A SHORT - TERM LONGITUDINAL STUDY OF HABITUATION IN TWO - AND FOUR - MONTH - OLD INFANTS

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ABSTRACT

A SHORT-TERM LONGITUDINAL STUDY OF HABITUATION IN TWO- AND FOUR-MONTH-OLD INFANTS

By

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A longitudinal design was used to investigate habituation of attention in human infants. Sixteen boys and sixteen girls participated in auditory and visual habituation tasks at two and at four months of age. The visual stimuli were blinking lights that described simple geometric patterns, and the auditory stimuli were simple pure tones of 500 and 1100 Hz. Heart rate deceleration, changes in general body activity, visual fixation time, skin conductance, and skin potential were used as indices of attention.

A habituation-dishabituation paradigm was used to determine whether the response decrement obtained was specific to the stimulus that was repeatedly presented or was due to other factors such as fatigue. One-half the infants were presented the same stimulus throughout the testing session, while the remaining infants received a "dishabituation" (novel) stimulus on the last two trials.

The infants who were presented the dishabituation stimulus exhibited significant recovery of attention on all variables except heart rate (HR) deceleration (and HR deceleration was in the predicted direction). There were no age by treatment interactions. Thus, habituation was demonstrated for two- and four-month-old infants.

There were several other major areas of concern in the study. Specifically, there was interest in (1) the cross-age correlation of habituation and dishabituation; (2) the extent to which habituation and dishabituation are specific to particular stimulus-response connections as opposed to being holistic phenomena; and (3) the degree of cross-modal correlation for habituation and dishabituation within ages. Little support obtained for the hypothesized positive cross-age and cross-modal correlations. In addition, habituation was seen to be a specific process. That is, the correlations among the several indices of attention were generally not significant for habituation, though there were several significant correlations for dishabituation in the visual task.

The study included the following important methodological features. First, the state of the infants was scrupulously monitored throughout testing. Second, the age at each testing and the interval between testing sessions was tightly controlled. Third, the auditory and visual stimuli were randomly chosen. Therefore, the results of the study may be generalized to other stimuli to a relatively greater extent than is usually the case. Fourth, the stimuli presented for response decrement and for recovery trials were completely counterbalanced across infants. Thus, the treatment effect for dishabituation cannot be attributed to differential response-eliciting power of the stimuli used. Finally, several indices of attention (and thus of habituation and dishabituation of attention) were used. The use of several indices provided a more general assessment of the questions posed in the study than would have been possible with a single index.

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A DISSERTATION

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This dissertation is dedicated

to my wife, Mary.

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CHAPTER I

INTRODUCTION

It is certain that the human infant is not an insensate organism. It is also certain that William James was not accurate when he asserted that the infant's world is a "blooming grey mass of confusion." Several lines of research provide an empirical basis for these assertions, and for modern views of the capacities and capabilities of young humans. Research in several areas including attention (Fantz, 1956, 1958), conditioning and learning (Fitzgerald & Porges, 1971; Sameroff, 1971), and habituation (Jeffrey & Cohen, 1971) indicates that considerable response modification occurs early in life, and that human infants from months of age and older are perceptually and cognitively capable organisms. The present work was an attempt to further explore the phenomena of habituation and attention in early infancy.

Definitions

Jeffrey and Cohen (1971) and Kessen, Haith, and Salapatek (1970) have observed that the term habituation continues to be used inconsistently. Thus, it must be made clear that habituation refers to response decrement to repeated stimulus presentation, such decrement not being due solely to peripheral processes such as sensory adaptation, effector fatigue, or changes in arousal (Kessen *et al.*, 1970). Response decrement is a general term that is used without regard to the mechanisms of decreased responding. Habituation, on the other hand, refers to a specific class of mechanisms, i.e., central nervous system (CNS) processes, as explanations of decreased responding. Neuronal model (Sokolov, 1963), schema (McCall & Kagan, 1967), and cognitive process (Lewis, 1970) are all terms which implicate the CNS comparison mechanisms assumed to be involved in response decrement.

Inextricably bound with the definition of habituation is the thing "habituated." In the present study the phenomenon of interest was attention. Attention, in a general sense, seems to be the process by which organisms direct their sensory and elaborating (cognitive) systems (Lewis, 1970). Researchers have attempted to operationalize the construct by using physiological and behavioral measures as indices of attention. For example, decreases in activity (Collins, Kessen, & Haith, 1972; Kagan & Lewis, 1965), decreases in sucking rate (Kaye, 1966), heart rate deceleration (Graham & Clifton, 1966; Lewis & Spaulding, 1967), change in galvanic skin resistance (Crowell, Davis, Chun, & Spellacy, 1965), and cortical changes (Sharpless & Jasper, 1956) have all been used as operational definitions of attention. It should be noted further that much of the Russian work on habituation of the orienting reaction (OR) can be regarded as studies of habituation of basic attentional processes (e.g., Sokolov, 1960, 1963).

Overview of the Study

The basic interest in the present research was on performing a well controlled study of habituation of attention in human infants. Specifically, the study was designed to eliminate and/or control a variety of reasonable alternative explanations of response decrement in two- and four-month-old infants. This was done in order to investigate whether habituation is indeed a major mechanism of response decrement in young infants.

A within subjects longitudinal design was used to examine the stability of individual differences in habituation of attention. In addition, the holistic versus specific nature of habituation was investigated by using several behavioral and physiological indices of attention for both the auditory and visual stimulus modalities. Finally, the relative durability of responsivity to visual and auditory stimulation was examined by between modality comparisons of habituation of attention.

CHAPTER II

LITERATURE REVIEW

Visual Stimuli

The available evidence strongly suggests that infants four months of age and older habituate to repeated visual stimulation (Jeffrey & Cohen, 1971). This conclusion is based mainly on the consistent finding of response decrement in virtually all studies rather than on the fact that peripheral processes have been eliminated as possible explanations of response decrement in many individual studies. For example, Lewis, Goldberg, and Campbell (1969) demonstrated decrement of visual fixation time to repeated presentations of a blinking light in infants aged 3, 6, 9, 12, and 18 months. Stimulus duration and inter-trial interval (ITI) were both 30 seconds. Nonetheless, the failure in their study to obtain recovery of the fixation response when a new stimulus was presented leaves the finding of response decrement open to several possible explanations in addition to the Lewis *et al*. interpretation that it was habituation, e.g., fatigue and/or state changes may have caused the decrease in visual fixation. It should be noted that the original ITI of 30 seconds yielded little response decrement in the three-month-olds. Use of a zero

ITI, however, produced some (though a nonsignificant degree) visual response decrement.

Similarly, the findings of response decrement by Kagan and Lewis (1965) and McCall and Kagan (1970) are open to several alternative interpretations. In the Kagan and Lewis study, six-month-old babies were repeatedly presented with blinking lights--the same stimuli that Lewis et al. (1969) had used. Visual fixation time decreased over trials, though little decrement in heart rate (HR) deceleration occurred. Since no test for response recovery was attempted, the decrement in visual fixation is not clearly interpretable.

McCall and Kagan (1970) did include a test for recovery in their study of four-month-olds; however, only those infants who exhibited response decrement were tested for recovery. Therefore, even though recovery of visual fixation obtained, there is a strong possibility that the recovery simply reflected a regression to the mean effect.

Pancratz and Cohen (1970), however, obtained what appears to be a clear demonstration of habituation of visual fixation in four-month-old infants. Pancratz and Cohen presented slides of simple geometric forms, each for ten fifteen-second trials with a .5 second ITI. In the test for recovery, the familiarized stimulus was alternately presented with a nonfamiliarized stimulus. Boys showed response decrement and recovery of visual fixation, while girls showed neither decrement nor recovery.

Using the same stimuli, Cohen, Gelber and Lazaar (1971) replicated and extended the results of Pancratz and Cohen. Again boys, but not girls, habituated. Also, there was greater recovery of visual fixation time to stimuli that differed from the habituation stimuli in form and color as opposed to form or color only. In other words, the boys' recovery was a direct function of the discrepancy between the standard (habituation) stimulus and the comparison (recovery) stimulus.

Demonstrations of habituation to visual stimuli in infants less than four months of age generally are less convincing than in older infants. For example, neonates (Haith, 1966) and two- to four-month-olds (Haith, Kessen, & Collins, 1969) did not show a decrease in cessation of sucking with repeated presentations of patterns of blinking lights.

Caron and Caron (1969) and Saayman, Ames, and Moffett (1964) did report response decrement of visual fixation as well as recovery to a novel stimulus. The infants in these studies were three and one-half and three months of age, respectively. Since presentations of the habituated and recovery stimuli were not counterbalanced in either study, however, response recovery may simply have resulted because the recovery stimuli were capable of producing higher levels of responding.

Recently Friedman (1972) apparently has demonstrated habituation of visual fixation to checkerboard stimuli in neonates one to three days old. This finding needs replication, since it is the only demonstration to date of such an effect in neonates. Friedman's study appears to have been well controlled except for the strong possibility of statistical regression effects. Only 40 of the 90 subjects observed actually showed response decrement. Of these 40, only 29 percent (12) showed the recovery effect. The habituation criterion Friedman used was a fixation time of 8 seconds less than the mean of the fixation time on the first three trials on which the stimulus was presented. A large difference between Friedman's study and other studies is the number and length of habituation trials employed. Each trial was 60 seconds with an ITI of 5-10 seconds. The range of trials to the habituation criterion was 8-26 with a mean of 13.2 for the 40 babies who reached criterion. This degree of exposure to the stimuli far exceeds that reported for any other study of this nature in the literature. It was further reported that state was monitored and that all babies were alert when tested.

Several things are apparent from this brief review of visual habituation studies. First, a wider range of dependent variables should be sampled. It is true that several investigators have used responses other than visual fixation and heart rate as indices of attentional processes in infants (e.g., Lewis, Wilson, & Baumel, 1971; Stechler, Bradford, & Levy, 1966), but these efforts have been few and far between. Second, research is needed on visual habituation in the neonatal to four-month age range. The number of studies using infants in this age range is small, though three months may be a transition period for many aspects of development (e.g., EEG changes, the elimination of various reflexes, etc.). [See Lewis _et al_. (1969) for a brief review of physiological and behavioral changes that occur in the eight- to twelve-week age range.]

Auditory Stimuli

A detailed review of studies that have dealt with habituation to auditory stimulation can be found in Jeffrey and Cohen (1971). Studies of auditory habituation have overwhelmingly employed neonates as subjects, and virtually all have used heart rate responsivity as the dependent variable. Further, there is ample evidence from these studies to suggest that the discrimination of sounds of various kinds does take place (Kessen _et al_., 1970). Unfortunately, most of the results concerning response decrement of neonatal heart rate responsivity can be adequately accounted for in terms of arousal or state changes (e.g., Bartoshuk, 1962; Hutt, Von Bermuth, Lenard, Hutt, &

Prechtle, 1968; Graham, Clifton, & Hatton, 1968). Consequently, evidence of human neonatal habituation to auditory stimulation is not very convincing. On the other hand, studies by Moffett (1968), Clifton and Meyers (1969), and Horowitz (1972) indicate that four- to six-month-old infants do habituate to auditory stimulation.

It is important to note that the number of response measures used in auditory habituation studies is even more restricted than is the case in visual habituation studies. Specifically, heart rate responsivity (usually acceleration because of the ages of the subjects) has been the dependent measure for all practical purposes. It must be emphasized that other variables be used, particularly since the heart rate component of the orienting reaction (i.e., heart rate deceleration) is difficult to elicit in young infants (Jackson, Kantowitz, & Graham, 1971).

Other Studies

A study by Moreau, Birch, and Turkewitz (1970) is of direct concern, since it was one of the studies that prompted the present research. These experimenters tried to measure the relative durability of responsiveness of newborns to repeated presentation of initially equivalent auditory and somesthetic stimuli, and to determine whether habituation is a general phenomenon or is specific to particular stimulus-response connections. Newborns were presented with 40 one-second applications of either an auditory (90 db white noise) or a somesthetic (stroke on the cheek with a brush) stimulus. The ITI was eight seconds and the dependent variables were cardiac acceleration and eye movement. Among other difficulties, the most serious problems with the Moreau et al. study are:

1. There were no controls for sensory adaptation, effector fatigue, or state changes as possible explanations of the response decrement;

2. The eight-second ITI is too short when cardiac responses are of interest, since heart rate cannot return to baseline in so short a time (Kagan & Lewis, 1965); and

3. The auditory stimulus had a rise-decay time of less than .05 milliseconds (rise-decay time is the total time it takes a tone to reach maximum intensity from onset and then to decrease to offset) and it has been suggested that fast rise times cause startle responses and are not conducive to habituation (Graham & Jackson, 1970).

Because of these and other methodological problems, the results of the Moreau et al. study must be cautiously considered. Nonetheless, their work leads to the suggestions that:

1. Response decrement of HR acceleration was more readily obtained to somesthetic stimulation than to auditory stimulation; and

2. "Changes in the frequency of occurrence of the two types of response (eye movement and HR acceleration)

cannot be considered as resulting from general and ubiquitous changes in the infants' 'responsiveness' to stimulation," since the cardiac response to repeated auditory stimulation was more persistent than the eye movement response, and since the two responses were independent of each other in individual infants.

