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ABSTRACT

This monograph is a collection of papers describing a series of loosely related studies of visual attention, auditory stimulation, and language discrimination in young infants. Titles include: (1) Infant Attention and Discrimination: Methodological and Substantive Issues; (2) The Addition of Auditory Stimulation (Music) and an Interspersed Stimulus Procedure to Control Visual Attending Behavior in Infants; (3) The Effects of Variations of Auditory Stimulation (Music) and Interspersed Stimulus Procedures on Visual Attending Behavior in Infants; (4) The Use of the Mother's Voice to Control Infant Attending Behavior; (5) Infant Control and Response Decrement and Recovery as an Index of Visual Discrimination in Young Infants; (6) Visual Fixation and Voice Discrimination in Two-Month-Old Infants; (7) Visual Fixation and the Effect of Voice Quality and Content Differences in Two-Month-Old Infants; and (8) Discussion and Conclusions (based on the preceding papers). An appendix presents principles and procedures in the operation of an infant experimental research laboratory. (Author/SB)

UNIVERSITY OF KANSAS

KANSAS CENTER FOR RESEARCH IN EARLY CHILDHOOD EDUCATION

MONOGRAPH

Infant Discriminative Abilities

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Frances D. Horowitz
Principal Investigator

KANSAS CENTER FOR RESEARCH IN EARLY CHILDHOOD EDUCATION
Department of Human Development
University of Kansas

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MONOGRAPH

Visual Attention, Auditory Stimulation, and Language Discrimination in Young Infants

Frances Degen Horowitz, Editor

The University of Kansas

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Preface

In 1967 the Office of Education developed a network of laboratories levoted to the understanding of the development of young children from irth through 8 years of age. Originally designated as the National Laboratory n Early Childhood Education, its purpose was to foster basic research that ould contribute to our understanding of how best to educate the young child or optimal developmental outcome. A component of the resources was levoted to the research during the infancy period and in 1968 the Kansas nfant Research Laboratory, as part of the Kansas Center for Research in arly Childhood Education, became part of the National Laboratory. The tudies reported in this volume were, in large part, supported by the Office f Education through the National Laboratory program that eventually became he National Program in Early Childhood Education within the administrative tructure of the Central Midwestern Regional Education Laboratories (CEMREL). ore recently the funding source has been shifted to the newly organized ational Institute of Education. A full record of the many funding resources sed for the research reported in this monograph is given in the acknowledge- ents.

The purpose of the program of research in the Kansas Infant Research aboratory was two-fold: to identify those individual differences that unctionally affect learning; to identify the conditions that control infant ttending behavior and the abilities of the infant to use and discriminate nvironmental stimuli. The studies reported in this volume are primarily he result of research directed at the second purpose.

It would have ... possible to have reported the studies included n this volume one by one through a variety of journals. This approach has een rejected for two reasons. Firstly, though experimental child research is typically a study-by-study enterprise and often only loosely an eventual "program" of research, the experiments undertaken here were conceived as a program of research designed to understand some basic questions about the conditions under which infant attending behavior is maintained and the kinds of discrimination that can be made by young infants. In the process we believe that we have come to some useful methodological techniques and the demonstration of some exciting phenomena. That process becomes evident as study succeeds study. Secondly, infant research is a costly effort. The fewer infants needed for any one demonstration, the more we could attempt. Thus, the studies typically have relatively small numbers of subjects. The impact of the results is partly in the aggregate of effects across studies and the continued partial replication of effects from study to study.

We have been fortunate to have had a large group of colleagues interested in and facilitative of our work. Barbara Etzel and then John C. Wright, as Directors of the Kansas Center for Research in Early Childhood Education were always willing and amazingly able to make the budget fit our needs. Richard Schiefelbusch, Director of the Bureau of Child Research and Ross Copeland, Associate Director provided the very initial resources that helped establish the Infant Research Laboratory and have continually provided essential sources of support. We have, from time to time, received support from federal funds available to the University of Kansas in the purchase of equipment in the support of personnel. All of the work reported here has been conducted in the John T. Stewart Children's Center on the University of Kansas campus. The Center is part of a larger and more complex organization known as the Kansas Center for Research in Mental Retardation and Human Development.

There have been numerous individuals who have been part of the research program. Many are specifically mentioned in the reports of the individual studies. However, two particular individuals were, at different times, central to our continuing effort. Ms. Mary Ellen Mann, R.N. and then Ms. Sue Tims, R.N. were successively full-time members of the staff. To them fell the task of securing the cooperation of mothers and infants, scheduling visits, stocking and maintaining the laboratory, and supervising the experimental sessions. Above all, they provided the important support on those days when things went badly and happily shared our excitement on those days when things went well. And finally, without the willingness of mothers to go to the effort to bring their infants to the laboratory, we could not have been productive. To all these individuals, collectively, and individually, we are pleased to acknowledge our very great debt.

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Infant Attention and Discrimination

Methodological and Substantive Issues

Frances Degen Horowitz

The University of Kansas

Introduction

In the last 15 years one of the most exciting and productive areas of research in the field of child development has concerned itself with infant development. Indeed, "infancy" as a topic has expanded at a geometric rate in both abstract periodicals and at scientific meetings. The reasons for this are varied. Partly, they involve the enormous influence of Piaget's theoretical account of infant development and the attempts to experimentally verify some of his proposals. Partly, they also involve the coincidental availability of money and a developing technology that increasingly permitted the reliable observation and recording of infant behavior in the laboratory and, more recently, in the natural environment. And finally, the interesting and sometimes surprising abilities of infants discovered in the research were important spurs to further investigation. From the intriguing reports by Fantz (1963) and his colleagues and from the work of others it soon became apparent that not only was it possible to make reliable observations of very young infants but that the infant organism was more competent, more complex, and more fascinating than had been thought possible (Appleton, Clifton & Goldberg, in press; Kessen, Haith & Salapatek, 1970).

Within all of this activity several distinct lines of research have developed that reflect divergent views of the infant organism. On the one hand the infant is seen as an active processor of the environment. On the other hand the infant is seen as subject to control by environmental events.

The first emphasis has generated a good deal of research on infant attention with the results being used to speculate about underlying cognitive development; the second emphasis has generated research showing that the infant is conditionable with the results being used to bolster the viability of an associative model for behavioral acquisition. While these two foci have sometimes been used to identify supposedly "opposing" viewpoints about early infant development; the research thrusts generated by these different perspectives have rarely intersected directly. There have been almost no crucial tests of one position against the other. It is entirely plausible to think of the infant as an active environmental processor with a species specific developmental sequence inherent in the appearance of processing strategies while, at the same time, conceiving of the infant as being under the kind of control of environmental stimuli that is represented in the traditional models of conditioning, with the role of conditioning becoming increasingly complex as development proceeds. Indeed, the data bank on infant development may soon be sufficient for a serious integration of the two approaches to take place that would, almost ironically, bring us back to a "common sense" view of infant development.

