covert Ratio $\left(\frac{B}{A}\right)$ ____.	**TOTAL RAW SCORE** ____ (A + B)
Stens:	$Q_3(-)$____, C(−)____, L ____, O____, Q_4____.	**TOTAL, STANDARD STEN SCORE** ____ (from Table 4)

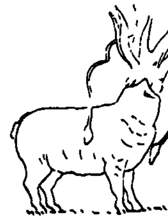
Qualitative Observations:

Diagnostic Summary:

APPENDIX 2

HABITUATION SLIDES AND LEARNING SLIDES

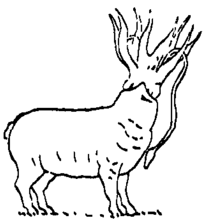
APPENDIX 2



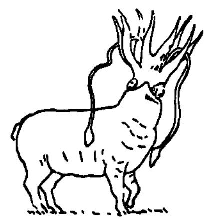
GEY

HABITUATION SLIDE A
LEARNING SLIDE A

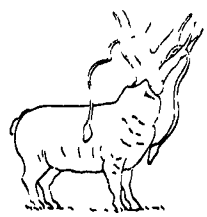
LEARNING TEST SLIDES GROUP A:



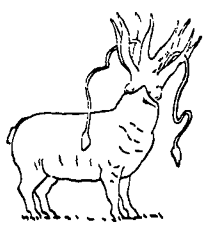
GEY



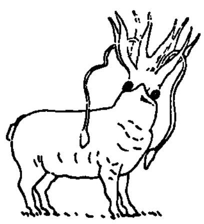
GEY



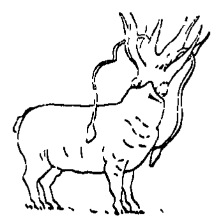
CEY



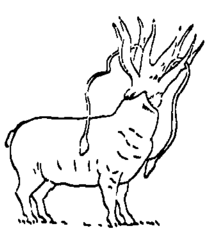
GEY



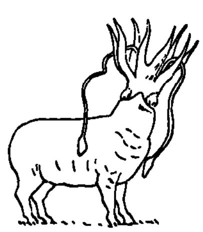
GEY



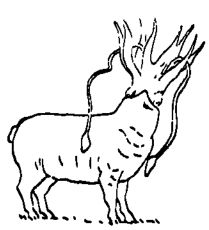
GEK

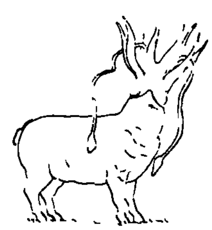


GEP

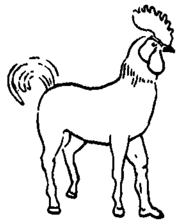


GEY





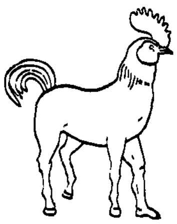
GEY



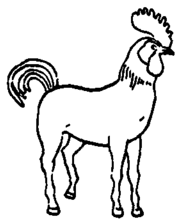
WAZ

HABITUATION SLIDE B
LEARNING SLIDE B

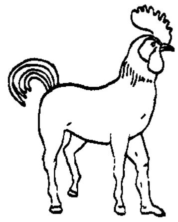
LEARNING TEST SLIDES GROUP B:



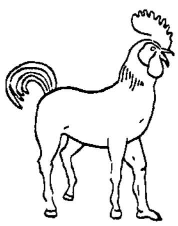
WAZ



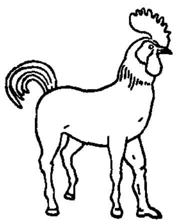
WAZ



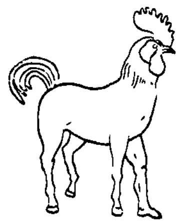
WAW



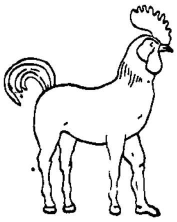
WAZ



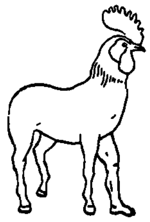
WOZ.