Moreau et al. concluded that habituation, rather than being a unitary phenomenon which affects all response systems that are activated by a given stimulus, is specific to the particular stimulus-response conjunction examined. They may be right, but it is just as reasonable to conclude that somatic responses may habituate in one fashion, while autonomic responses habituate in a different way. To choose between these alternatives, it is necessary to study habituation to two or more somatic responses and to two or more autonomic responses. Thus, heart rate change, skin potential, skin conductance, visual fixation, and general body activity were used as response measures in the present study. The first three responses are autonomically mediated, while the last two are mediated somatically.

Another pertinent study is the investigation by Brotsky and Kagan (1971). They investigated the stability of the OR longitudinally at four, six, and thirteen months. But instead of measuring habituation of the OR, Brotsky and Kagan measured degree of attention to stimulus presentations across a variety of visual and auditory stimuli, attention being defined as cardiac deceleration. The two major findings were (1) a significant correlation for girls between the degree of the OR at eight and at thirteen months; and (2) a significant correlation for both boys and girls between the degree of the OR to auditory and to visual stimulation.

Wetherford and Cohen (1971) performed the only longitudinal investigation of habituation with infants three months of age and younger. They tested babies at six, eight, ten, and twelve weeks of age and found habituation of visual fixation only at the two oldest ages. Wetherford and Cohen were interested in age differences and testing effects and did not examine the stability of individual differences in habituation.

Finally, Lewis and his co-workers have reported two studies in which infant attention across two modalities was investigated. In the first of these (Lewis & Spaulding, 1967), there was greater heart rate deceleration to auditory than to visual stimulation for six-month-old infants. In this study, a variety of auditory stimuli (e.g., 70 db tones, mother's voice) and visual stimuli (blinking lights describing various patterns) were used. Interest in the study by Lewis, Baumel, and Groch (1971) was on response decrement, and is, therefore, more germane to the present study. These investigators found no significant decrement in visual fixation time (i.e., length of first fixation), heart rate deceleration, or activity change over six 30-second presentations of the visual stimuli. Similarly, there was no response decrement in HR deceleration or activity change for the auditory stimuli. The babies were three months old in this study, the visual stimuli were the same as in Lewis' other studies, and the auditory stimuli were C-tones and C-chords. Of particular relevance to the present study were the findings of no between modality differences in decrement of heart rate deceleration and activity. These results obtained despite between modality differences in overall heart rate deceleration (i.e., greater HR deceleration for the auditory stimuli) and in overall activity (i.e., greater activity for the auditory stimuli). Similarly, though there were no sex differences in response decrement, the sex by modality interaction was significant for overall levels of responding. That is, girls showed greater HR deceleration to the auditory stimuli than to the visual stimuli, while boys showed comparable degrees of HR deceleration across modalities.

Conclusions

It is clear from this review that most studies of infant response decrement have examined only one dependent variable. This variable has usually been cardiac activity in auditory habituation studies, and some measure of visual fixation in visual habituation studies. It is also clear that too little is known about visual habituation in the neonatal to four-month-old age range, while the same can be said for ages beyond the neonatal period in studies of response decrement to repeated auditory stimulation. The present study was designed to contribute to reducing these deficiencies by using several dependent variables to assess response decrement to auditory and to visual stimulation for infants at two and at four months of age.

CHAPTER III

PURPOSES AND HYPOTHESES OF THE STUDY

Purposes

The first and most basic purpose of the study was to perform a well controlled investigation of habituation of attention in human infants. Though many researchers in infancy have interpreted the results of their response decrement studies in terms of neuronal models (Lewis *et al.*, 1969), schema formation (McCall & Kagan, 1970), and other constructs which imply some form of "memory" and comparison process (i.e., habituation), the response decrement obtained in the overwhelming majority of cases can just as easily be ascribed to peripheral factors such as those previously mentioned (e.g., Bartoshuk, 1962; Kagan & Lewis, 1965; Lewis, Goldberg, & Rausch, 1967; Moreau *et al.*, 1970).

Even in those studies where the investigators were working within an explicit theoretical framework that defined habituation in a specific way, e.g., as acquisition of a neuronal model (Lewis *et al.*, 1969), the empirical demonstration of response decrement could often be attributed to any one of a number of potential mechanisms. It must be pointed out that no attempt was made in the design of the present study to differentiate between theoretical positions that implicate cortical mechanisms of habituation (e.g., Sokolov, 1963) and positions that implicate other central mechanisms (e.g., Horn, 1967). Rather, what was emphasized is the difference between this type of explanation of response decrement and those explanations that rely on changes in peripheral receptor/effector systems. The distinction drawn between habituation and other decremental processes (such as sensory adaptation or fatigue) is that in habituation, the sensitivity of receptors and effectors is thought to be unaltered (Kling, 1971). Changes are assumed to be occurring in the central nervous system.

The second purpose of the study was to assess the stability of individual differences in habituation over a short age span in infancy. There have been several longitudinal investigations of habituation (e.g., Lewis et al., 1969; Wetherford & Cohen, 1971) but none has systematically addressed this issue (Ratner, 1970). A longitudinal examination of the stability of individual differences in habituation is important also because of the suggestive relationships found between response decrement and other individual difference variables. For example, response decrement at 44 months was found to correlate significantly with performance on a two-choice discrimination task (r = .39) and with performance on a concept formation task (r = .37; Lewis et al., 1969). Also response decrement at 12 months was related to Stanford Binet I.Q. scores at 44 months (r = .46 for girls and r = .50 for boys; Lewis, 1967).

The third purpose of the study was to initiate investigation of the features of the environment to which human infants remain responsive. This line of research is important, though often unrecognized as being so, in that the identification of the infant's effective environment is a necessary precursor to analyzing the infant's psychological level of functioning (Hess, 1970; Schneirla, 1957). The general question concerns the relative durability of the effectiveness of stimulation in different sensory modalities. This translates in the present study to a comparison of habituation between the auditory and visual modalities.

The final purpose of the experiment was to investigate whether habituation is a unitary phenomenon or is specific to particular stimulus-response conjunctions. This was the major reason for using multiple indices of attention in the present study. In addition, as Lewis (1970) observed, it is inappropriate to use only one response measure to indicate a behavior process, particularly when infants are the subjects of study, since the meaning of responses changes over time. For example, crying at nine months of age may be a very aggressive response (e.g., when a toy is taken from a nine-month-old there is not much else the infant can do but wail). On the other hand, if taking a toy away from a three-year-old elicits crying, the reaction may well be considered a nonaggressive or dependent one. Second, it was desirable to use a variety of responses, since habituation has not been clearly demonstrated in two-month-old infants (the youngest infants in the study). Finally, there have been very few attempts to use more than one measure of habituation in a particular study. Moreau *et al*. (1970) and Lewis *et al*. (1971) used two or more response measures, but the need for multiple response measures in habituation research was not met because of problems in research design and differences in the purposes of these studies.

Hypotheses

The first hypothesis was based on the consistent findings from many studies that have used neonates, and infants four months of age and older as subjects:

> H_1: There will be decreases in response magnitude with repeated stimulus presentations for both two- and four-month-old infants.

The hypothesis seems straightforward, but it was actually an "extrapolation" from two sides. It is quite possible that the decrement obtained with neonates is qualitatively different than that obtained with four- to six-month-olds. If this is the case, and remembering Lewis' failure to obtain decrement for a variety of responses in three-month-olds, as well as the variety of cerebral reorganization that occurs around three months of age, it is possible that there would be an age difference in the decrease in attention. These considerations and the Lewis et al. (1969) finding of age differences in response decrement led to the second hypothesis:

> H_2: There will be greater decreases in response magnitude to repeated stimulus presentation for four-month-olds than for two-month-olds.

Given response decrement (i.e., decreased attention) to repeated stimulation, it becomes meaningful to talk about response recovery. Therefore, hypothesis three was:

> H_3: Following familiarization as a result of repeated stimulation, such familiarization being indicated by response decrement, there will be response recovery when a nonfamiliarized stimulus is presented.

As indicated previously, and as will be made clearer when details of experimental design are considered later, this was the crucial hypothesis. If evidence obtained which supported the hypothesis, then the conclusion that habituation is a viable and operative cause of response decrement in human infants would be empirically based.

It was also hypothesized, on the basis of the sex differences in duration of first visual fixation presented by Cohen and his co-workers, that males would show greater habituation than females. The hypothesis was:

> H_4: There will be greater decreases in response magnitude and greater response recovery for males than for females.

The next hypothesis was truly of the hunch variety, since there is no previous work on which it could be based. It is true that Wilson and Lewis (1971) performed a longitudinal study of attention, but their study did not address the issue of habituation of attention (and they used infants six months of age and older).

> H_5: There will be positive correlations between ages for both response decrement and response recovery.

The hypothesis was based on the work of Lewis who found significant correlations between performance in a response decrement task at 12 months of age and I.Q. performance at 44 months of age. This hypothesis was for each modality of stimulation separately.

The sixth hypothesis was:

> H_6: There will be positive correlations, within age, between modalities for both decrement and recovery of responsivity.

This prediction was derived mainly from the neural systems theory of habituation which implicates the reticular activating system as a major mechanism in habituation (Groves & Lynch, 1972). A basic feature of the reticular activating system (RAS) is that it receives collateral input from all sensory modalities. Therefore, at least to some extent, responsivity of the RAS is independent of type of stimulation.

The final purpose of the study was to examine, within each type of stimulation, habituation of several indices of attention. This type of investigation is needed from a purely descriptive standpoint (Kagan & Lewis, 1965); however, information also obtained that is relevant to Sokolov's (1963) neuronal model of the orienting reflex (OR) and its habituation (Lynn, 1966). The OR, or "what-is-it" reaction, was described by Pavlov as follows:

> It is this reflex which brings about the immediate response in man and animals to the slightest changes in the world around them, so that they immediately orientate their appropriate receptor organ in accordance with the perceptible quality in the agent bringing about the change, making a full investigation of it. The biological significance of this reflex is obvious. If the animal were not provided with such a reflex its life would hang at any 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. [Pavlov, 1927.]

Do several autonomic and somatic indices of attention habituate as a group? Or as Moreau et al. (1970) put it: Is habituation a characteristic of the input system per se or is it dependent on particular constellations of input-output relationships? Evidence supporting a single arousal mechanism underlying the various vegetative and central nervous system (CNS) response systems would obtain if habituation in each modality occurred for all indices of attention. Such an outcome would support Sokolov's notion of a nonspecific orienting response. On the other hand, differential habituation for the several indices of attention would indicate different arousal properties and habituation features for specific stimulus-response relationships. The latter result would be consistent with the conclusion of Moreau _et al_. (1970) that different responses habituate with differential ease to the same type of stimulation. Thus, the final hypothesis, investigative in nature, was:

> H_7: There will be positive correlations among the indices of habituation (i.e., decrement and recovery) of attention within each input modality for each age.

CHAPTER IV

METHOD

Subjects

Four hundred and five letters requesting participation in the study were sent to parents who had made announcements in a local newspaper of their child's birth. Seventy-nine (19.5 percent) returned the postcard that had been enclosed with the letter to indicate their permission to allow their baby to take part in the study. [Copies of the letter and postcard appear in Appendix A.] Complete sets of data were obtained for 32 (16 boys and 16 girls) of the 79 infants who initially came to the laboratory. Data from 47 of the initial group who participated in the experiment have not been included in the present study for the following reasons: (1) six babies failed to meet pre-established criteria for inclusion in the study; (2) seventeen of the subjects were affected by experimenter error and/or equipment failure, or were part of the pilot study; and (3) twenty-four babies experienced state problems that were judged to interfere with the purposes of the study.

The criteria for inclusion in the study were (1) assurance from the parents that the baby would be brought back for retesting at four months of age; (2) birth weight $\geq$ 2,500 grams (Tanner, 1970); (3) normal spontaneous or low forceps delivery; (4) no genetic defects or congenital abnormalities; (5) good maternal obstetrical history; and (6) normal postnatal medical history. A questionnaire which addressed these criteria was filled out by the mother. [A copy of the questionnaire is presented in Appendix B.]

Other characteristics about the testing of infants appear in Table 1. Note particularly the restricted range of time between testing, and the fact that all babies were tested between 1:00 P.M. and 6:00 P.M. The latter procedure was used in an attempt to control for the potential impact of differences in diurnal rhythms on state and

TABLE 1

AGE* AND TIME OF TESTING OF INFANTS

	Range	$\overline{X}$
First testing	51-69	60.18
Second testing	116-128	123.75
Interval between Testing Sessions	53-70	61.25
Time of day tested	1:00-6:00 P.M.	

*Numbers in rows 1-3 represent ages in days.

responsivity of the infants (see Luce, 1971, for a readable compendium of "biorhythm" research). All babies were tested within nine days of their two-month birthdays, and within eight days of their four-month birthdays.

The influence of "state" on a variety of infant behaviors is well documented (e.g., Ashton, 1971). State refers to the infant's overall level of functioning at any given period of time on a continuum ranging from deep sleep to awake, alert, and active (Brackbill and Fitzgerald, 1969). State was carefully monitored in the present study by an experimenter who remained in the testing room with the infant. If the baby was judged to have state problems (sleep-drowsiness or fussy-crying) on trials one and/or two, the baby was removed from the apparatus and handled by the mother, then testing was begun anew (n = 6). If handling by the mother did not induce a testable state in the infant, or if state problems occurred on or after the third trial, the baby was eliminated from the study (n = 24). Finally, if the baby normally used a pacifier he was allowed it at any time during the testing session. In these cases (n = 12) the experimenter presented the pacifier to the baby during a trial interval or the mother gave the baby the pacifier prior to starting the experiment.