One area of research that can be seen as representing something of an oblique intersect of the cognitive and learning approaches is concerned with the process of habituation. Most simply put, habituation refers to the situation in which, after repeated stimulation, the organism ceases to attend to the stimulation; and it can be demonstrated that the cessation cannot be accounted for by receptor fatique. More technically, habituation is said to occur when response decrement is observed with repeated stimulation. The test of occurrence of habituation is that presentation of a different stimulus immediately following response decrement can result in a response increment to the new stimulus. A frequently cited example involves the presentation of a visual stimulus that typically produces initial looking behavior. With repeated presentation of the same visual stimulus, looking behavior declines. If a new and different visual stimulus is introduced immediately following the decline, then looking behavior will often "recover" or show an increase. When appropriate controls have been employed, it can be said that the organism has "habituated" to the first stimulus and "dishabituated" to the second stimulus.

The intersect of the active processor model and the associative model may not be immediately apparent in the phenomenon of habituation. Yet, it is possible that associative learning requires the successful recruitment and maintenance of attending behavior and that the developmental aspects of active processing of stimulation involve the interplay of associative learning and successive habituation to stimulus configurations. The full development of such a proposal requires further data but its potential for integrating the data from now diverse research efforts may be significant.

Habituation in young infants has been demonstrated to both auditory and visual stimuli (Jeffrey & Cohen, 1971);but there are problems with regard to the consistency with which it can be found within a given infant, the youngest age at which it can be said to have been demonstrated, and direct measurement. From the evidence to date it appears that neonates in the first few days of life are capable of habituation to both auditory and visual stimuli (Friedman, 1972a; Graham, Clifton & Hatton, 1968) but not every infant shows the phenomenon when tested. While habituation to visual stimuli can be observed directly in terms of visual attending behavior, habituation to auditory stimuli requires the measurement of a response that does not emmanate directly from the receptor organ. Sucking (Bronstein & Petrova, 1967) and heart rate (Bartoshuk, 1962) have been the most frequently used responses to demonstrate habituation to auditory stimuli.

The significance of habituation or of response decrement and recovery as a process that is demonstrable in the newborn is that it means the newborn i nt is already equipped not only to recognize repetitive stimulation but to inhibit attending behavior and to selectively attend to new stimuli or new stimulus components. This has been dramatically demonstrated in the olfactory modality (Engen & Lipsitt, 1965) where component changes in olfactory stimuli were sufficient to produce dishabituation. How stable or generalized habituation is as an ability in the newborn is unclear. Friedman (1972a) has noted that he could not get habituation in all the newborns he tested and he suggested this may be an important individual difference variable in early development. To date, there have been no longitudinal attempts to answer the question of whether or not there is a developmental significance in the consistency or stability of habituation in different areas in individual infants, but this is an interesting possibility.

While habituation can be studied as a process that is present in early infancy, it has also been used as a tool to identify other abilities in infants. Most frequently this has involved the study of the ability of infants to discriminate stimuli. For example, auditory discrimination in 1- and 4-month-old infants was studied using habituation of sucking to one sound until sucking had declined and then introducing a different sound. Given appropriate controls, if sucking increases with the new sound, then it is concluded that the infant discriminated between the two sounds or that the second sound was perceived as different from the first sound (Eimas, Siqueland, Jusczyk & Vigorito, 1971). A more extensive use of habituation, especially in the visual modality, has been its employment to trace cognitive development with regard to identifying characteristics of stimulus components that maintain attention. Within a developmental context age differences in habituation and dishabituation to different stimuli are regarded as revealing changing cognitive organization and encoding processes in infants. When familiar vs. novel stimuli are studied in this manner, we begin to introduce the possible intersect of associative learning with active cognitive processing, though few investigators (with the possible exception of Kagan, 1971) have recognized the potential of that intersect.

What the facts have so far established with regard to habituation is that it can be demonstrated to occur in the first few days of life in the auditory, visual, and olfactory modalities. As Jeffrey & Cohen (1971) have noted there appear to be several parameters that affect habituation of responding in infants. Some of these parameters involve stimulus and presentation characteristics: Complexity, rate of presentation, etc. Other parameters may be age and sex of subjects. It is also clear, both from the studies reviewed by Jeffrey & Cohen (1971) and from subsequent research, that there are complex interaction patterns in many studies. The behavior of individual infants may not replicate the behavior described by the group data; patterns of findings across studies or laboratories are not always consistent. There has been a tendency to minimize differences in data, to attribute such difference to methodological variations between laboratories, and to introduce order into the data by speculation. As the hard, consistently replicable data bank on habituation is still relatively small, methodological issues may well be siginificant factors in making major advances in this area.

Methodological Considerations

There are many problems that the researcher concerned with infant attending and habituation behavior encounters which the behavioral scientist concerned with older children does not share. Some of these problems are inherent in the nature of the infant organism and in the requirements of research involving laboratory control of phenomena.

The human infant is a rapidly developing organism whose response repertoire, under the natural conditions of the environment, is constantly changing. At any one point in time a known part of the repertoire of the behavior may or may not be displayed, and once displayed can sometimes be easily disrupted and difficult to re-elicit. The often reported high percentage of subject loss in infant research attests to the frequency of state changes and disrupted behavior patterns.

It is also possible that the ways in which infant behavior is studied in the laboratory often imposes sufficiently artificial conditions that interrupt and/or disturb some of the more naturally flowing patterns of behavior. An argument typically made to justify the sometime sterile atmosphere of the laboratory is that science is a process of identifying variables and describing the ways in which they interact to control simple and complex phenomena; by being able to determine the timing of events, by the use of a variety of sophisticated recording devices, and by the ability to control the presentation of stimulation, interfering variables can be reduced to a minimum, precision in recording behavior can be maximized, and highly controlled manipulations can be undertaken. In infant research this can effect a high price: The complexity of co-occurring natural events of the normal environment are reduced to a minimum, responses to be observed are often made to occur in unnatural densities, and normally occurring interspersed environmental events that possibly maintain attending behavior such as caretaker soothing, position changes, and shifts in tactile stimulation must be eliminated from many experimental procedures. It is possible that the development of procedures in the laboratory study of infant behavior that more closely approximate some features of the behavior in the natural environment will tend to produce more consistent results, reduce subject loss, and demonstrate the same pattern of effects for individual subjects as are shown by the grouped data. Some of the studies reported in this monograph were undertaken with these goals in mind.

The development of improved procedures for studying infant attention and habituation may require two different kinds of considerations. The first concerns the grossness of the behavior being measured. In infant visual attending behavior the general direction of gaze or centered reflection of light on the eye are the two most frequent sources of observations and definitions of response occurrence and non-occurrence. The behavior being observed is very gross and yet, when results from one laboratory do not replicate results from another laboratory very small differences in procedure are sometimes cited as explanations for failure to replicate. However, it is difficult to conceive that gross visual fixation is so fragile a phenomenon as to fail to obey the same laws when small details in experimental proceudre differ. Given the enormous variability of conditions in the natural environment development would not occur so easily if it were dependent upon the exact specifications of conditions similar to those often cited as governing the demonstration of behavioral phenomena in the laboratory. On the other hand, we might expect behavior observed in the laboratory to be less stable under relatively controlled, simple conditions if the development and maintenance of behavior in the natural environment is partially the product of the complex setting. However, the investigator of infant behavior might be well advised to look at the non-replication of results both within and across laboratories, as well as within and across subjects, as signals that the procedures being used may be imposing unnecessarily unnatural or restrictive conditions on the infant making for both erratic and artifactual results.