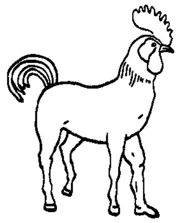
WUZ

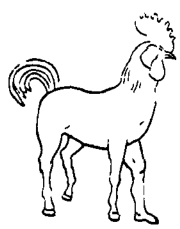


WAZ



WAZ





WAZ

APPENDIX 3

SCORE SHEETS FOR THE LEARNING TASK

APPENDIX 3

SUBJECT ____________
NUMBER

LEARNING GROUP A SCORE ____
GEY 1ST ____ 2nd ____
ORDERS OF PRESENTATIONS

HABITUATION GROUP B
WAZ 1ST ____ 2nd ____
SCORE ____

											LEARNED YES	NO
I	4	2	10	8	7	5	3	1	6	9		
II	3	6	10	8	1	2	7	5	4	9		
III	7	4	6	9	8	3	5	10	2	1		
IV	8	10	7	6	3	1	4	5	9	2		
V	8	7	4	3	10	9	6	2	1	5		
VI	5	4	10	1	6	7	3	2	9	8		
VII	5	4	6	7	1	2	10	8	9	3		
VIII	1	7	8	5	3	2	6	10	9	4		
IX	6	7	3	2	5	9	1	8	4	10		
X	6	8	9	10	2	1	7	5	3	4		
XI	4	6	1	5	2	3	8	9	10	7		
XII	1	7	5	8	4	10	3	2	9	6		
XIII	8	5	3	7	1	2	6	4	9	10		
XIV	7	1	4	6	9	2	10	3	5	8		
XV	7	3	5	2	1	8	10	9	6	4		
XVI	2	10	5	3	4	9	1	8	7	6		
XVII	10	8	3	9	4	2	7	5	1	6		
XVIII	3	8	9	5	2	1	6	10	4	7		
XIX	6	10	9	8	2	5	7	4	1	3		
XX	4	5	2	9	6	10	8	7	3	1		

 SUBJECT ____________
NUMBER

LEARNING GROUP B SCORE _____
WAZ 1ST __ 2nd __

HABITUATION GROUP A
GEY 1ST __ 2nd __
SCORE _____

	ORDERS OF PRESENTATIONS										LEARNED YES	LEARNED NO
I	4	2	10	8	7	5	3	1	6	9		
II	3	6	10	8	1	2	7	5	4	9		
III	7	4	6	9	8	3	5	10	2	1		
IV	8	10	7	6	3	1	4	5	9	2		
V	8	7	4	3	10	9	6	2	1	5		
VI	5	4	10	1	6	7	3	2	9	8		
VII	5	4	6	7	1	2	10	8	9	3		
VIII	1	7	8	5	3	2	6	10	9	4		
IX	6	7	3	2	5	9	1	8	4	10		
X	6	8	9	10	2	1	7	5	3	4		
XI	4	6	1	5	2	3	8	9	10	7		
XII	1	7	5	8	4	10	3	2	9	6		
XIII	8	5	3	7	1	2	6	4	9	10		
XIV	7	1	4	6	9	2	10	3	5	8		
XV	7	3	5	2	1	8	10	9	6	4		
XVI	2	10	5	3	4	9	1	8	7	6		
XVII	10	8	3	9	4	2	7	5	1	6		
XVIII	3	8	9	5	2	1	6	10	4	7		
XIX	6	10	9	8	2	5	7	4	1	3		
XX	4	5	2	9	6	10	8	7	3	1		

APPENDIX 4

HABITUATION TASK INSTRUCTIONS

APPENDIX 4

HABITUATION TASK INSTRUCTIONS

Please make yourself comfortable in this chair. The experiment that you are about to participate in is designed to study learning. In doing this I want to determine the number of times that the blood volume in the finger and in the head changes while an individual is learning. The tiny boxes that I am now showing to you have a light source in them. One box will be attached to your finger and one box will be attached to your forehead. The light in these boxes will shine on your skin and indicate changes in the amount of blood. The information from the boxes will be recorded on the instrument that I am now showing to you. Please try not to move while the experiment is in progress because motion will interfere with the recordings.

A slide will be projected on this screen for three seconds at thirty second intervals. The slide will have a drawing of an imaginary animal on it. Beneath the drawing there is a printed three letter nonsense syllable. Try to learn all the details of the animal drawing and the three letter nonsense syllable that is associated with the animal. After you have seen this slide a number of times you will be given a simple test in which you will try to pick out this slide from a number of slides which are very similar to it.

If you are comfortable, we shall begin.

APPENDIX 5

LEARNING TASK INSTRUCTIONS

APPENDIX 5

LEARNING TASK INSTRUCTIONS

Please make yourself comfortable in this chair. The experiment that you are about to participate in is designed to study learning. A slide will be projected on this screen for three seconds. The slide will have a drawing of an imaginary animal on it. Beneath the drawing there is a printed three letter nonsense syllable. Try to learn all the details of the animal drawing and the three letter nonsense syllable that is associated with the animal. After seeing the slide to be learned, there will be a three second interval. Ten other slides will then be projected on the screen one at a time, each for a three second duration. One of these ten slides is exactly the same as the slide to be learned. The other nine slides are very similar to the slide to be learned, but are not exactly the same. Your task is to choose the slide which is exactly the same as the slide to be learned. When the correct slide appears on the screen, respond by saying "yes". Respond only when you think that it is the correct slide. Once you have responded, whether or not your choice is correct, there will be an interval of three seconds and then the correct slide will be shown to you. Again you will be presented with the ten slides but they will appear in a different order. Again respond when you think it is the correct slide. When you have correctly identified the slide three consecutive times, we will stop.

If you are comfortable, we shall begin.