The twelve babies who used pacifiers at one time or another were distributed by chance among the groups in the study. Further, there were not systematic differences on any of the dependent variables between "pacifier" and "non-pacifier" babies. For example, the mean heart rate change scores (i.e., pre-stimulus minus post-stimulus heart rate in beats/minute) for trials one plus two were 5.06 and 5.42 for pacifier and non-pacifier babies.

Research Design

Operational Definition of Habituation

The general response decrement/response recovery paradigm employed in the study (often referred to in the literature as a habituation/dishabituation paradigm) had two key features. First, all infants were repeatedly presented a stimulus (the decrement stimulus) for 8 trials. This was the habituation or response decrement phase of the procedure. Second, on trials 9 and 10 half of the infants were presented a different stimulus (the recovery stimulus) while the remaining infants continued to experience the decrement stimulus. This was the dishabituation or response recovery phase.

A general representation of the basic paradigm is depicted in Figure 1. It should be noted that the paradigm was identifical for both habituation tasks at both ages.

The comparison between the treatment and control groups on trials 9 and 10 was the crucial comparison in

Groups	Trials									
	1	2	3	4	5	6	7	8	9	10
T	A	A	A	A	A	A	A	A	B	B
C	A	A	A	A	A	A	A	A	A	A

T: Treatment group presented recovery stimulus on trials 9-10
C: Control group presented decrement stimulus on all 10 trials
A: Any stimulus in a given modality
B: Any stimulus, other than A, in the same modality as A

Figure 1.--General Response Decrement/Response Recovery Paradigm.

the present study. Assuming that response decrement in "attention" from trial 1 to trial 8 obtained (an assumption which was tested), the decrement was defined as habituation only if there was a difference between treatment and control groups on the recovery or dishabituation trials. If there was no treatment effect for dishabituation, then the initial decrement on trials 1 to 8 was not stimulus-specific. On the other hand, if recovery of attention was greater for the treatment group, it was likely to be for one reason (besides Type I error). Namely, the decrement in attention was specific to the stimulus that was presented on trials 1 to 8 and was not the result of receptor fatigue, drowsiness, sensory accommodation or other peripheral factors. Therefore, two conditions were necessary for habituation to be demonstrated. First, there must be a decrease in response magnitude with repeated "experiences" or presentations of the stimulus. Second, it must be shown that the decrement was stimulus-specific.

The latter requirement was addressed by including the test for response recovery. An important concern here had to do with potential differential response-eliciting powers of the decrement and recovery stimuli. That is, an apparent dishabituation effect might simply obtain because the recovery stimulus was a more powerful response elicitor than the decrement stimulus. If this were the case, then the response decrement over trials 1-8 could not be clearly interpreted as being habituation.

One method of handling this possible confounding would have been to pretest the pool of possible stimuli to determine which ones were comparable response elicitors. This was not done for one important reason. Namely, there was no basis for choosing the response with which to compare the response-eliciting powers of the stimuli. Since there were multiple responses for both habituation tasks it seemed reasonable not to make what would have to be an arbitrary decision on this matter. Rather, the decrement and recovery stimuli in each habituation task were simply counterbalanced <u>across</u> subjects. Thus, each stimulus was used equally often as the decrement and as the recovery stimulus.

Experimental Design

The study was longitudinal with all infants taking part in visual and auditory habituation tasks at two and at four months of age. The order of task was counterbalanced across subjects, and the groups were equally composed of males and females. Thus the full design was a 2 (treatment/control) x 2 (sex) x 2 (order of habituation task) x 2 (age) x 2 (modality of stimulation). The last two factors were repeated measures, and there were four subjects per cell. The design is represented in Figure 2.

Referring to Figure 2, the three factors across the top of the design matrix were between subjects factors, while factors listed along the left of the matrix were within or repeated measures factors. The only restriction on random assignment was the desire to have equal numbers of both sexes in all cells. Thus equal numbers of males and females were randomly assigned to combinations of treatment/control and order of habituation task. The treatment group (decrement/recovery) received one stimulus on trials 1-8 and a different stimulus on trials 9-10. Control group infants were presented the same stimulus for all ten trials. Order of habituation task connotes simply that the sequence of testing (visual followed by auditory

		Treatment (D/R)				Control (D)			
		S_1		S_2		S_1		S_2	
		O_1	O_2	O_1	O_2	O_1	O_2	O_1	O_2
A_1	M_1	n_1 n_2 n_3 n_4	n_5 n_6 n_7 n_8	n_9 n_{10} n_{11} n_{12}	n_{13} n_{14} n_{15} n_{16}	n_{17} n_{18} n_{19} n_{20}	n_{21} n_{22} n_{23} n_{24}	n_{25} n_{26} n_{27} n_{28}	n_{29} n_{30} n_{31} n_{32}
	M_2								
A_2	M_1								
	M_2								

NOTE: See text for complete explanation of the figure.

D/R: Represents groups presented a decrement stimulus on trials 1-8 and a recovery stimulus on trials 9-10

D: Represents groups presented only the decrement stimulus for all 10 trials

O: Order of task (O_1: visual then auditory; O_2: auditory then visual)

S_1: Male — M_1: Visual habituation task

S_2: Female — M_2: Auditory habituation task

A_1: 2 months of age

A_2: 4 months of age

$n_1 \ldots n_{32}$: Represent each infant in the study

Figure 2.--Matrix Depicting the Design of the Study.

for O_1, or vice versa for O_2) was counterbalanced across infants. Thus, there were four infants in each of the eight cells which resulted from the combination of treatment, sex, and order of habituation task.

The within subjects factors were age and modality of stimulation. In short, all infants took part in both visual (M_1) and auditory (M_2) habituation tasks at two (A_1) and at four (A_2) months of age. Therefore, though not specified in Figure 2, the <u>same</u> 32 subjects that appeared in the A_1M_1 combination of factors were also present in A_1M_2, A_2M_1, and A_2M_2.

Finally, it should be specified that once an infant was randomly assigned to a particular combination of conditions that was his placement for the entire study. For example, as can be seen in Figure 2, assignment to the treatment condition was for both tasks at both ages. Similarly, once order of task was specified for a subject, the same order was used at both ages.

Choice of Stimuli

Two auditory and two visual stimuli were chosen randomly from pre-selected pools of possible stimuli. The pool of auditory stimuli consisted of two sets of six pure simple tones each with ranges of 200-700 Hz and 1000-1500 Hz. The tones increased in steps of 100 Hz. Random numbers were assigned to all tones and one was selected from each set of six. In this manner it was determined that a 500 Hz and an 1100 Hz tone would be used in the present study. The tones were played at 72 db since this intensity appears to be appropriate for eliciting heart rate deceleration (Berg, Berg, & Graham, 1971).

It should be noted also that tones in the two pre-selected ranges have been shown to be discriminable in six-month-old infants (e.g., Horowitz, 1972). Further, by the restricted random selection of tones, i.e., setting two nonoverlapping ranges of tones, discriminability of the two tones finally selected seemed certain. Pilot work did in fact indicate that the 500 Hz and the 1100 Hz tones were discriminable to infants from 1-1/2 to 5 months of age. Discriminability of the tones was pilot tested by continuously playing one of the tones while a mother was feeding her infant. The other tone was then presented after 40 seconds of the first tone. All eight infants tested in this manner invariably demonstrated cessation of sucking when the second tone was introduced. It is important that both orders of presentation resulted in clear discrimination and that there was not a "break" between the tones. That is, the tones were played continuously, one <u>immediately</u> following the other.

The choice of visual stimuli for the present study was based on several factors. First, the use of blinking lights is consistent with previous work in this area (e.g., Collins <u>et al</u>., 1972; Lewis <u>et al</u>., 1969) and, therefore, facilitates comparisons of this study with others.

Second, pilot work demonstrated the need to use visual stimuli that were somewhat more compelling than stationary objects such as geometric forms. This was particularly true for two-month-olds. It was not desirable to restrain the infant's head (e.g., by using a head brace) since this could potentially interfere with the body activity measure. Also it seems certain that the infant should have the opportunity to "escape" from impinging visual stimulation in a study of habituation. Thus, blinking lights which described geometric forms were chosen as the visual stimuli.

Third, choosing visual stimuli that differed in color, form, and intensity (number of lights) made the stimuli as discriminable as possible. It was thought that this would be particularly important for two-month-old infants, since dishabituation has not been clearly demonstrated with infants of this age. Cohen et al. (1971) support this contention with their demonstration of generalization of habituation in four-month-olds. Although the choice of visual stimuli that differed in several respects did not allow a conclusion about what particular feature(s) of the stimuli were habituated, the purpose of this study was to demonstrate the basic process of habituation, not to investigate specific stimulus parameters that affect habituation. Other studies will have to address the issue of specifying which parameters of a stimulus are habituated fastest and which remain salient (e.g., Horowitz, 1972).

The visual stimuli, like the auditory, were selected in a semi-random manner. A pool of possible geometric patterns was specified which included triangle, circle, square, diagonal line, and horizontal line. Similarly, yellow, red, blue, and green were the possible colors. Random numbers were assigned to each pattern and each color. In this manner a red triangle and a green square were chosen as the visual stimuli.

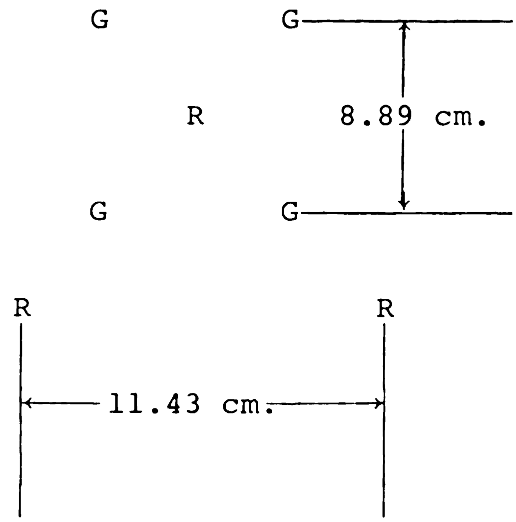
It should be noted that the method of choosing the stimuli allowed the stimulus dimension (not in the design except as a replications factor) to be considered a random factor. Thus, even though there was counterbalancing of the stimuli presented across subjects, it was legitimate to ignore this counterbalancing in the design, since the stimuli were meant to represent a larger domain of possible stimuli. In effect, the stimuli were considered to be parallel forms of a test.

Testing Apparatus, Visual and Auditory Stimuli

The babies were seated in a standard infant chair which was adjusted to a reclining position of approximately 45 degrees. The infant chair was placed into a four-sided Plexiglas structure which had an inflatable air mattress on its floor and on top of the air mattress a 12.7 cm.

thick piece of foam rubber that fit snugly into the bottom of the structure. The Plexiglas structure measured 48.26 cm. (wide) x 38.10 cm. (high) x 77.47 cm. (long), had no top, and was slid into the main testing apparatus, a box-like enclosure entirely light blue in color. The box-like enclosure was 63.50 cm. x 77.47 cm. x 72.39 cm., and had three sides and a roof, but was completely open at the back (i.e., to the back of the infant after he had been moved into the enclosure). There were two peepholes in the roof of the enclosure, each being .63 cm. in diameter. These peepholes were located 31.75 cm. from the open end (back) of the enclosure and 15.87 cm. in from either side.

The visual stimuli were composed of seven lights which were attached to a 12.70 cm. square piece of black cardboard so that only the lights and not the wires were visible to the infant. Four of the lights were green and formed the four corners of a square with 8.89 cm. "sides." Three red lights formed the corners of an equilateral triangle having 11.43 cm. "sides." The picture in Figure 3 illustrates the locations of the seven lights. Note that there were not physical sides to either the square or the triangle, but that when the appropriate lights were on, a square or triangle was described by the placement of the lights. When all lights were off, a clear pattern did not easily emerge--at least for adult observers. The lights describing the red triangle and those describing the green



G = green; R = red.

Figure 3.--Display of Visual Stimuli.

square were turned on independently and automatically via a set of Hunter timers and a 125 V source. Each stimulus presentation lasted 30 seconds, and the inter-trial interval was random from 15-25 seconds ($\bar{x}$ = 20.8). During stimulus presentation the red (or green) lights were on 1 sec., off 500 msec., on 1 sec., off 500 msec. etc. The 12.70 cm. square of black cardboard containing the lights was attached to the center of a strip of plywood which measured 16.51 cm. from top to bottom and extended from side to side of the enclosure 11.43 cm. below the roof. The piece of blue plywood, and therefore the lights, was slanted to an angle of 45 degrees. Thus, the visual stimuli were approximately perpendicular to the infant's line of vision. Eye to stimulus distance was 27.94 cm. to 38.10 cm.

after the baby was in place in the box-like enclosure. The light bulbs used for the stimulus patterns were standard Christmas bulbs of approximately one watt. Background illumination was provided by a 40 watt bulb located at the foot of the testing apparatus. The light was not directly visible to the infant. The room in which testing took place was sound-attenuated and electrically shielded. The polygraph, timers, tape recorder, and all other equipment were in an adjacent room.