The second consideration involves the use of information on subject loss as an important indicator that experimental procedures may be in need of critical analysis. It is not unusual for infant researchers to experience more than 50% subject loss in the course of a study. Indeed, Caron, Caron & Caldwell (1971) reported almost 75% subject loss. It is possible that procedures which are more compatible with the natural flow of infant behavior will result in fewer subject losses and will generate more stable results. Unfortunately, we do not have a good data base on relative subject loss with different procedures because until recently it has not been standard to indicate the incidence of subject loss in infant research.

When we first began to study infant attending behavior, we noticed that under conditions where we imposed an arbitrary stimulus exposure time upon the infant (30 seconds) many infants were gazing intently at the stimuli at the end of the 30-second period while others looked only for a few seconds and then had to wait the full period before seeing another stimulus. So, we decided to leave the stimulus on for only as long as the infant looked at it and, as has been reported (Horowitz, Paden, Bhana & Self, 1972) two things happened. The first was that many infants looked at stimuli for much longer periods than either experimenters have typically used or most people expected. Durations of over 1, 2, 3, 4, and 5 minutes were not uncommon and some infants attended to a single stimulus much longer than 5 minutes. The second result was a greatly reduced percentage of subject loss, less crying and fussiness during sessions, and more completed sessions without interruptions. Thereafter this procedure which we have called "infant control" came to be used in all of our research.

In this monograph we are reporting a series of studies that evolved out of the development and refinement of the infant control technique for studying infant attending and habituation. First we present our substantive findings with regard to the effectiveness of auditory stimuli for re-recruiting visual attending behavior. With the establishment of this phenomenon in three different studies, we then undertook to employ this fact to study early discrimination of language stimuli. We have tried to demonstrate that the use of the infant control procedure to study visual response decrement and recovery could be used to map some of the early discriminative abilities of infants for visual and auditory stimuli. In this we have been able to demonstrate the utility of using visual attending as an index of auditory discrimination.

Each study has employed a relatively small number of subjects. It has been our assumption throughout these studies that we are using gross techniques to measure relatively gross kinds of phenomena and that minor variations in procedures should therefore not result in a failure to replicate earlier findings. In addition to statistical analyses two criteria have been employed in evaluating the importance of results: The degree to which every subject in a study displayed the same behavioral pattern and the degree to which partial replications of results could be shown from study to study. Using these criteria we have been encouraged by the consistencies in the data suggesting that the procedures we have developed may prove highly useful in the study of infant attention and discrimination. Since a basic set of common procedures were used throughout all of the studies to be reported here, a general methodological description is provided in this introduction. In the report of each separate study the variations particular to that study are noted.

In the course of this program of research the individual investigators represented in the monograph worked as a team with various individuals successively overlapping each other. We discussed and argued at length about issues of reliability and about rationales for stimulus selection. In the process we learned the kinds of things that tend to become matters of "folklore" in infant research laboratories. The acquisition of this folklore must often be discovered anew by each beginning investigator of infant behavior. In an attempt to reduce the trial and error aspect of this process three appendices are included in this monograph. One is concerned with the non-experimental aspects of laboratory procedures, the second is a discussion of reliability of observations of infant attending behavior, and the third is a presentation of data that may help investigators in the choice of visual stimuli for use with young infants.

General Methodology

All of the research reported in this monograph was conducted at the Infant Research Laboratory housed in the John T. Stewart Children's Center at the University of Kansas in Lawrence, Kansas. Infants were brought to the laboratory by their parents after telephone contacts had been made that explained the purposes and procedures of the research and requested the infants' participation. The basic procedures used in the studies were similar and are described below.

Apparatus

Two observational arrangements were used depending upon the age of the subjects in the study. Figure 1 depicts the apparatus used for infants who

Insert Figure 1 about here

were younger than eight weeks of age and Figure 2 shows the apparatus used when infants were eight weeks of age or older.

Insert Figure 2 about here

When the apparatus shown in Figure 1 was in use, the infant was placed on his or her back and the stimuli were projected onto a mirror that then reflected down on a plexiglass screen about 12 inches from the infant's eyes. The experimental crib shown in Figure 1 consisted of a plywood box 44 inches long, 36 inches wide, and 24 inches high and rested on legs measuring 19 inches. It was painted a light gray and had a peephole on each side through which the observers looked. The floor of the box was midway between the top and the bottom. A hinged plywood hood was attached to the plywood 14 inches from the front of the apparatus and 3 inches down over the sides. The hood contained a plexiglass screen which extended for 12 inches over the top of the apparatus, and then the plywood slanted down 12 inches to the top again. A mirror 12 inches by 36 inches was attached to the sides of the hood by wooden supports 21 inches long and extended at a 45 degree angle over the plexiglass screen on the hood. When the hood was down, the stimulus slides were projected onto the mirror and reflected down onto the plexiglass screen. The infant lay in a supine position on the floor of the crib and viewed the stimuli projected on the plexiglass screen at the top of the apparatus.

Two seven-watt light bulbs were situated on the interior of the apparatus, one bulb on each side. Each bulb was covered with a piece of frosted plexiglass in order to diffuse the light.

Two observers sat on either side of the screen, shielded from the stimuli and from each other, observing the infant's eyes through two small observer holes covered with wire-mesh screen.

When the apparatus shown in Figure 2 was used, the infant was placed in an infant seat and turned to face the plexiglass screen approximately 12 inches from the infant's eyes and surrounded on three sides by a brown masonite experimental booth. Observers sat on either side of the screen, shielded from each other and the stimuli, observing the infant's eyes through small observer holes covered by wire-mesh screen. A dim light level of 5 ft. candles provided a low level of surround light between and during stimulus presentations.

Stimuli measuring 6 x 6 inches were rear-screen projected onto each apparatus by a Kodak Carousel 750 projector. Each observer was provided with a set of piano-like keys that were used to record looking behavior. These keys were wired directly into an Esterline-Angus 20-pen recorder and into solid-state programming equipment that counted the duration of non-fixation behavior recorded by the observers and using these data, controlled the onset and offset of stimuli being projectd by the Kodak Carousel projector.

Stimulus slides were mounted in the Carousel tray alternating with blank slides that imposed a 2-second interval between all stimulus presentations.

Procedures

As infants reached the age necessary for a particular study, an appointment was made to have them brought into the laboratory. If, upon arrival, the infant was judged to be in an awake-alert state he or she was placed supine in the apparatus shown in Figure 1 or in an infant seat set in the crib as shown in Figure 2.