APPENDIX 6

TABULATED RAW DATA AND SUMMARIZING STATISTICS OF THE STUDY

APPENDIX 6

TABLE I

Raw Scores Yielded by the Learning Task and the Habituation Task. (N:60)

S	Learning Task Scores	Habituation Task Scores
	Group $H_A - L_B$	
1	13	10
2	12	8
3	15	12
4	16	14
5	12	15
6	17	21
7	6	11
8	15	10
9	17	4
10	6	11
11	18	23
12	18	22
13	6	14
14	18	21
15	14	25
	Group $H_B - L_A$	
16	6	7
17	12	19
18	22	24
19	19	15
20	20	10
21	6	8
22	14	17
23	11	13
24	15	20
25	3	6
26	6	15
27	18	25
28	13	6
29	9	20
30	4	11

TABLE I. - (Continued)

Raw Scores Yielded by the Learning Task and the Habituation Task. (N:60)

N	Learning Task Scores	Habituation Task Scores
	Group L_A - H_B	
31	8	15
32	14	16
33	12	17
34	6	10
35	12	11
36	9	19
37	8	14
38	16	15
39	14	13
40	7	9
41	11	9
42	22	25
43	9	19
44	13	13
45	6	13
	Group L_B - H_A	
46	23	25
47	15	11
48	10	10
49	19	5
50	22	24
51	21	13
52	8	22
53	13	12
54	22	21
55	11	12
56	14	10
57	10	13
58	18	13
59	6	13
60	23	21

TABLE II

Summarizing Statistics

Group	N	Mean		Median		σ		Range		r
		L	H	L	H	L	H	L	H	
L_A-H_B	15	11.133	14.533	11	14	4.177	4.161	6-22	9-25	.567*
L_B-H_A	15	15.666	15.000	15	12.8	5.664	5.784	6-23	5-25	.411
H_A-L_B	15	13.533	14.733	15	14	4.240	6.038	6-18	4-25	.386
H_B-L_A	15	11.867	14.400	12	15	5.920	6.140	3-22	6-25	.566*
H - L	30	12.700	14.566	13.5	14	5.216	6.092	3-22	4-25	.484**
L - H	30	13.400	14.760	12.5	13.2	5.467	5.044	6-23	5-25	.442*
Entire Group	60	13.050	14.666	13	13.4	5.312	5.458	3-23	4-25	.493**

* Significant at the 0.05 level.
**Significant at the 0.01 level.

APPENDIX 7

ABSTRACT OF

Habituation of the Vasomotor Components of the Orientation Reaction as a Correlate of Stimulus Recognition Learning

APPENDIX 7

ABSTRACT OF

Habituation of the Vasomotor Components of the Orientation Reaction as a Correlate of Stimulus Recognition Learning[1]

The orientation reaction is evoked by a novel or significant stimulus of moderate intensity. Apart from the attention given to the source of this stimulus, there are a number of physiological changes involved in this phenomenon. These include skeletal, autonomic, electro-encephalographic, and sensory adjustments. The purpose of these changes, in general terms, is to make the organism more sensitive to incoming stimuli in order that the animal may better deal with what is happening. Upon repeated stimulus presentation the orientation reaction will habituate. A number of investigations seem to support the assumption that habituation of the orientation reaction is a kind of stimulus learning. Based on Sokolov's model of the orientation reaction, it is proposed that the stimulus learning that takes place during habituation of the orientation reaction is similar to the process that is evidenced

---

1 Anthony J. Gallo, doctoral thesis presented to the School of Education of the University of Ottawa, Ontario, 1972, viii-86 p.

by recognition learning (both entail the storage and retention of a stimulus in memory). The hypothesis tested in this study states that OR habituation is not a precondition to stimulus recognition learning and therefore the Habituation Scores from the Habituation Task and the Learning Scores from the Learning Task will not show a significant correlation.

Sixty male volunteers from undergraduate classes at Seton Hall University, New Jersey, served as subjects in the experiment. Their mean age was twenty-one years and eight months. All scored in the fifth or sixth sten of the IPAT Anxiety Scale Questionnaire.

The experimental design consisted of two tasks (a Learning Task and a Habituation Task) which were given in counterbalanced order. The stimuli used in both of these tasks were alternate forms of a drawing of an incongruent animal and a printed three letter nonsense syllable of 47% Glaze association value. In both of these tasks the subjects were instructed to learn the details of the figure and the nonsense syllable which appeared beneath it. Learning was defined as three consecutive selections of the learning slide from a number of somewhat similar slides. Plethysmographic transducers attached to the volar pad of the right middle finger and to the medial region of the forehead were used in the Habituation Task. Ongoing changes in blood volume were recorded on a polygraph. The orientation reaction was defined as simultaneous cephalic vasodilation and digital vasoconstriction. Habituation was defined as three consecutive failures on the part of the subject to evoke an orientation reaction to the stimulus.

A coefficient of correlation of 0.493 was found between the Learning Scores and the Habituation Scores. Because this correlation was found to be significant, the null hypothesis was rejected. The result of this study was interpreted as supporting Sokolov's model which claims that habituation of the orientation reaction is a precondition to the establishment of a neuronal model.

Possibilities for future research in the areas of education and psychology were suggested.