An EICO audio-generator (Model 377) was used to produce 1100 and 500 Hz tones of approximately 72 decibels which were recorded on Scotch Low Print recording tape with a Viking tape recorder. The tones were 15 seconds in duration, and a Grason-Stadler Electronic Switch (Model 829E) was used to maintain the rise-decay time of the tones at 250 milliseconds. Graham and Jackson (1970) have discussed the necessity of using tones with "slow" rise times in studies of human infants, since the use of fast rising tones (e.g., rise time less than .05 msec) leads to startle responses. The inter-tone interval was 15-25 seconds ($\overline{x}$ = 20.4 secs.). The tones were played using the Viking recorder in conjunction with a DYNA stereo amplifier, and a Realistic Solo-1 speaker (24.13 cm. x 30.48 cm.). The speaker was located directly in back of the infant at a distance of 50.80 cm.-55.88 cm. after the infant was placed in the apparatus.

Recording Equipment: Polygraph, Electrodes, Electrode Paste, Observers

A Grass Polygraph (Model 7) was used for recording all responses. Heart rate, skin conductance, skin potential and body activity were recorded on the four channels of the polygraph. Stimulus onset and offset, and visual fixation time appeared on the event channel of the polygraph.

Cardiac activity was continuously monitored via two Grass Silver Cup Electrodes. The electrodes were filled with Beckman Electrode Paste, a hypertonic paste that reduces skin resistance, and were then attached above the babies left nipple and below the right rib cage with surgical tape. A ground electrode was attached near the navel. A light blanket, which did not restrict movement, was then placed across the chest to protect the electrodes. The electrodes were connected to a cable which fed into a Wide Band A.C. Pre-Amplifier and Integrator (Grass Model 7P3A). The Model 7P3A was in turn connected to a Tachograph Pre-Amplifier (Grass Model 7P4C) which transformed the raw cardiac activity (electrocardiogram) to instantaneous heart rate in beats per minute. Cardiac activity thus appeared as a tracing on one channel of the polygraph paper in which heart rate could be read as beats per minute.

Continuous recording of general body activity was accomplished by using an inflatable rubber air mattress located under the foam rubber pad on which the infant's chair was placed. The slightest body movements caused a change in pressure in the air mattress. Change in air mattress pressure was monitored by a Grass Volumetric Pressure Transducer (Model PT5A) attached to the stem of the air mattress and to a Grass Low-Level D.C. Pre-Amplifier (Model 7P1A). Therefore, the changes in air mattress pressure (i.e., body activity) appeared on one channel of the polygraph as upward and downward pen deflections.

Onset and offset of the visual stimuli were automatically recorded as an upward pen deflection on the event channel of the polygraph by connecting the event channel to the timers which turned on the stimuli. Visual fixation time as judged by an observer was also recorded on the event channel. An observer looked through the peephole in the roof of the testing chamber and depressed a hand-held switch whenever the visual stimulus was reflected in the right pupil of the infant. This technique of judging "fixation" has been demonstrated repeatedly to be quite reliable (e.g., Fantz, 1964; Cohen <u>et al</u>., 1971).

Skin potential responses (SPR) and skin conductance responses (SCR) were recorded using large silver-silver chloride electrodes (9.5 mm. in diameter). The electrode paste described by Lykken and Venables (1971) was used for both electrodermal responses. The paste is an electrolyte concentration which is very similar in its chemical properties to sweat. Electrode placements for the SPR were the arch of the right foot and the shin of the right leg approximately 1/8 of the way up between the foot and the knee (Brown, 1967). For SCR the two electrodes were placed side by side on the arch of the left foot. For both types of electrodermal recording, the skin was cleansed with 70% ethenol prep pads prior to the electrodes being attached with surgical tape. Finally, booties were placed securely on the babies' feet to keep the temperature of the skin relatively constant and to assist in keeping the electrodes in place.

A Low-Level D.C. Pre-Amplifier (Grass Model 7P1A) was used for recording both types of electrodermal activity. While SPR is endomatic (i.e., requires no external current), SCR requires the application of current to the subject. A 1/2 volt (constant voltage) conductance coupler was used to supply the electrical current to the arch of the left foot. The conductance coupler in conjunction with the Pre-Amplifier allowed the direct recording of skin conductance in μmhos, the reciprocal of skin resistance (ohms). SPR was recorded in millivolts.

Procedure

Upon arrival at the Infant and Toddler Development Laboratory at Michigan State University, the mother (and father on a few occasions) was greeted by the experimenter and his assistant, both of whom were males. After some initial amenities, the mother was given a consent form which required her signature prior to commencing the session (see Appendix C). The experimenter usually played with the baby while the mother read and signed the form. During this time and while the electrodes were being attached, any and all questions about procedure, purpose of study, and so on were answered. The mother was then seated near the testing apparatus, and held the baby, in the infant chair, on her lap while the electrodes were attached. The baby was then placed into the Plexiglas structure, which was slid into the testing apparatus. One of the experimenters remained in the testing room with the baby, but was not visible to the baby. The other experimenter and the baby's mother retired to an adjacent room which contained the polygraph, timers, tape recorder, etc. Final calibrations were made on each channel of the polygraph, and a baseline recording period of approximately thirty seconds ensued. The experimental session then began. While the experiment was in progress the mother filled out the short questionnaire concerning obstetrical history (presented in Appendix B).

Each infant took part in both the auditory and visual habituation tasks with order counterbalanced across subjects. The tasks were separated by an interval of approximately one minute unless the baby appeared to be getting fussy or sleepy in which case the mother returned to the experimental room to see what she could do to get the baby back into a testable state. Both habituation procedures consisted of ten trials and the entire experimental session took approximately 25 minutes. The babies returned to the laboratory when four months of age for the same sequence of events.

Response Measures, Reliability and Scoring

Four indices of attention were recorded for both habituation tasks: heart rate deceleration, change in body activity, skin conductance, and skin potential. In addition, visual fixation was recorded in the visual habituation task. It is emphasized that all of the indices of attention are regarded as facilitating the reception of stimulus input and/or preparing the organism to act on the stimulus. Heart rate deceleration, for example, is regarded as one component of the orienting reaction by Graham and as a facilitator of stimulus reception by Lacey.

Similarly, a decrease in activity seems to be a potentially useful index of attention. Recently, Collins _et al_. (1972) found suppression of limb activity to be associated with looking at blinking lights for four-month-old infants.

The use of skin conductance responses (SCR) and skin potential responses (SPR) also was based on the notion that these responses serve a primitive function of getting the organism "ready" to respond (Lynn, 1966). Both of these responses, and particularly the SCR, were included in a more or less investigatory fashion in the present study, since many investigations have been unsuccessful in obtaining reliable SCR (e.g., Appel, Campos, Silverman, & Conway, 1971, with one-month-old infants). SPR does appear to be more reliable. In any case, in the spirit of trying to find several useful indices of attention for the infant, both measures were included. Finally, visual fixation was used as the fifth index of attention for the visual habituation task.

There are, of course, many ways to score each of the variables included in the present study. Graham and Jackson (1970) have shown that many of the scoring procedures used for cardiac activity are potentially very biased in their outcomes. These researchers suggest either a second-by-second or beat-by-beat analysis of heart rate (HR). Therefore, in the present study, the 20 beats immediately preceding stimulus onset and the 20 beats immediately following stimulus onset were scored (recall that each beat is in beats-per-minute). The mean of each of the 20 beats was then calculated and a difference score of the prestimulus mean minus the poststimulus mean was formed. This heart rate change score was the basic heart rate datum for each subject on every trial. A positive heart rate change score indicated heart rate deceleration from pre- to poststimulus, and a negative heart rate change score indicated heart rate acceleration. It has been found generally that infants less than three months of age do not show HR deceleration easily, but this may be because the state of the infant and the rise-decay time of tones is usually poorly controlled (Berg *et al*., 1971). Both of these factors were scrupulously controlled in the present study. Thus, attention was indicated by a positive change score.

The activity record was scored by rating the degree of change in amount of pen movement from the five second interval immediately preceding stimulus onset to the interval consisting of the first five seconds after stimulus onset. Two raters who had no knowledge of the purposes of the experiment rated all the activity data. A five point Likert scale was used for the ratings in which zero meant that the amount of movement was judged to be the same for the two five-second intervals. A *positive* rating meant that there was a little (+1) or a lot (+2) *more* pen movement following stimulus onset than preceding stimulus onset. A *negative* rating, on the other hand, meant there was a little (-1) or a lot (-2) less pen movement following stimulus onset than preceding it. The reliability of this rating procedure was assessed by having both raters make independent judgments on the same 100 trials of pilot data. There was exact agreement between the raters on 86 trials, a discrepancy of 1 point on 12 trials and a discrepancy of 2 points on 2 trials.

For ease of coding negative signs were eliminated by adding 3 to each rating. Thus, 3 designated no change in activity from prestimulus to poststimulus interval, 1 and 2 designated a large and a little decrease from prestimulus to poststimulus interval, and 4 and 5 designated a little and a large increase in activity from the prestimulus to the poststimulus interval. Therefore, each infant had one activity change score for each trial, and small scores indicated attention.

Total visual fixation (TF) for each 30 second presentation of the visual stimulus and first fixation (FF) were both recorded. The correlation between these measures over all trials was .84, a finding consistent with previous research (e.g., Lewis *et al.*, 1969). Total fixation was chosen as the index of attention, since it seems intuitively more appealing than FF. For example, the infant may be momentarily distracted by stomach gurgling or whatever, and it would seem inappropriate to regard a short FF in such cases as a good index of attention.

TF seems to be more likely to control for such events. Thus each infant has a TF index of attention on each trial, relatively large TF designating attention.

The reliability of fixation judgments was estimated by having two observers make judgments on several of the babies who served as pilot subjects. All aspects of the experimental set-up and procedure were the same as they were in the actual study except that two observers looked through the peepholes and each observer made judgments on fixation time. Judgments were based on observing the stimulus in the right pupil of the infant. Interobserver reliability was computed by correlating total fixation times recorded by the two observers on each trial (length of fixation is easily determined from the polygraph tracing by taking paper speed into account). The resulting correlation coefficient was .91. This reliability index is based on judgments made on 4 two-month-olds (80 trials) and 2 four-month-olds (40 trials).

Finally, SCR and SPR were scored very similarly. For both of these indices an interval was marked off from stimulus onset to 5 seconds after stimulus onset. Then the first response that <u>began</u> between 1.5 to 5 seconds after stimulus onset was scored (Edelberg, 1972). For SC this meant that a positive change in slope of the SC curve had to occur, since SCR is a uniphasic response. If the change in slope occurred, the difference between the point where the slope changed and the maximum level the response reached was scored as the response (even if this was 7 or 8 seconds after stimulus onset). Thus, on each trial the infant had either a SCR score of zero or a positive score in µmhos (the reciprocal of galvanic skin response in ohms).

The SPR was scored in the same manner except that SPR can be uniphasic, biphasic, or rarely even triphasic (Steinschneider, 1967), though no triphasic responses were observed in the present study. Thus, the first change in slope in the prescribed interval, whether it be a positive or negative change, was considered the beginning of the SPR. The SPR was scored as a uniphasic response if the peak was attained and the pen did not go back past the point where the response started within three seconds. In this instance the SPR was scored like the SCR (except it could be in either direction). On the other hand, if an SPR started, reached a peak (positive or negative), then went (within three seconds) back past the point where the response began and continued on to a lower (or higher) level, the distance from peak to peak was scored as the response. Thus, SPRs were scored regardless of direction to give an estimate of total skin potential change (Edelberg, 1967). The SPR was scored in mv.

Dependent Variables: Data Reduction

The following dependent variables were formed for each index of attention. The subject's index of attention on trial 1 was added to the same index on trial 2. Similarly, the scores on the index for trials 7 and 8 were added, as were those for trials 9 and 10. This was done for each subject on each index of attention. Then, difference scores were calculated between $T_{1+2} - T_{7+8}$ and $T_{9+10} - T_{7+8}$. All the analyses in this study were performed on these two difference scores. The first difference score is a decrement score. The second difference score is a recovery score. Each infant had a pair of these scores for each index of attention, and they form the basic data for analysis. The scores for one subject are presented in Table 2.

Statistical Analysis

A 2^5 factorial analysis of variance (ANOVA) with repeated measures on two factors was used to analyze decrement and recovery scores for each index of attention. The repeated measures factors were age (A) and modality of habituation task (M). The other factors were order of task (O), treatment/control (T), and sex (S). There were four infants per cell of the design (n = 4) and all factors were considered fixed except the replication factor (R). R is, of course, crossed with A and M but nested within O, T, and S (see Figure 2).