Two observers sat on either side of the viewing screen monitoring fixation responses through the observing holes. Screening panels between the observers prevented their observing each other and kept them unaware of the stimulus being shown to the infant. All observers had previously been trained to a criterion of .90 reliability, using as a definition for a fixation response the presence of the light from the stimulus centered on the infant's pupil. The observer depressed the appropriate key as long as this condition was judged to exist. In particular studies, additional response might also be recorded by the observers on other keys.

A program operator in an adjoining room initiated the stimulus program upon a signal from the observers that a session was ready to begin. Sessions continued without interruption unless the infant's state changed to crying, extremely fussy, or asleep. At that point a break would be taken, the infant calmed if necessary, and the session resumed if possible. Infants were allowed to use pacifiers during sessions but care was taken not to provide for reinsertion of a pacifier in the response decrement sequence just prior to a stimulus change. The occurrence of all breaks and pacifier use was recorded. The point during the session where a break occurred was noted on the Esterline-Angus record. If a break had to be taken first prior to the point where a condition change was scheduled to occur, then that subject was typically eliminated from the study. At the completion of each session the mother was shown an array of infant toys and gift items and asked to choose one.

Infant Control Procedure. The infant control procedure described here allowed the infant to control the duration of each stimulus exposure. While there are some minor variations in its execution from study to study, the general characteristics were similar. For each session, one of the two observers was designated as the Control observer and the other as the Reliability observer. Observers were not initially informed about whether they were the Control or Reliability observer. Data from the Control observer controlled the timing components of the solid-state programming equipment and the data generated by the Control observer were used for the results of a study. The data from the second observer were used only to calculate reliability. When the Control observer depressed the observing key, the timing period was begun. If a "hold" procedure was being used, then with each stimulus presentation an initial criterion look of a half to a full second was required before the infant control phase of the time program could be activated. If a hold procedure was not used, this infant control phase occurred immediately. The infant control phase kept the stimulus on the screen as long as the Control observer was recording the occurrence of visual fixation. If the Control observer recorded no fixation, nothing happened unless a particular "no fixation" period lasted for as long as approximately 2 continuous seconds. At the end of 2 continuous seconds of no fixation, a projector change mechanism was activated, a blank intertrial slide was presented for 2 seconds, and then the next stimulus slide in the Carousel was automatically presented. At the presentation of this next slide the entire timing procedure was begun again.

Reliability. Reliability was calculated for every session from the data recorded on the Esterline-Angus by dividing the number of half-seconds of agreement by the total presentation time (agreements and disagreements) in half-seconds. The reliabilities for each study are reported separately. It has been our experience that not all infants can be reliably observed and that state changes can seriously affect reliability. Subjects whose data were not reliably recorded by two observers were replaced whenever possible, but due to the limited infant population in Lawrence, Kansas replacement was sometimes difficult. Three types of reliability were usually calculated using the agreements/agreements plus disagreements formula: Overall reliability of the observations, reliability of observations of looking behavior (on-time) and the reliability of the observations that the infant was not -looking (off-time).

Observers. In any one study a pool of from 5 to 10 different individuals served as observers and the particular individuals are acknowledged in each study. The observers were each trained to a criterion of over .90 reliability. Initial observer training was generally conducted using televised tapes from previously recorded sessions; once reliability had been achieved on the tapes, training was transferred to special live training sessions. Once trained, observers were scheduled in accordance with the compatibility of their schedules and infant appointments. This resulted in an almost random pairing of observers and a random assignment of observers to particular infants. Even so, reliabilitie were not always acceptable and continuous retraining was necessary in order to prevent the development of idiosyncratic observing conventions. Our experience indicates that with human observers in research involving infant visual attention, the practice of assuming reliability because someone else has reported reliability in a similar procedure is extremely questionable.

Stimuli

The particular stimuli employed in each of the studies are described in the separate reports. The most frequently used stimuli, however, were black and white checkerboard squares. These stimuli included ones with as few squares as 4 (2 x 2) to ones as complex as 1024 (32 x 32) with the in-between values of 16 (4 x 4), 64 (8 x 8), 256 (16 x 16), and 576 (24 x 24). After our initial research with these stimuli (Horowitz, Paden, Bhana, Aitchison & Self, 1972; Horowitz, Paden, Bhana & Self, 1972) we began to realize that we were choosing stimuli based upon some rather clear expectations as to whether the stimulus was likely to elicit long fixations or short fixations. For instance, as might be expected, the 2 x 2 checkerboard square rarely elicited a long fixation upon initial presentation. But, interestingly enough, the 8 x 8 checkerboard square, more than any of the others, across a variety of ages, was the most likely stimulus to elicit a long fixation upon initial presentation. As a result, if we were using checkerboard squares, we began to select our stimuli in terms of whether we wanted a sample of longer or shorter initial looking times. In a study requiring many stimulus presentations, stimuli that elicit fixations that are very long proved to be less desirable than stimuli that elicit intermediate fixations because the fatigue factor became more prominent. Control of the amount of behavior to be elicited by judicious stimulus selection may be very desirable. For procedures that do not produce strong effects, for instance, the results might be more clearly shown if stimuli that elicit longer fixations are chosen.

The studies reported in this monograph are interrelated by procedures and stimuli and by the common quest for understanding infant attending behaviors. Though the specific questions asked in one study might be very different from the question asked in another, for the most part, the research was done sequentially. Decisions of procedure and the choice of the question to be asked were often influenced by the study that had just been completed. In the six separate data articles that follow, a total of eight studies are reported.

The first two articles (by Self and by Paden) report our first attempts to see if visual attending behavior could be re-recruited, once it had declined, by the addition of auditory stimulation in the same session though the visual stimulus did not change. These studies used music as the auditory stimulus. Also the repetition of a target stimulus (checkerboard square) employed to study response decrement over trials was interspersed with novel stimuli.in these studies. In the next article, Culp reports two studies which were also concerned with the addition of auditory stimulation to re-recruit visual attending behavior. However, the demonstration was across session and the auditory stimuli were language recordings. In these studies, as in the ones by Self and by Paden, visual attending behavior was recovered by the addition of auditory stimulation and thus, cannot technically be called habituation in the classical sense because the two different stimulus modalities employed were not present throughout the sessions. However, in the last studies reported in this monograph (by Boyd and by Culp) both visual and auditory stimuli were present throughout the sessions and therefore, these paradigms possibly met the more technical definition of habituation. It is interesting to note, however, that there was not much difference in the effects achieved in the recovery phases of the different paradigms, thus suggesting that the phenomenon of habituation may deserve a wider definition on the behavioral level.

The third article by Bhana and Laub reports the use and refinement of the infant control proceudre totally within the visual modality. The last two articles, by Boyd and by Culp, already mentioned above, combined the visual and auditory modalities for investigation of auditory discrimination of language stimuli using the decrement and recovery of visual attending behavior within-session as the index of discrimination.

The final article in this mcnograph is an attempt to integrate the results of the research reported and to speculate on some of the implications.