The usual assumptions associated with analysis of variance were made for the present analysis, i.e., homoscedasticity of variance, and normal and independent

TABLE 2

EXAMPLE OF DECREMENT AND RECOVERY SCORES USED IN DATA ANALYSIS*

	SCR	SPR	HR Change	Activity Change	TF
T1	.62	1.00	6.00	1	20.10
T2	.50	1.62	2.30	3	24.00
T7	.69	.87	.30	3	19.40
T8	0	.67	.45	3	6.30
T9	.37	1.75	.55	3	25.00
T10	.25	1.00	2.45	3	28.00
T1+T2	1.12	2.62	8.30	4	44.10
T7+T8	.69	1.54	.75	6	25.70
T9+T10	.62	2.75	3.00	6	53.00
Decrement Score (T1+T2)-(T7+T8)	.43	1.08	7.55	-2	18.40
Recovery Score (T9+T10)-(T7+T8)	-.07	1.21	2.25	0	27.30

$T_1 \ldots T_{10}$: Trial 1...Trial 10

SCR: Skin conductance response in µmhos

SPR: Skin potential response in mv

HR Change: Heart rate change from pre- to poststimulus in beats/minute

Activity Change: Relative activity in poststimulus versus prestimulus interval

TF: Total fixation time

*See text (Response Measures, Reliability and Scoring) for complete description of Table 2.

distribution of scores. With regard to the first two assumptions, Box (1954) has shown that for balanced designs ANOVA with fixed effects is robust to violations of normality and homoscedasticity. Since the design of the present study was balanced, these assumptions were not important. The last assumption, however, is a crucial concern in studies which employ repeated measures and has associated with it assumptions concerning the variance-covariance structure of the data. In addition to the fact that independence of replications was assured by the experimental procedure, however, the use of only two levels for each repeated measures factor assures that the stringent variance-covariance assumptions are met (Kirk, 1969; Winer, 1971).

In addition to the ANOVA, Pearson product-moment correlation coefficients for decrement and recovery scores were calculated across ages for each modality and across modalities within each age. Finally, correlations among indices of attention for decrement and recovery were calculated within each modality for each age.

Summary

The longitudinal study of two- to four-month-old infants was designed to address several concerns. First, the age range included in the present study is sorely under-researched with regard to investigations of habituation. Second, several measures of response decrement and recovery were included since habituation in two-month-old infants has not been demonstrated, and since it was believed that multiple outcome measures are beneficial in any study of infant behavior. Also, the question of the global versus specific nature of habituation was addressed by using several autonomic and somatic indices of attention. Third, a preliminary examination of cross-modal habituation and within infant consistency in habituation across ages was seen as an important first step in determining the mechanism(s) of response decrement. Finally, the design of the study minimized the impact of peripheral mechanisms such as effector fatigue as explanations of response decrement, i.e., if decrement and recovery were present, it was likely that habituation was demonstrated.

An order of habituation task x treatment/control x sex x age x modality analysis of variance with repeated measures on the last two factors was used to analyze response decrement and recovery scores. Further, Pearson correlation coefficients across modalities within ages, across ages within modalities, and among indices of attention within age and modality were calculated for the decrement and recovery scores.

CHAPTER V

RESULTS

Descriptive Statistics

Before the results are analyzed, two tables of descriptive statistics are presented. Table 3 contains the means, standard deviations, and standard errors of the mean for the three sets of trials used in forming the decrement and recovery scores. Note that the means in Table 3 are each based on the sum of two trials. For example, looking at HRC for trials 1 _and_ 2, there was an average heart rate deceleration of 5.36 beats.

The means, standard deviations, and standard errors of the mean for the two difference score variables formed by Trial_{1+2} - Trial_{7+8} and Trial_{9+10} - Trial_{7+8} are presented in Table 4. Note that for decrement a positive score indicates decreased attention while for recovery a positive score indicates increased attention. This holds for _all_ variables _except_ the activity change score. For the latter variable relatively high scores on each trial indicate increases in activity from pre- to poststimulus intervals. Thus, decrement and recovery in suppression of activity is indicated by a negative score.

TABLE 3*

MEANS, STANDARD DEVIATIONS, AND STANDARD ERRORS OF THE MEAN OVER ALL SUBJECTS FOR THE SUMS OF TRIALS 1+2, TRIALS 7+8, AND TRIALS 9+10

Trials	Response Measure	Mean	S.D.	S.E.
1+2	SCR	.86	.76	.07
	SPR	1.14	.88	.08
	HRC	5.36	5.76	.51
	AC	4.37	1.69	.15
	TF	43.67	13.17	1.65
7+8	SCR	.66	.88	.08
	SPR	.98	.70	.06
	HRC	1.86	5.45	.48
	AC	5.72	1.32	.12
	TF	33.61	16.07	2.01
9+10	SCR	.68	.48	.04
	SPR	1.21	.75	.07
	HRC	2.53	4.58	.40
	AC	5.57	1.33	.12
	TF	37.21	17.78	2.22

*All measures are for both modalities, except TF which is just for the visual modality.

SCR: Skin conductance response (μmhos)
SPR: Skin potential response (millivolts)
HRC: Heart rate change (i.e., prestimulus-poststimulus in bpm)
AC: Activity change from prestimulus to poststimulus
TF: Total fixation time out of 30 seconds presentation/trial

TABLE 4*

MEANS, STANDARD DEVIATIONS, AND STANDARD ERRORS OF THE MEAN FOR THE TWO DIFFERENCE SCORES USED IN HYPOTHESIS TESTING

Difference Score	Response Measure	Mean	S.D.	S.E.
	SCR	.20	.95	.08
(Trial 1+2) -	SPR	.16	1.02	.09
(Trial 7+8) =	HRC	3.50	8.03	.71
Decrement	AC	-1.35	2.00	.18
	TF	10.06	16.84	1.48
	SCR	.02	.90	.08
(Trial 9+10) -	SPR	.23	.74	.06
(Trial 7+8) =	HRC	.67	6.57	.58
Recovery	AC	-.15	1.76	.16
	TF	3.60	15.68	1.38

*See Legend for Table 3.

Hypothesis Testing

Overall Decrement of Attention

The first hypothesis predicted a decrease in attention with repeated stimulus presentations. That is, the decrement scores for each index of attention should be greater than zero, except for the decrement score for activity which should be less than zero. Tables 5 through 9

TABLE 5

ANALYSIS OF VARIANCE SUMMARY TABLE FOR
SKIN CONDUCTANCE DECREMENT SCORES

Source	SS	d.f.	MS	F*	p
Gd Mean	5.28	1	5.28	6.14	<.05
Total	114.78	127	.90		
O	.74	1	.74		
T	.14	1	.14		
OT	.31	1	.31		
S	.09	1	.09		
OS	.16	1	.16		
TS	.38	1	.38		
OTS	.08	1	.08		
R:OTS	20.65	24	.86		
A	.82	1	.82		
OA	1.60	1	1.60		
TA	1.39	1	1.39		
SA	.36	1	.36		
TOA	.01	1	.01		
SOA	.04	1	.04		
TSA	.62	1	.62		
OTSA	.00	1	.00		
AR:OTS	32.67	24	1.36		
M	.81	1	.81		
OM	.65	1	.65		
TM	.44	1	.44		
SM	.12	1	.12		
OTM	.24	1	.24		
OSM	.10	1	.10		
TSM	.54	1	.54		
OTSM	.09	1	.09		
MR:OTS	27.75	24	1.15		
AM	.80	1	.80		
OAM	.38	1	.38		
TAM	5.05	1	5.05	8.16	<.01
SAM	.17	1	.16		
OTAM	.02	1	.02		
OSAM	.04	1	.04		
TSAM	2.17	1	2.17		
OTSAM	.35	1	.35		
AMR:OTS	14.84	24	.61		

O: Order of habituation task
T: Treatment/control
S: Sex
A: Age
M: Modality of stimulation
R:OTS: Replications (subjects) nested within O, T, and S

*In all tables F's not presented were not statistically significant at $p \leq .05$.

TABLE 6*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR SKIN POTENTIAL DECREMENT SCORES

Source	SS	d.f.	MS	F	p
Gd mean	3.14	1	3.14	1.92	n.s.
Total	131.01	127	1.03		
O	.35	1	.35		
T	3.87	1	3.87		
OT	2.98	1	2.98		
S	.41	1	.41		
OS	.06	1	.06		
TS	1.20	1	1.20		
OTS	.08	1	.08		
R:OTS	39.34	24	1.63		
A	1.81	1	1.80		
OA	.65	1	.65		
TA	.03	1	.03		
SA	3.30	1	3.30		
TOA	.12	1	.12		
SOA	.06	1	.06		
TSA	.28	1	.28		
OTSA	1.17	1	1.17		
AR:OTS	20.22	24	.84		
M	4.89	1	4.89	4.62	<.05
OM	.23	1	.23		
TM	.00	1	.00		
SM	.28	1	.28		
OTM	.12	1	.12		
OSM	1.63	1	1.63		
TSM	.24	1	.24		
OTSM	1.22	1	1.22		
MR:OTS	25.57	24	1.06		
AM	.28	1	.28		
OAM	.17	1	.17		
TAM	.35	1	.35		
SAM	.10	1	.10		
OTAM	.08	1	.08		
OSAM	.41	1	.41		
TSAM	.16	1	.16		
OTSAM	.03	1	.03		
AMR:OTS	19.15	24	.79		

*See Legend for Table 5.

TABLE 7*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR
HEART RATE CHANGE DECREMENT SCORES

Source	SS	d.f.	MS	F	p
Gd mean	1566.60	1	1566.60	22.47	<.01
Total	8184.52	127	64.44		
O	2.47	1	2.47		
T	75.64	1	75.64		
OT	37.41	1	37.41		
S	40.27	1	40.27		
OS	77.19	1	77.19		
TS	5.44	1	5.44		
OTS	25.92	1	25.92		
R:OTS	1673.35	24	69.72		
A	284.70	1	284.70	4.63	<.05
OA	.61	1	.61		
TA	.56	1	.56		
SA	5.16	1	5.16		
TOA	.96	1	.96		
SOA	16.03	1	16.03		
TSA	210.89	1	210.89		
OTSA	45.00	1	45.00		
AR:OTS	1474.20	24	61.42		
M	77.50	1	77.50		
OM	2.53	1	2.53		
TM	72.30	1	72.30		
SM	39.82	1	39.82		
OTM	6.39	1	6.39		
OSM	2.70	1	2.70		
TSM	46.08	1	46.08		
OTSM	40.95	1	40.95		
MR:OTS	1550.05	24	64.58		
AM	39.49	1	39.49		
OAM	202.25	1	202.25		
TAM	4.84	1	4.84		
SAM	164.93	1	164.93		
OTAM	32.70	1	32.70		
OSAM	14.64	1	14.64		
TSAM	169.97	1	169.97		
OTSAM	45.96	1	45.96		
AMR:OTS	1695.50	24	70.64		

*See Legend for Table 5.

TABLE 8*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR ACTIVITY CHANGE DECREMENT SCORES

Source	SS	d.f.	MS	F	p
Gd mean	233.82	1	233.82	64.24	<.01
Total	507.18	127	3.99		
O	3.44	1	3.44		
T	4.13	1	4.13		
OT	10.69	1	10.69		
S	1.32	1	1.32		
OS	4.88	1	4.88		
TS	33.00	1	33.00	9.04	<.01
OTS	4.88	1	4.88		
R:OTS	87.56	24	3.64		
A	6.57	1	6.57		
OA	4.13	1	4.13		
TA	.94	1	.94		
SA	4.88	1	4.88		
TOA	.19	1	.19		
SOA	.38	1	.38		
TSA	2.25	1	2.25		
OTSA	9.57	1	9.57		
AR:OTS	128.81	24	5.36		
M	.00	1	.00		
OM	7.50	1	7.50		
TM	20.32	1	20.32	7.51	<.01
SM	8.50	1	8.50		
OTM	.63	1	.63		
OSM	.94	1	.94		
TSM	10.69	1	10.69		
OTSM	6.57	1	6.57		
MR:OTS	65.56	24	2.73		
AM	.63	1	.63		
OAM	1.32	1	1.32		
TAM	1.75	1	1.75		
SAM	.94	1	.94		
OTAM	2.25	1	2.25		
OSAM	6.57	1	6.57		
TSAM	1.32	1	1.32		
OTSAM	4.13	1	4.13		
AMR:OTS	59.81	24	2.49		

*See Legend for Table 5.

TABLE 9*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR
TOTAL FIXATION DECREMENT SCORES

Source	SS	d.f.	MS	F	p
Gd mean	6474.41	1	6474.41	20.26	<.01
Total	17872.18	63	283.68		
O	62.23	1	62.23		
T	22.21	1	22.21		
OT	769.43	1	769.43		
S	23.99	1	23.99		
OS	34.53	1	34.53		
TS	48.98	1	48.98		
OTS	7.97	1	7.97		
R:OTS	7689.93	24	320.41		
A	506.86	1	506.86		
OA	484.49	1	484.49		
TA	1187.75	1	1187.75	5.40	<.05
SA	273.94	1	273.94		
TOA	527.21	1	527.21		
SOA	350.57	1	350.57		
TSA	251.18	1	251.18		
OTSA	354.33	1	354.33		
A:ROTS	5276.50	24	219.85		

*The Legend for this table is the same as Table 5 except all sources with M as a component have been removed since the fixation measure is only appropriate for the visual modality.

contain the relevant tests of significance. Each table contains a summary ANOVA of the decrement scores for one of the indices of attention.