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Figure Captions

1. Apparatus used for infants younger than eight weeks of age.

2. Apparatus used for infants eight weeks of age or older.

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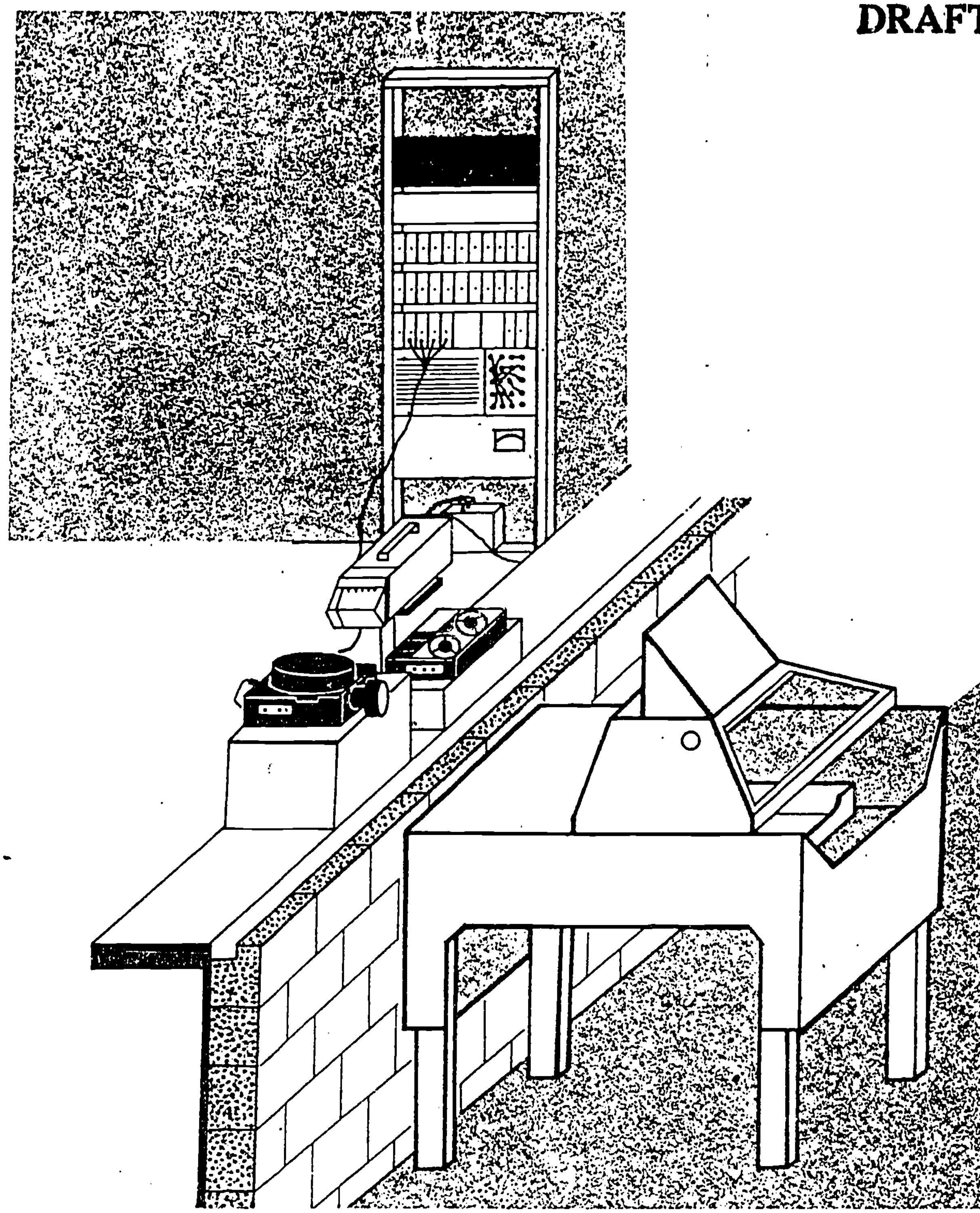

FIGURE I

DRAFT

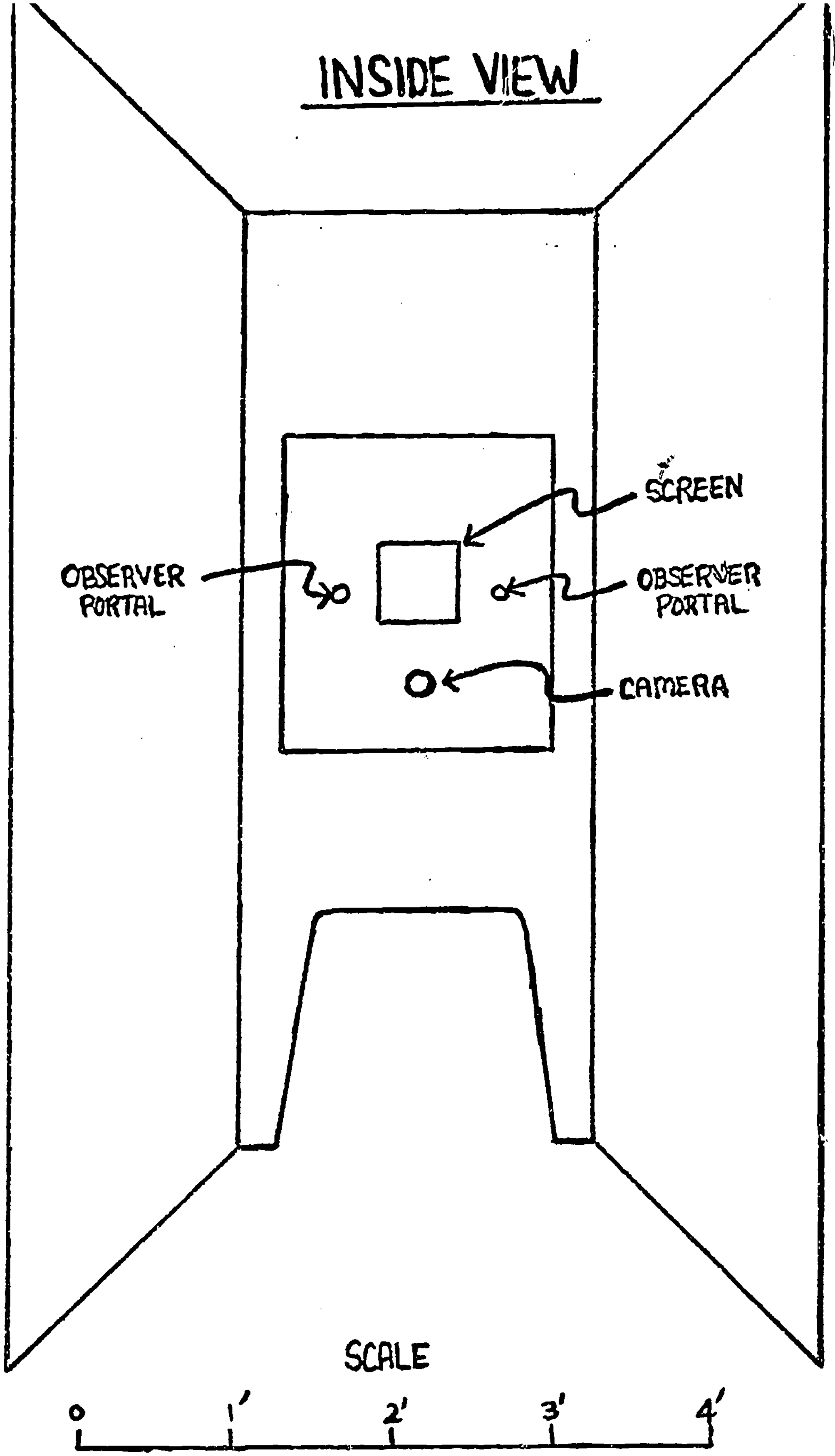

FIGURE 2

DRAFT

The Addition of Auditory Stimulation (Music) and an Interspersed Stimulus Procdure to Control Visual Attending Behavior in Infants[1]