The hypothesis of overall decreases in attention over trials received substantial support, and was accepted. In fact, the grand mean for decrement scores was significantly different than zero for all indices of attention but skin potential. Decrement for SCR was significant at

$p < .05$ (Table 5), while HRC, AC, and TF were all significant at $p < .01$ (Tables 7, 8, 9). Thus, as indicated by the mean decrement scores in Table 4, there was significantly less skin conductance (.20 μmhos), less heart rate deceleration (3.5 bpm), less total fixation time (10.06 secs.) and <u>more</u> activity (-1.35 rating) on trials 7 and 8 than on trials 1 and 2.

As indicated in Table 6, while there was no significant overall decrement in SPR, SPR decrement scores did differ as a function of modality. The mean SPR decrement score for the visual stimulation was .352 mv, while that for the auditory stimulation was -.039. This indicates that with repeated presentations of the stimuli SPR decreased for visual stimulation, but increased very slightly for auditory stimulation.

Before moving on to the second hypothesis, several significant interactions must be specified. First, there was a significant treatment x age interaction for TF decrement scores (Table 9). This effect was due to the fact that for infants in the treatment group there was much more decrement in TF at four months of age (17.77 secs.) than at two months of age (3.52 secs.). On the other hand, for infants in the control group, there was slightly less TF decrement at four months (7.97 secs.) than at two months (10.96 secs.).

There were also significant interactions involving AC decrement: treatment x sex, and treatment x modality (Table 8). The former interaction obtained because there was greater AC decrement for females (-1.94) than for males (-1.12) in the treatment group. But, in the control group, there was more AC decrement for males (-1.78 vs. -.56 for females). The treatment x modality interaction was reflected in greater AC decrement, in the treatment group, for auditory stimulation (-1.63) than for visual stimulation (-1.00). Further, for controls the opposite was the case: visual = -1.57 and auditory = -.48.

Finally, there was a significant treatment x age x modality interaction for SCR decrement (Table 5). For the treatment group, at two months of age there was greater SCR decrement to visual stimulation (.28 μmhos) than to auditory stimulation (.21 μmhos), while the opposite was the case at four months of age (.29 and .33 μmhos for M_1 and M_2, respectively). For the control group, the same relationship, though of a larger magnitude, held at two months of age (.60 and .03 μmhos for M_1 and M_2). But, at four months for the controls, SCR decrement was virtually identical and, in fact, slightly incremental (-.05 for M_1, -.08 for M_2).

<u>Age Effects</u>

The second hypothesis was that four-month-old babies would demonstrate greater decreases in attention than two-month-old infants. The significant age main effect for the HRC decrement scores is presented in Table 7 ($F = 4.63$, $p < .05$). The mean HRC decrement scores for the two- and four-month-old infants were 2.0 and 4.99, respectively. Thus, the older infants showed significantly greater decrement (i.e., less HR deceleration on later trials). Therefore, the hypothesis of age effects in response decrement was only partially supported, since there were not significant age main effects for the other indices of attention.

Treatment/Control: Recovery of Attention

The third hypothesis was the most important, since it dealt with the stimulus specificity of response decrement. Greater dishabituation or recovery of attention on the last two trials was hypothesized for infants presented a nonfamiliarized stimulus relative to infants presented the stimulus familiarized over the previous eight trials. As indicated in Table 15, the differences in dishabituation between treatment (decrement/recovery stimuli) and control (decrement stimulus only) groups were in the predicted direction for all five indices of recovery of attention. Further, as presented in Table 10-14, the treatment main effects for recovery scores were statistically reliable for all indices of attention except heart rate change.

TABLE 10*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR
SKIN CONDUCTANCE RECOVERY SCORES

Source	SS	d.f.	MS	F	p
Gd mean	.03	1	.03		
Total	102.81	127	.80		
O	.04	1	.04		
T	5.52	1	5.52	6.08	<.05
OT	.53	1	.53		
S	1.66	1	1.66		
OS	.04	1	.04		
TS	1.85	1	1.85		
OTS	.21	1	.21		
R:OTS	21.80	24	.90		
A	1.97	1	1.97		
OA	.58	1	.58		
TA	.49	1	.49		
SA	2.05	1	2.05		
TOA	.01	1	.00		
SOA	.07	1	.07		
TSA	.18	1	.18		
OTSA	.02	1	.02		
AR:OTS	21.46	24	.89		
M	.07	1	.07		
OM	.04	.	.04		
TM	1.11	1	1.11		
SM	1.14	1	1.14		
OTM	.06	1	.06		
OSM	.00	1	.00		
TSM	2.00	1	2.00		
OTSM	.40	1	.40		
MR:OTS	16.88	24	.70		
AM	2.61	1	2.61	4.76	<.05
OAM	.24	1	.24		
TAM	1.96	1	1.96		
SAM	2.72	1	2.72	4.94	<.05
OTAM	.24	1	.24		
OSAM	.02	1	.02		
TSAM	1.01	1	1.01		
OTSAM	.36	1	.36		
AMR:OTS	13.33	24	.55		

*See Legend for Table 5.

TABLE 11*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR SKIN POTENTIAL RECOVERY SCORES

Source	SS	d.f.	MS	F	p
Gd mean	6.85	1	6.84		
Total	69.38	127	.54		
O	.51	1	.51		
T	7.35	1	7.35	12.68	<.01
OT	.25	1	.25		
S	1.04	1	1.04		
OS	.08	1	.08		
TS	.02	1	.02		
OTS	.00	1	.00		
R:OTS	13.92	24	.58		
A	1.72	1	1.72		
OA	.11	1	.11		
TA	.00	1	.00		
SA	.43	1	.43		
TOA	.14	1	.14		
SOA	.10	1	.10		
TSA	.00	1	.00		
OTSA	.62	1	.62		
AR:OTS	11.92	24	.49		
M	.00	1	.00		
OM	.13	1	.13		
TM	.00	1	.00		
SM	.54	1	.54		
OTM	.87	1	.87		
OSM	.05	1	.05		
TSM	.17	1	.17		
OTSM	.49	1	.49		
MR:OTS	16.17	24	.67		
AM	.01	1	.01		
OAM	.05	1	.05		
TAM	.19	1	.19		
SAM	.02	1	.02		
OTAM	.00	1	.00		
OSAM	1.03	1	1.03		
TSAM	.01	1	.01		
OTSAM	.23	1	.23		
AMR:OTS	11.09	24	.46		

*See Legend for Table 5.

TABLE 12*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR HEART RATE CHANGE RECOVERY SCORES

Source	SS	d.f.	MS	F	p
Gd mean	57.11	1	57.11		
Total	5487.58	127	43.20		
O	.15	1	.15		
T	140.49	1	140.49	3.80	n.s.
OT	110.63	1	110.63		
S	.52	1	.52		
OS	5.16	1	5.16		
TS	2.00	1	2.00		
OTS	48.14	1	48.14		
R:OTS	887.41	24	36.97		
A	2.07	1	2.07		
OA	.81	1	.81		
TA	92.65	1	92.65		
SA	15.54	1	15.54		
TOA	2.53	1	2.53		
SOA	.18	1	.18		
TSA	95.22	1	95.22		
OTSA	33.51	1	33.51		
AR:OTS	1282.67	24	53.44		
M	111.19	1	111.19		
OM	6.12	1	6.12		
TM	18.22	1	18.22		
SM	23.12	1	23.12		
OTM	64.41	1	64.41		
OSM	110.81	1	110.81		
TSM	100.11	1	100.11		
OTSM	6.52	1	6.52		
MR:OTS	776.07	24	32.33		
AM	.82	1	.82		
OAM	66.12	1	66.12		
TAM	18.22	1	18.22		
SAM	117.42	1	117.42		
OTAM	22.78	1	22.78		
OSAM	1.73	1	1.73		
TSAM	11.40	1	11.40		
OTSAM	.48	1	.48		
AMR:OTS	1312.23	24	54.67		

*See Legend for Table 5.

TABLE 13*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR
ACTIVITY CHANGE RECOVERY SCORES

Source	SS	d.f.	MS	F	p
Gd mean	2.82	1	2.82		
Total	394.18	127	3.10		
O	.07	1	.07		
T	51.25	1	51.25	15.82	<.01
OT	10.69	1	10.69		
S	.19	1	.19		
OS	9.57	1	9.57		
TS	15.82	1	15.82	4.88	<.05
OTS	.63	1	.63		
R:OTS	77.68	24	3.23		
A	.00	1	.00		
OA	.19	1	.19		
TA	2.82	1	2.82		
SA	.07	1	.07		
TOA	.19	1	.19		
SOA	.00	1	.00		
TSA	.94	1	.94		
OTSA	2.82	1	2.82		
AR:OTS	46.68	24	1.94		
M	2.82	1	2.82		
OM	.19	1	.19		
TM	1.32	1	1.32		
SM	.63	1	.63		
OTM	.63	1	.63		
OSM	.38	1	.38		
TSM	6.57	1	6.57		
OTSM	1.75	1	1.75		
MR:OTS	40.43	24	1.68		
AM	1.32	1	1.32		
OAM	1.75	1	1.75		
TAM	.19	1	.19		
SAM	29.07	1	29.07	8.94	<.01
OTAM	2.82	1	2.82		
OSAM	1.75	1	1.75		
TSAM	.00	1	.00		
OTSAM	4.88	1	4.88		
AMR:OTS	77.93	24	3.24		

*See Legend for Table 5.

TABLE 14*

ANALYSIS OF VARIANCE SUMMARY TABLE FOR TOTAL FIXATION RECOVERY SCORES

Source	SS	d.f.	MS	F	p
Gd mean	829.87	1	829.87		
Total	15443.47	63	245.13		
O	63.52	1	63.52		
T	4779.30	1	4779.30	23.24	<.01
OT	85.00	1	85.00		
S	63.48	1	63.48		
OS	3.08	1	3.08		
TS	28.97	1	28.97		
OTS	60.52	1	60.52		
R:OTS	4934.70	24	205.61		
A	326.97	1	326.97		
OA	139.35	1	139.35		
TA	246.72	1	246.72		
SA	520.18	1	520.18		
TOA	33.12	1	33.12		
SOA	94.67	1	94.67		
TSA	283.67	1	283.66		
OTSA	40.25	1	40.25		
AR:OTS	3739.90	24	155.82		

*See Legend for Tables 5 and 9.

TABLE 15

MEANS FOR DISHABITUATION FOR TREATMENT AND CONTROL GROUPS

	Treatment	Control
SCR	.224	- .192
SPR	.471	- .008
TF	12.242	-5.041
AC	-.781	.484
HRC	1.716	- .380

SCR: Skin conductance (μmhos)
SPR: Skin potential (millivolts)
TF: Total fixation (seconds)
AC: Activity change score
HRC: Heart rate change score (deceleration in beats per minute)

Thus, the hypothesized dishabituation effect clearly obtained. The inference, therefore, is that response decrement was stimulus-specific and that habituation was the mechanism responsible for the decrement.

For dishabituation, sex was the only factor which interacted significantly with treatments (Table 13). The interaction is depicted in Figure 4 where it is seen that, on trials 9 + 10 compared to trials 7 + 8, girls in the control group were more active (recovery score = .87) than boys in the control group (recovery score = .09). On the other hand, girls in the treatment group exhibited a greater decrease in activity (recovery = -1.09) than boys in the treatment group (recovery = -.47). The interaction is due to the greater difference in activity dishabituation scores between treatment groups for girls ($t = 3.06$, $p < .01$).

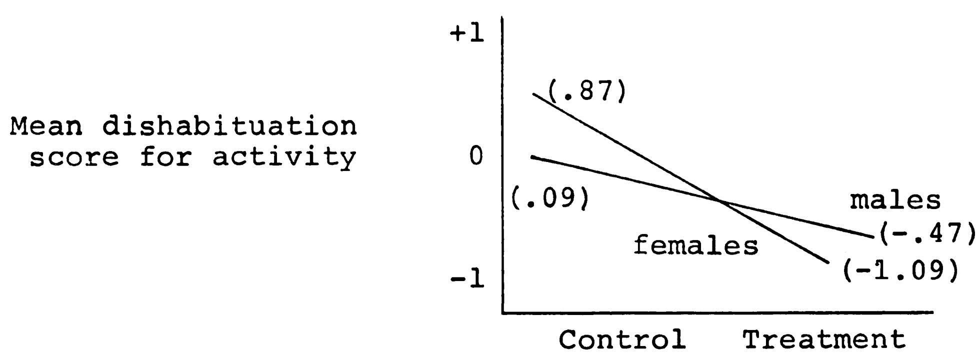


Figure 4.--Treatment by Sex Interaction for Dishabituation on the Activity Measure.

There were three other significant interactions for dishabituation. The sex x age x modality interaction was significant for SCR and for activity (Tables 10 and 13). For SCR, males at both ages showed greater dishabituation for visual stimulation (.20 μmhos at two months and .21 μmhos at four months) than for auditory stimulation (.06 μmhos at both ages). Females, on the other hand, exhibited no clear pattern of dishabituation for SCR. At two months, females showed recovery for visual stimulation (.32 μmhos), but slight continued decrement for auditory stimulation (-.02 μmhos). The opposite result obtained for females at four months. That is, they demonstrated rather substantial continued decrement for visual stimulation (-.76 μmhos) and only slight recovery for auditory stimulation (.06 μmhos).

With regard to the activity measure, the significant sex x age x modality interaction had the following characteristics. First, for males at two months of age, there was dishabituation of activity suppression for auditory stimulation (-.75), but continued decrement for visual stimulation (.44). At four months males exhibited dishabituation for both modalities, though only slightly for the auditory (-.37 for visual, -.06 for auditory). For females, there was dishabituation of activity suppression for visual stimulation at two months (-.62) and for auditory stimulation at four months (-.75). On the other hand, there was continued decrement in activity suppression for auditory stimulation at two months (.37) and for visual stimulation at four months (.56).

Finally, the age by modality interaction for dishabituation of SCR was significant (Table 10). The interaction is depicted in Figure 5 and is due to the significant age difference in dishabituation for the visual habituation task only ($t = 2.53$, $p < .05$). That is, there was not dishabituation at either age for auditory stimulation. On the other hand, for visual stimulation there was dishabituation only for the two-month-old infants (.259 μmhos), while there was continued decrement for the four-month-olds (-.275 μmhos).

Sex Differences

It was predicted that males would exhibit greater decrement and recovery of attention than females. Perusal

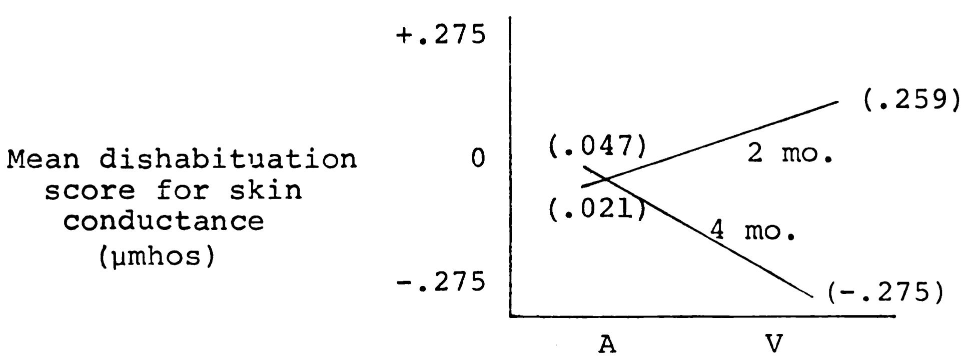


Figure 5.--Age by Modality Interaction for Dishabituation of Skin Conductance.

of Tables 5 to 9 reveals not a single main effect for sex. In fact, the only interaction with sex for decrement scores was the previously cited treatment by sex interaction for activity (Table 8). Thus, the hypothesis of sex differences in response decrement was rejected.

Similarly, the analyses of variance for recovery scores revealed no significant main effects for sex (Tables 10-14). Therefore, the hypothesis of an overall sex difference in recovery of attention did not obtain. As discussed previously, there was a significant treatment x sex interaction for dishabituation on the activity measure. Thus, there was some evidence of greater dishabituation for females.

Decrement and Recovery: Cross-Age Correlations

A positive correlation between ages (for each modality separately) was hypothesized for decrement of attention. The same prediction was made for response recovery or dishabituation. The between age correlations for the auditory habituation task are presented in Tables 16 and 17 for response decrement and response recovery, respectively. It is clear from these tables that for the auditory habituation task, none of the cross-age correlations for dishabituation were significant. For response decrement, only the cross-age correlation of .41 for SCR was significantly different than zero ($p < .05$).

TABLE 16

BETWEEN AGE CORRELATIONS FOR RESPONSE DECREMENT
FOR EACH INDEX OF ATTENTION
(AUDITORY STIMULATION)

	Two Months			
	SCR	SPR	HRC	AC
Four months:				
SCR	.41*			
SPR		.06		
HRC			-.19	
AC				.08

SCR: Skin conductance
SPR: Skin potential
HRC: Heart rate change (i.e., deceleration)
AC: Activity change score

*Correlation significantly different than zero ($p<.05$).

TABLE 17*

BETWEEN AGE CORRELATIONS FOR RESPONSE RECOVERY
FOR EACH INDEX OF ATTENTION
(AUDITORY STIMULATION)

	Two Months			
	SCR	SPR	HRC	AC
Four months:				
SCR	.08			
SPR		.29		
HRC			-.30	
AC				.24

*See Legend for Table 16.

For the visual habituation task, Table 18 contains the cross-age correlations for response decrement, while Table 19 contains the correlations for response recovery. The conclusion from Tables 18 and 19 is that none of the cross-age correlations for response recovery are significant for the visual habituation task. Further, only the correlation for SPR is significantly greater than zero for the decrement scores. Thus, there was only meager support for the hypothesized cross-age positive correlations for response decrement and no support for the corresponding predictions for response recovery.

Decrement and Recovery: Cross-Modal Correlations

A positive correlation between modalities for response decrement was hypothesized for each index of attention. The same hypothesis was made for response recovery. Tables 20 and 21 contain the correlations for response decrement and response recovery for the two-month-old babies, while the correlations for response decrement and response recovery for the four-month-old infants are presented in Tables 22 and 23.

Examination of Tables 20 to 23 reveals that the hypothesis received very meager support. The only cross-modal correlation that was significantly greater than zero was the correlation for SPR response decrement for the two-month-old subjects. Thus, the hypothesis of

TABLE 18*

BETWEEN AGE CORRELATIONS FOR RESPONSE DECREMENT FOR EACH INDEX OF ATTENTION (VISUAL STIMULATION)

	Two Months				
	SCR	SPR	HRC	AC	TF
Four months:					
SCR	-.25				
SPR		.48**			
HRC			.20		
AC				.10	
TF					.00

TF: Total fixation time

*See Legend for Table 16.

**p<.01

TABLE 19*

BETWEEN AGE CORRELATIONS FOR RESPONSE RECOVERY FOR EACH INDEX OF ATTENTION (VISUAL STIMULATION)

	Two Months				
	SCR	SPR	HRC	AC	TF
Four months:					
SCR	.16				
SPR		.20			
HRC			-.03		
AC				-.04	
TF					.33

*See Legend for Tables 16 and 18.

TABLE 20

CROSS-MODAL CORRELATIONS FOR RESPONSE DECREMENT
FOR EACH INDEX OF ATTENTION
(TWO-MONTH-OLD INFANTS)

	Visual Stimulation			
	SCR	SPR	HRC	AC
Auditory Stimulation:				
SCR	.07			
SPR		.38*		
HRC			-.19	
AC				.13

SCR: Skin conductance
SPR: Skin potential
HRC: Heart rate deceleration
AC: Activity change score

*p<.05

TABLE 21*

CROSS-MODAL CORRELATIONS FOR RESPONSE RECOVERY
FOR EACH INDEX OF ATTENTION
(TWO-MONTH-OLD INFANTS)

	Visual Stimulation			
	SCR	SPR	HRC	AC
Auditory Stimulation:				
SCR	.18			
SPR		.01		
HRC			-.03	
AC				.15

*See Legend for Table 20.

TABLE 22*

CROSS-MODAL CORRELATIONS FOR RESPONSE DECREMENT FOR EACH INDEX OF ATTENTION (FOUR-MONTH-OLD INFANTS)

	Visual Stimulation			
	SCR	SPR	HRC	AC
Auditory Stimulation:				
SCR	.07			
SPR		-.18		
HRC			.10	
AC				.32

*See Legend for Table 20.

TABLE 23*

CROSS-MODAL CORRELATIONS FOR RESPONSE RECOVERY FOR EACH INDEX OF ATTENTION (FOUR-MONTH-OLD INFANTS)

	Visual Stimulation			
	SCR	SPR	HRC	AC
Auditory Stimulation:				
SCR	.28			
SPR		.25		
HRC			.05	
AC				.10

*See Legend for Table 20.

positive cross-modal correlations, within ages, for recovery of attention and for decrement of attention was not accepted.

Habituation: Global Versus Specific Nature

The last hypothesis concerned the question of the specificity of decrement and recovery of attention. It was predicted that, within each age and within each modality, the indices of attention would be positively correlated for response decrement. The same hypothesis was made for response recovery. Table 24 contains the appropriate correlations for the infants at two months of age. The correlations for the four-month-old infants appear in Table 25.

Before discussing the results in Tables 24 and 25, it should be noted that decrement of activity suppression and recovery of activity suppression are defined as negative numbers. Since decrement and recovery for all other indices are defined as positive numbers, the correlation between activity and any other response is hypothesized to be negative.

Inspection of the upper portions of Tables 24 and 25 reveals little support for the hypothesis that response decrement is a global or holistic phenomenon. For each type of stimulation, and for each age, there are only sporadic significant correlations among the indices of

TABLE 24

CORRELATIONS AMONG INDICES OF ATTENTION
FOR TWO-MONTH-OLD INFANTS

	SCR	SPR	HRC	AC	TF
Response Decrement:					
Visual Stimulation:					
SCR	1.00				
SPR	.34	1.00			
HRC	-.05	-.30	1.00		
AC	-.20	-.05	-.39*	1.00	
TF	-.12	-.28	.30	-.27	1.00
Auditory Stimulation:					
SCR	1.00				
SPR	.42*	1.00			
HRC	-.15	.03	1.00		
AC	.02	-.13	.11	1.00	
Response Recovery:					
Visual Stimulation:					
SCR	1.00				
SPR	.04	1.00			
HRC	.31	.07	1.00		
AC	-.42*	.09	-.31	1.00	
TF	.23	.57**	.05	-.21	1.00
Auditory Stimulation:					
SCR	1.00				
SPR	.53*	1.00			
HRC	.01	-.34	1.00		
AC	-.14	.07	-.06	1.00	

SCR: Skin Conductance
SPR: Skin Potential
HRC: Heart Rate Change
AC: Activity Change
TF: Total Fixation

* p<.05

** p<.01

TABLE 25*

CORRELATIONS AMONG INDICES OF ATTENTION FOR FOUR-MONTH-OLD INFANTS

	SCR	SPR	HRC	AC	TF
Response Decrement:					
Visual Stimulation:					
SCR	1.00				
SPR	-.49**	1.00			
HRC	.08	.14	1.00		
AC	.17	.09	-.16	1.00	
TF	.16	-.28	-.16	.04	1.00
Auditory Stimulation:					
SCR	1.00				
SPR	.36*	1.00			
HRC	-.29	-.14	1.00		
AC	.34	.26	-.61*	1.00	
Response Recovery:					
Visual Stimulation:					
SCR	1.00				
SPR	.16	1.00			
HRC	.07	.20	1.00		
AC	-.36*	-.39*	-.07	1.00	
TF	.32	.50**	.21	-.54**	1.00
Auditory Stimulation:					
SCR	1.00				
SPR	.64**	1.00			
HRC	.08	-.01	1.00		
AC	-.06	-.25	-.41**	1.00	

*See Legend for Table 24.

response decrement. The only hint of a pattern is that SPR and SCR were significantly positively correlated at both ages for auditory stimulation ($r = .42$ and $.36$ for two and four months, respectively; $p < .05$). On the other hand, the same two response measures were significantly negatively correlated at the older age for visual stimulation ($r = -.49$; $p < .01$). Finally, decrement in HR deceleration and decrement in suppression of activity were significantly correlated in the predicted direction for visual stimulation at two months ($r = -.39$; $p < .05$), and for auditory stimulation at four months ($r = -.61$; $p < .05$).

The hypothesized global nature of response recovery was supported to a somewhat greater extent than the analogous prediction for response decrement. This was particularly true for visual stimulation. At the two-month age (Table 24) there were significant correlations in the predicted direction for activity suppression with SCR ($r = -.42$; $p < .05$), and for TF with SPR ($r = .57$; $p < .01$). The same two pairs of variables were significantly correlated at four months of age ($r = -.36$; $p < .05$, and $r = .50$; $p < .01$, respectively). In addition, at four months of age TF and SPR were significantly correlated in the hypothesized direction with activity suppression ($r = -.54$; $p < .01$, and $r = -.39$; $p < .05$, respectively). Thus, for visual stimulation, the pattern of significant correlations supported the hypothesized global nature of recovery of attention.

The results for response recovery for auditory stimulation were exactly the same as those found for response decrement for auditory stimulation. (Compare within Tables 24 and 25 the significant correlations for auditory stimulation.) Thus, the hypothesis received only meager support for the auditory modality. In summary, the hypothesized global nature of habituation was not accepted.

Summary of Hypotheses and Analyses

The results are summarized in Table 26. All the "a priori" hypotheses are listed in capsule form along with either n.s. (the hypothesis was rejected) or $p < .01$ ($p < .05$) (the hypothesis was accepted). For the last hypothesis the significant correlations between indices of attention are presented.

TABLE 26*

SUMMARY OF HYPOTHESES AND RESULTS

Hypotheses	SCR	SPR	HRC	AC	TF
(1) RD for the Grand Mean	p<.01	n.s.	p<.01	p<.01	p<.01
(2) Sex Difference in RD	n.s.	n.s.	n.s.	n.s.	n.s.
Sex Difference in RR	n.s.	n.s.	n.s.	n.s.	n.s.
(3) Age Difference in RD	n.s.	n.s.	p<.05	n.s.	n.s.
(4) Treatment Effect for RR	p<.05	p<.01	n.s.	p<.01	p<.01
(5) Between Age "r" for RD:					
Visual	n.s.	p<.01	n.s.	n.s.	n.s.
Auditory	p<.05	n.s.	n.s.	n.s.	
Between Age "r" for RR:					
Visual	n.s.	n.s.	n.s.	n.s.	n.s.
Auditory	n.s.	n.s.	n.s.	n.s.	
(6) Cross-Modal "r" for RD:					
2 Months	n.s.	n.s.	n.s.	n.s.	
4 Months	n.s.	p<.05	n.s.	n.s.	
Cross-Modal "r" for RR:					
2 Months	n.s.	n.s.	n.s.	n.s.	
4 Months	n.s.	n.s.	n.s.	n.s.	