Patricia A. Self[2]

West Virginia University

Introduction

One of the main concerns in infant research has been to understand infant attending behavior. By observing and studying the conditions under which infant attention is maintained, recruited or wanes, it has been hoped that some clues to the more complex area of cognitive development might be gleaned. The repeated presentation of a stimulus typically results in decrement of responding to that stimulus. By introducing a new stimulus and noting whether the new stimulus results in a recovery of attending behavior some clues as to the components of stimulus configurations discriminable to the infant have been discerned. Most of the visual attention studies using response decrement and recovery techniques with infants have paired a familiar stimulus with a novel one (Fantz, 1964), or have given a single repeated presentation of a stimulus, followed at some point by a novel stimulus (Lewis, 1967; Lewis, Bartel, Fadel & Campbell, 1966; Lewis, Goldberg & Rausch, 1967; McCall & Kagan, 1970; Saayman, Ames & Moffett, 1964). These data have indicated that infants from 11 weeks to 18 months do show a visual response decrement and recovery phenomenon. Infants younger than 11 weeks have not always shown habitation clearly. There has been some interest in investigating the parameters of response decrement and recovery. Pancratz and Cohen (1970) reported on the effect of the length of the post-habituation interval and McCall and Kagan (1970) examined individual differences.

The duration of attending behavior in infants is a very individual matter. Casual observation confirms that under the natural conditions of the normal environment, there is enormous variability in the frequency and duration of visual attention. Furthermore, in the natural environment a familiar stimulus is often one that remains present in the infant's environment and one that the infant can return to repeatedly while interspersing attention to other varying stimuli in the environment. In the present study an attempt was made to mirror this natural flow of attention to a repeated stimulus interspersed with a set of variable stimuli in an attempt to see if response decrement behavior might be reliably produced to the repeated stimulus. This and several other interests were the main goals of the research.

In all, the present study was designed to examine four aspects of the response decrement and recovery process. First, the subjects of the study were 5 and 6 week old infants -- an age group where response decrement and recovery had not always been clearly demonstrated (Jeffrey & Cohen, 1971). Second, the procedure was repeated for the same infants at 6 weeks of age to evaluate the stability of infant visual behavior. Third, the repeated stimulus was alternated with novel stimuli in an attempt to determine response decrement and recovery. And finally, the fourth aspect was perhaps the most central one. The study of attention using response decrement and recovery has confined itself to a single stimulus modality. Thus response decrement has been observed to one visual stimulus and the recovery of the visual attending behavior has typically involved the introduction of a different visual stimulus. This has permitted the use of the term "habituation" to describe the process. However, it is quite possible that visual attending behavior is maintained and recovered by stimulus events that are not in the visual modality. Again, casual observations of infants in the normal environment often reveal that they are subject to a cadre of procedures aimed at maintaining or retrieving visual attending behavior: Mothers shift the infant's position, add or subtract tactile stimulation, and use auditory stimulation. In its fourth aspect this study was designed to assess the ability of the addition of auditory stimulation to recover visual attending behavior when the visual stimulus was unchanging.

Methodology

The overall design of this study involved the use of the infant control procedure combined with a fixed trial procedure combined with a fixed trial procedure in the presentation of one stimulus that was repeated in alternation with a set of changing stimuli. Each infant was seen twice, approximately one week apart and each session was conducted in the same manner.

Subjects

A total of 28 infants were seen in the course of this study. Three infants were lost due to uncooperative behavior resulting in a subject loss rate approaching 11%. The average age of the 25 infants who provided the data reported here was 36.48 days the first session and 44.72 days for the second session. Sex was not counterbalanced in this study due to a particularly uneven distribution of sex in the population available at the time this study was conducted. As a result the experimental group consisted of 11 males and 8 females while the control groups was comprised of 4 males and 2 females.

Stimuli

The repeated visual stimulus was a black and white checkerboard slide containing 576 squares. The interspersed stimuli included multi-colored slides of a flowered pattern, a peg truck, a turkey and a jayhawk. The slides when projected before the infant measured 6 inches square and were approximately 13 inches from the infant's eyes.

The auditory stimulation consisted of purely instrumental music provided by the Ventures and Al Hirt. While the music was playing, the average noise level in the room was measured at about 74 decibels re .0002 microbar by a Bruel and Kjear Sound Level Meter, as compared to 60 decibels with no music.

Apparatus

The apparatus described by Horowitz (page 11) and shown as Figure 1 in that article was used in this study. The visual stimuli were mounted in a Kodak Carousel Projector, Model 550, in an adjacent control room. Voice communications between the rooms was possible. The Esterline Angus Recorder was also in the control room and was operated from the experimental room when the keys were depressed by the observers as described by Horowitz in this monograph. Slide changes were automatically recorded on the Esterline Angus along with durations of visual fixation.

A small cassette recorder (York Model K-50) was wired to a switch and connected to a speaker placed beneath the experimental crib. The onset and offset of the music was controlled by the person who operated the slide projector.

Procedure

Each infant was given two experimental sessions, approximately one week apart. The exact time between sessions varied from 3 days to 16 days. The two experimental sessions were identical in procedure.

Each infant was brought into the laboratory and put in a supine position in an infant seat. The infant seat with the infant in it was then positioned in the experimental crib underneath the plexiglass screen. The observers took their places and the session began. A series of eight slides (hereafter known as the stimulus series) was shown in this order: 576 checkerboard, flowered pattern, 576, toy truck, 576, jayhawk, 576, and turkey. The infant control procedure as described by Horowitz in this monograph was used. A slide remained on the screen as long as a pre-selected observer recorded that the infant was fixating the stimulus. As soon as the observer indicated that the infant had looked away for a consecutive period of 2 seconds, the projector advanced to the next slide. A fixation could be any length of time, with the only requirement being that the infant had to look at least 1 second continuously before a recording of a 2 second consecutive period of looking away would cause the projector to advance. After the stimulus series had been presented, the same slides were presented again in the same order. However, whenever the 576 checkerboard slide appeared it was accompanied by music. The other four slides were not presented with music. Again, a look of 1 second duration and a subsequent 2 second consecutive look away were required from the infant to make the projector advance to the next slide.

The control group of six infants saw the stimulus series twice, as did the other infants, but music was not presented with the second presentation series of the 576 checkerboard.