(7) 2 Months:		
Visual RD	AC-HRC r=-.39(p<.05)	
Visual RR	SCR-AC r=-.42(p<.05)	SPR-TF r=.57(p<.01)
Auditory RD	SCR-SPR r=.42(p<.05)	
Auditory RR	SCR-SPR r=.42(p<.05)	
4 Months:		
Visual RD	SCR-SPR r=-.49(p<.01)	
Visual RR	SCR-SPR r=.36(p<.05)	AC-HRC r=-.41(p<.05)
Auditory RD	AC-SCR r=-.36(p<.05)	AC-SPR r=-.39(p<.05)
	TF-SPR r=.50 (p<.01)	TF-AC r=-.54(p<.01)
Auditory RR	SPR-SCR r=.64(p<.01)	AC-HRC r=-.41(p<.05)

SCR: Skin Conductance
SPR: Skin Potential
HRC: Heart Rate Deceleration
RD: Response Decrement
RR: Response Recovery
AC: Activity Suppression
TF: Total Fixation

*See text for further explanation of Table 26.

CHAPTER VI

DISCUSSION

Conclusions

The main conclusions are listed below:

1. Habituation of attention to auditory and visual stimulation occurred in infants as young as two months of age.

2. Two- and four-month-old infants were equally capable of habituation. The only exception to this conclusion was the age difference in response decrement for heart rate deceleration but there was not recovery for HR.

3. There was not a sex main effect for habituation or for dishabituation of attention. There was, however, a treatment by sex interaction for activity dishabituation. This indicated a greater difference, between infants presented a nonfamiliarized stimulus and those continuing with the familiar stimulus, for females than for males.

4. There was only meager support for the notion that habituation and dishabituation are correlated between two and four months of age.

5. Cross-modal correlations for habituation and dishabituation of attention did not obtain.

6. Habituation was not a global or holistic phenomenon. Dishabituation, however, was relatively global for visual stimulation.

The finding of habituation for two- as well as four-month-old infants is the major result of the study. It is particularly important in view of the fact that habituation and dishabituation were demonstrated for skin conductance, visual fixation, and body activity. In addition, heart rate deceleration decreased significantly, but did not recover significantly (though the direction of recovery was that required for dishabituation). Finally, skin potential did not decrease significantly, but "recovered" significantly.

The demonstration of habituation for the two-month-old infants was not consistent with the findings of Wetherford and Cohen (1971). These researchers found habituation of visual fixation for ten- and twelve-week-old infants, but not for infants six and eight weeks old. Similarly, Lewis et al. (1969) and Lewis, Baumel, and Groch (1971) found no decrement (thus no habituation) for length of first fixation, heart rate deceleration, or activity change.

Procedural differences between the present study and the studies by Lewis et al. and Wetherford and Cohen may account for the inconsistency. For example, in Lewis' studies, the infants were presented the visual stimuli for only four 30-second trials and the ITI was fixed at 30 seconds. The number of trials was eight (for decrement) in the present study and the ITI was random from 15 to 25 seconds ($\bar{x}$ = 20). Thus, the infants in the present study were presented the visual stimuli twice as often and with a shorter ITI than in Lewis' studies.

Wetherford and Cohen (1971) presented pictures of geometric forms placed at a viewing distance of 25.4 cm. from the baby. The accommodative capacity of infants changes rapidly during the first several months of life (White, 1971). Therefore, "visual fixation" in the Wetherford and Cohen study may have been a relatively random process and thus might not decrease. On the other hand, the accommodative capacity of the infants did not appear to be a matter of concern for the present study. The blinking lights, in an enclosed space, were probably perceived, even if the form they described could not be ascertained by the infant, since the visual stimuli differed in intensity and color as well as in form. Finally, the use of multiple response measures may have led Wetherford and Cohen to different conclusions about age differences in habituation.

The treatment by sex interaction on the activity measure for dishabituation was also of interest. Cohen et al. (1971) found a greater degree of habituation and dishabituation for males than for females. While there were no main effects for sex in the present study, there was an indication that dishabituation was stronger for females--at least for one index of attention. Since this result only obtained for activity suppression it is suggestive, but by no means conclusive.

There are no studies with which to compare the lack of significant correlations across age for decrement and recovery. The Brotsky and Kagan (1971) study which found a significant correlation for girls between the degree of the OR (HR deceleration) at eight and thirteen months was suggestive, but habituation and dishabituation of the OR were not examined. Brotsky and Kagan also found a significant correlation between auditory and visual stimulation in degree of the OR.

The lack of cross-modal correlations is a bit of negative evidence for the Groves and Lynch (1972) theory of habituation. But developmental differences in the morphological and functional state of the reticular activating system eliminate the present study as a "crucial" test of the Groves and Lynch theory.

Finally, the results of the present study regarding the specificity of habituation confirm and extend the conclusions of Moreau et al. (1970). There was a hint of general dishabituation for the visual modality, but the results do not justify the conclusion that habituation is a holistic phenomenon as theorized by Pavlov (1927).

General Discussion

The study concerned a type of behavior that is essential for the survival of organisms. It is difficult to imagine how any organism could survive if some mechanism for selecting or "tuning out" impinging stimulation were not possessed. The "blooming grey mass of confusion" which William James described would truly be a reality for the infant. But, the selection mechanism does exist, and the results of the present study indicate that the mechanism for human infants is operative at two months of age.

The mechanism is not a haphazard or random one such as would be the case if the infant had to depend, for example, on fatigue to tune out unneeded or harmful stimuli. Rather, the results of the study support the conclusion that an active process of habituation is involved. Further, though the "crucial" experiment demonstrating that habituation in human infants is a cortical comparison process has not been done, the evidence from the present study supports the hypothesis that the mechanism is cortical in nature.

Other studies in the literature lend further credence to the assertion that habituation is a cortically mediated phenomenon. For example, Brackbill (1971) performed an investigation with an anencephalic infant in order to assess the role of the cortex in the manifestation and inhibition (i.e., habituation) of the orienting reflex.

[Anencephaly refers to a neurological aberration by which the fetus develops without a brain, even though part of the midbrain or brainstem may be present (Cassady, 1969).] Brackbill found that as far as the elicitation of the orienting reflex, a basic attentional reflex, is concerned, the anencephalic subject's responsiveness to stimulation was equal to that of the normal infant. But the infant's ability to stop responding to the tones was either seriously impaired or nonexistent. Brackbill (1971, p. 195) concludes that "these data strongly suggest that the cortex may not be important to the elicitation of a response, but it is essential to attenuation and inhibition of response."

The review of Thompson and Spencer (1966) supports Brackbill's conclusion. The authors cite many studies which indicate that abnormal cortical development directly affects decrement of attention. For example, lesions in the auditory cortex of cats, and frontal or temporal lesions in man, monkeys, cats, and rats all reduce the degree of response decrement.

Further, Lewis (1970) cites a variety of research by Russian investigators which implicates cortical processes in response decrement. The degree of decrement in attention to auditory and tactile stimulation was, for example, directly related to degree of birth trauma in newborns (Bronstein, Itina, Kamenetskaia, & Sytova, 1958).

Finally, Hutt (1968) in an investigation of exploration of novelty, used normal and brain damaged children four to seven years of age. The lesions were "general cerebral lesions." Hutt found that the proportion of time spent investigating a specific object was longer for brain damaged subjects. After a two-week period, the children were again given the same toys. Normal children spent a significantly smaller amount of time touching and looking at the objects (i.e., they habituated).

Thus, indirect data for both humans and infrahumans at different age levels support the hypothesized cortical involvement in response decrement. These data taken in conjunction with the results of the present experiment lead to the parsimonious and important conclusion that infants two and four months of age exhibit response decrement that is mediated by cortical processes.

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APPENDICES

APPENDIX A

LETTER REQUESTING PARTICIPATION OF INFANTS

IN THE STUDY AND POSTCARD TO BE

RETURNED BY PARENTS

APPENDIX A

LETTER REQUESTING PARTICIPATION OF INFANTS IN THE STUDY AND POSTCARD TO BE RETURNED BY PARENTS

Michigan State University
Infant and Toddler Development
Laboratory
East Lansing, Michigan

Dear Parents:

As a parent you have probably noticed that your baby will attend to various sights and sounds that seem interesting. Eventually, however, the baby ceases to attend to a particular event. The event seems to bore him, but attention is renewed when a new sight or sound occurs. We at the Infant and Toddler Development Laboratory at Michigan State University have become interested in this facet of the infant's development. As part of an ongoing research program concerned with infant development under the direction of Dr. Hiram E. Fitzgerald, we will be carrying out a study with 2 to 4 month-olds which will deal with attention, its decrease and its renewal.

I am writing to ask if you would be willing to have your child participate in this study. The children will lie in a bassinet and look at simple patterns of lights, as well as listen to tones of different types. We will be observing the child's physical behavior, and recording his general body activity along with several physiological behaviors (e.g., the rate at which the baby's heart is beating when he is attending and not attending to the various stimuli).

Each infant will participate on two separate occasions, but each participation will last only 30 to 45 minutes. The first time we would like your infant to participate will be when the baby is close to 2 months of age. Then we would like you to bring him back when he is approximately 4 months old.

If you are willing to allow your child to take part in our study, please return the enclosed, stamped postcard with the information requested. I will then call you to answer any questions you may have and to arrange a convenient time for your child to participate. The Infant and Toddler Development Laboratory is located in room 103 of the Psychology Research Building on the Michigan University Campus. I have enclosed a map to aid you in locating it.

Thank you very much.

Sincerely,

Thomas R. Chibucos
Department of Psychology
Michigan State University

POSTCARD TO BE RETURNED BY PARENTS

Yes, I am interested and willing for my child to participate in the infant experiment. My phone number is

____

The times most convenient for me are:

M_______ T_______ W_______ TH_______ F_______

Morning_______ Afternoon_______

Name (Please print)____

Child's name________________________ Birthday_____________

APPENDIX B

QUESTIONNAIRE FOR MOTHERS WHOSE INFANTS ARE PARTICIPATING IN THE ATTENTION STUDY OF 2- TO 4-MONTH-OLDS

APPENDIX B

QUESTIONNAIRE FOR MOTHERS WHOSE INFANTS ARE PARTICIPATING IN THE ATTENTION STUDY OF 2- TO 4-MONTH-OLDS

Please remember that all information we obtain from you and your baby will always be held in the strictest confidence. Your answers to the following questions will be matched with the data we record from your baby. Please answer all items as thoroughly as possible, but don't guess. It's better to not answer an item at all than to answer it if you're not sure about your response.

If you don't want to answer any or all items, don't. We will respect your decision in this regard with no questions asked.

I choose not to answer the items listed. _____

I choose to answer the items listed. _____

(If answering) Signature ______________________________

Date ______________________________

1) What was your baby's weight at birth? ____________________
   What is her (his) present weight? ____________________

2) Did you have any complications (minor or major) before, during or after delivery? Specify as completely as possible (e.g., had to stay in bed during pregnancy, prolonged labor, forceps delivery, Caesarian birth, etc.).

   No_____ Yes_____ Describe__________________________

   ____
   ____
   ____

3) Did you receive medication(s) during labor and/or delivery? Specify or describe if possible.

No_____ Yes_____ Describe___________________________

____

____

____

____

4) Was the baby full term, premature or past due? If either of the latter, how long?

Full term_________________ How long?__________
Premature_________________ How long?__________
Past due__________________ How long?__________

5) Has the baby experienced any postnatal illnesses?
No_____ Yes_____ Describe___________________________

____

____

____

____

APPENDIX C

PARENT CONSENT FORM

APPENDIX C

PARENT CONSENT FORM

Attention in Two and Four Month Olds

This study is attempting to examine the process of attention, its decrease, and its renewal in 2 to 4 month-old infants. The infants in this study will be presented with simple patterns of light to view, as well as simple tones to listen to, as they lie in the enclosed bassinet-like structure. The length of the session will be 30 to 45 minutes each time the child participates (at approximately 2, then at 4 months of age).

The information gained in this study will help determine why babies of this age decrease their attention to auditory and visual stimuli. Attention will be measured by recording the infant's general level of activity, the sweating activity of the skin, and the heart rate prior to and during stimulus presentation. In addition, when the visual stimuli are presented, an observer will record the time the infant is looking at the stimulus. Please keep in mind that there are no right or wrong performances. The differences among babies are at least as great as the differences among adults, and all of the infants will be helping us to understand the process of attention.

We wish to assure you that the anonymity of all infants will be maintained.

Do you have any questions? Please be sure and ask because we want you to be completely informed before we start the study.

Having had a more thorough explanation of the study, we would again like to ask permission for your child's participation.

- -

Having had a full explanation of the 2 to 4 month-old attention study, I give my permission for my child to participate.

Signed____________________________________ Date_____________

I would _____ would not _____ like to receive a written report of the outcome of the experiment, realizing that no individual results will be presented in such a report. (Please include your address if you would like a copy of the report.)