The infants were allowed to use a pacifier if they normally used one and most of the infants did so. When breaks were taken, they were characteristically taken after the presentation of the 576 checkerboard. This procedure was followed in order to minimize the effects of state changes on either the stimulus series or the recovery series of 576 checkerboards. A total of [illegible] different observers served in this study.

Results

Reliability

Three different measures of reliability of observations of the visual behavior were calculated. First, the overall reliability for each session was figured over successive one-half second intervals, with the total number of agreements divided by the agreements plus the disagreements per session. Next, the on-time (intervals during which either observer reported that the infant was looking) reliability was computed; again, the one-half second interval was used and the number of agreements. Since an important part of the procedure involves a 2 second period of "not looking" by the infant in order for a slide change to occur, it was thought that a measure of reliability for the 2-second interval immediately preceding the slide change was necessary. For each session, then, there were 16 slide changes; the number of 2 second periods of these that the two observers agreed upon was thus divided by 16 to obtain reliability at slide change or what we have called criterion reliability. The mean overall reliability was .912, with a range from .740 to .978. The mean on-time reliability for all subjects and sessions was .852, with a range from .680 to .967. The criterion reliability was somewhat more variable, with a mean of .724, and a range from .500 to 1.00.

Group Data

Looking time to the repeated stimulus (576 checkerboard) was analyzed for experimental and control subjects. First individual data results were inspected for stability over the two sessions. Of the 19 experimental subjects, 17 subjects exhibited stable visual behavior over the 2 weeks in pattern.

The data from the two infants who exhibited unstable behavior were excluded from the group analyses reported here. Six infants provided data for the control group where no music was given in either session. Figure I shows the mean looking time for control and experimental subjects with

Insert Figure I about here

sessions combined. It is clear that the introduction of music resulted in an increased visual attending behavior to the repeated 24 x 24 checkerboard square.

These results were subjected to several analyses of variance. First, a repeated measures analysis of variance was done on the fixation time data for the 576 checkerboard. Groups (Experimental versus Control) were considered a between factor, with weeks, music versus no music, and trials as within variables. The F values for the major interactions are shown in Table I. Since F values for the tertiary interactions were non-significant

Insert Table I about here

the residual was not further analyzed. Changes in fixation time to the 576 checkerboard from Trial I to Trial 4 were found to give a significant F, as was interaction of trials with groups of infants either experimental or control. Further analyses of these data indicated that the infants looked significantly longer during Trial I than Trials 2, 3, or 4; as well, infants looked significantly less during Trial 4 than during Trials I, 2, or 3. In the interaction involving Trials with experimental or control groups, the experimental group (music presented with the second series) gave longer fixation time to the first trial when compared to all trials of the control group and the last two trials of the experimental group. The fixation time of the second trial of the experimental group was longer than trials 2, 3, and 4 of the control group, as well as being longer than trial 4 of the experimental group. Fixation time on the third trial for the experimental group was longer than the fourth trial for this group, and longer than the second, third, and fourth trials of the control group. The fixation time of the experimental group during Trial 4 was significantly longer than the fixation time on the second, third, and fourth trial of the experimental group. The first trial of the control group yielded significantly more fixation than did the last trial of the control group. In summary, infants of both groups tended to look longest during the first trial; looking time on the first trial for the experimental group was much greater than for all trials of the control group and the last two trials of the experimental group; and last, looking time for the control infants on Trials 2, 3, and 4 was in general less than for the experimental infants.

A repeated measures analysis of variance was also done on the slides other than the 576 checkerboard. Group was the between factor and weeks, conditions (music - no-music) and trials were within variables. Table 2 shows the F

Insert Table 2 about here

values for these data. Since the major interactions again proved nonsignificant, the residual was not further analyzed. Trails for these data also proved to be a significant factor. Further analysis showed that the infants gave much longer looks on the first trial than on the other trials. No other trials were significantly different from each other.

However, the data as shown in Figure 1 did not adequately describe the individual data of the infants. By inspection, the investigator divided the infants on the basis of their looking behavior. First, there were six infants who showed some evidence of decreased looking time over the four or over at least three of the presentations of the 576, with some increase in looking time when the music was then presented with the 576 in the second half of the session. Next, four infants gave much shorter looks to the initial presentations of the 576, with much greater proportionate changes when the music was then presented with the 576 checkerboard. Last, there was a group of seven infants who gave little evidence of habituation and little evidence of increased looking time to the 576 when it was paired with music. This subjective division of subjects was then subjected to a Stepwise Discriminant Analysis (UCLA, 1965) to ascertain if the infants were correctly divided into groups. This analysis compares and computes an F-ratio for each the variables compared to each other variable. Then, using the F-ratios, it divides the subjects into groups. In these data, by the time the sixth variable was analyzed, the three groups were apparent and discriminable. Further subdivision did not occur. Figure 2 shows the group as divided by the discriminant

Insert Figure 2 about here

analysis. This figure indicates that the division by inspection was replicated by the discriminant analysis.

The data from these three groups of experimental subjects were then analyzed by an analysis of variance. Groups were considered a between factor, with weeks, trials and music - no-music as within variables. Two single factors were found to be significant; weeks and trials. The infants had longer looking time at 6 weeks of age than at 5 weeks, making age a significant factor. Individual t-tests on trials indicated that looking time was longer on Trial I than on Trial 3 or 4, and longer on Trial 2 than on Trial 4.

This analysis of variance also demonstrated a significant interaction between the groups and the music - no-music effects. The t-tests showed that this effect was largely due to the short looking time of the Group II infants without music. This group of infants (those with short looking time to the habituation series) was significantly different from all other groups of subjects, either with or without music. The only other significant effect with this interaction was between Group I infants (those showing response decrement) without music and Group III (those with no response decrement) infants with music.

The groups with trials interaction was also significant in the analysis of variance of the 576 data. The t-test done with the separate means involved indicated that this was in large part due to the effects found on the first trial of Group I infants (response decrement), as this trial had significantly longer looking time than any of the trials of Group III (no response decrement) infants, as well as longer looking time than the second, third, and fourth trials of Group II (short fixation time) infants. Many other significant t-tests also were found to be associated with this factor. Several of these were differences associated with the significantly longer fixation time the infants in Group III (no response decrement) displayed on Trials 2, 3, and 4.

The data for the slides other than the 576 for the three experimental groups were also analyzed by analysis of variance.

The only significant factor found in these data was the trials factor, which was significant at the .05 level. Individual t-tests on the means were done. These showed that the first trial was significantly different from the third and fourth trial. The t-value for Trial I compared to Trial 3 was 2.39 (df = 134), which is significant at the .05 level. For Trial I compared to Trial 4, the t-value was 2.67 (df = 134), which exceeds the .01 level. For these data, Trial I elicited much longer looking time than did Trails 3 or 4.

Discussion

Whereas the demonstration of visual response decrement and recovery in infants younger than 8 weeks using typical fixed stimulus presentation times has not been clearly demonstrated, data from this study indicated that an 'infant-control' procedure combined with an interspersed stimulus procedure did result in response decrement to the repeated stimulus. Further, looking behavior in this study observed during Session I for individual subjects was replicated in Session 2 the following week. Thus, for studies of response decrement and recovery with infants as young as 5 weeks of age, the procedure described in this study may be a method of choice. There was also minimal subject loss in this study. Since subject loss may be a useful clue to the ecological validity of experimental procedures with infants, it may be helpful to analyze the source of subject loss. In this study, if an infant completed one session there was a probability of 96% that the second session the following week would be completed. Only one infant who came into the study as a control infant failed to complete both sessions. There were three infants who did not complete the first session and thus were eliminated from the study. All of these infants cried immediately when placed in the experimental crib and it is interesting to note that two of these three infants successfully completed sessions in similar studies at a later age where a sitting, rather than a supine position was used.

Except for the three infants described, state was apparently not too great a factor in this study. Several infants were in different degrees of quiet or active alertness in the two sessions, yet their visual behavior pattern in terms of the three patterns described was not markedly different. It is possible that the procedure employed in this study to some extent overrides the state variable, or that state is not too important in habituation-type studies as long as it does not involve a complete shutdown of behavior such as sleep or a highly agitated state such as crying.

Data from control infants was very similar to that of the experimental infants without the dramatic recovery effects. From inspection of individual data results, two control infants showed some tendency to spontaneous recovery, even without the music. However, just prior to some increase in looking time, their looking behavior was so low that perhaps the only change that could occur, given some normal variation, was upwards.

Habituation has been technically defined as response decrement and recovery with the introduction of a different stimulus when all the stimuli are in the same sensory modality. In this study the addition of an auditory stimulus when the visual stimulus did not change resulted in a recovery of attention to the visual stimuls. The form of the phenomenon was exactly like that typically demonstrated in studies of habituation in a single sensory modality. Further, this phenomenon is demonstrated with subjects at an age where habituation has not been easily demonstrable. It is possible that the phenomenon demonstrated in this study was possible because of the use of a different sensory modality and that with an older subject population, where traditional habituation has been more clearly demonstrated that the addition of an auditory stimulus would not produce results that resemble habituation. The subsequent studies reported in this monograph clearly indicate that this is not the case.

If response recovery using a stimulus in a different modality can be demonstrated to in all other ways resemble response recovery when the stimulus modality is unchanged then the form of the phenomenon termed habituation may be a very generalized process in the maintenance and recruitment of infant attending behavior. McCall (1970) and others have regarded habituation as a tool for studying early cognitive development: "...habituation of the attentional response to the repeated presentation of a stimulus reflects the acquisition of a memory engarm for that sitmulus." (McCall, 1970). McCall (1970) and Kagan (1970) both believe that after habituation occurs, the degree of discrepancy of a novel stimulus from a familiar one determines the amount of attention that the novel stimulus will receive. It is not clear where an experimental situation such as the one used in this study would fit into the discrepancy hypothesis. It is possible that after habituation has occurred to a stimulus, any sort of stimulus change will re-recruit attention to the stimulus, whether the change is within the same modality as the habituation stimulus or not. Theoretically, there should be some hierarchy of change (similar to the discrepancy hypothesis) which would maximize response recovery. Some of the subsequent research reported in this monograph involves data relevant to this issue.

The results of this study regarding patterns of individual differences in response decrement and recovery are remarkably similar to those reported by McCall and Kagan (1970). Even though the ages of the subjects were different and the methodology varied as well as the use of two as opposed to one sensory modality, the form of the results is very comparable. In this study and in the one reported by McCall and Kagan (1970) there were strong individual differences that differentiated the infants both in terms of the form of the response decrement as well as the subsequent degree of increase in looking behavior following change. The results reported here also support some of the observations made by Lewis (1967) with regard to the rate of response decrement predicting the response to discrepancy.

The concern that Lewis and others have expressed regarding the possibility that younger infants display less clear visual habituation over trials than older subjects (Jeffrey and Cohen, 1971) has not been subsequently supported. Friedman (1972a, b) has demonstrated visual habituation in newborns. The results reported here support McCall's (1970) belief that the demonstration of habituation in younger infants may be a matter of methodology. Lewis (1967) proposed that the occurrence of habituation in younger infants may require shorter inter-stimulus intervals than typically employed for older infants. However, in the interspersed stimulus procedure the inter-stimulus intervals between the repeated stimulus were extremely variable. It may not be the length of the inter-stimulus interval that is important but what occurs during this period. It is important, however, to eventually demonstrate response decrement and recovery with 5 and 6 week old infants using an interspersed stimulus procedure with all stimuli in the visual modality.

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Table I

Repeated Measures Analysis of Variance Results of 576 Data For Experimental Versus Control Infants

Source	df	Sum of Squares	Mean Squares	F Ratio
Between				
A	1	20260.308	20260.308	0.404
Error (a)	21	1054116.442	50196.000	
Within				
B	1	779.522	779.522	3.016
AB	1	2926.330	2926.330	1.135
Error (b)	21	54159.773	2579.030	
C	1	2805.042	2805.042	1.218
AC	1	223.589	223.589	0.097
Error (c)	21	49622.618	2302.980	
D	3	27188.902	9062.900	6.022[a]
AD	3	26545.141	8848.400	5.879[a]
Error (d)	63	98595.191	1505.000	
BC	1	600.275	600.275	0.040
ABC	1	563.553	563.553	0.038
Error (bc)	21	313615.588	14934.070	
BD	3	5681.826	1893.900	0.211
ABD	3	2409.835	803.280	0.089
Error (bd)	63	565819.776	8981.260	

Table I Cont'd

Source	df	Sum of Squares	Mean Squares	F Ratio
CD	3	2842.827	949.610	0.126
ACD	3	191.693	63.897	0.008
Error (cd)	63	474998.982	7539.666	

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Table 2

Repeated Measures Analysis of Variance Results of Data Other Than 576 for Experimental Versus Control Infants

	df	SS	MS	F
Between				
A	1	2083.297	2083.297	0.829
Error (a)	21	52782.692	2513.462	
Within				
B	1	421.837	421.837	0.294
AB	1	130.472	130.472	0.091
Error (b)	21	30096.441	1433.164	
C	1	984.793	984.793	0.922
AC	1	456.398	456.398	0.427
Error (c)	21	22428.059	1068.003	
D	3	21023.282	7007.761	4.994[a]
AD	3	6495.500	2165.167	1.543
Error (d)	3	88409.218	1403.321	
BC	1	0.044	0.044	0.000
ABC	1	252.890	252.890	0.023
Error (bc)	21	228068.700	10860.414	
BD	3	4919.490	1639.830	0.270
ABD	3	425.471	141.824	0.023
Error (bd)	63	381927.991	6062.349	

Table 2 Cont'd

	df	SS	MS	F
CD	3	13439.534	4479.845	0.657
ACD	3	945.396	315.132	0.046
Error (cd)	63	429514.508	6817.691	

$^{a}p < .01$

Figure Captions

1. Mean looking time of the experimental versus control groups to each presentation of the 576.
2. Three groups of infants as divided by the Stepwise Discriminant Analysis (UCLA, 1965).

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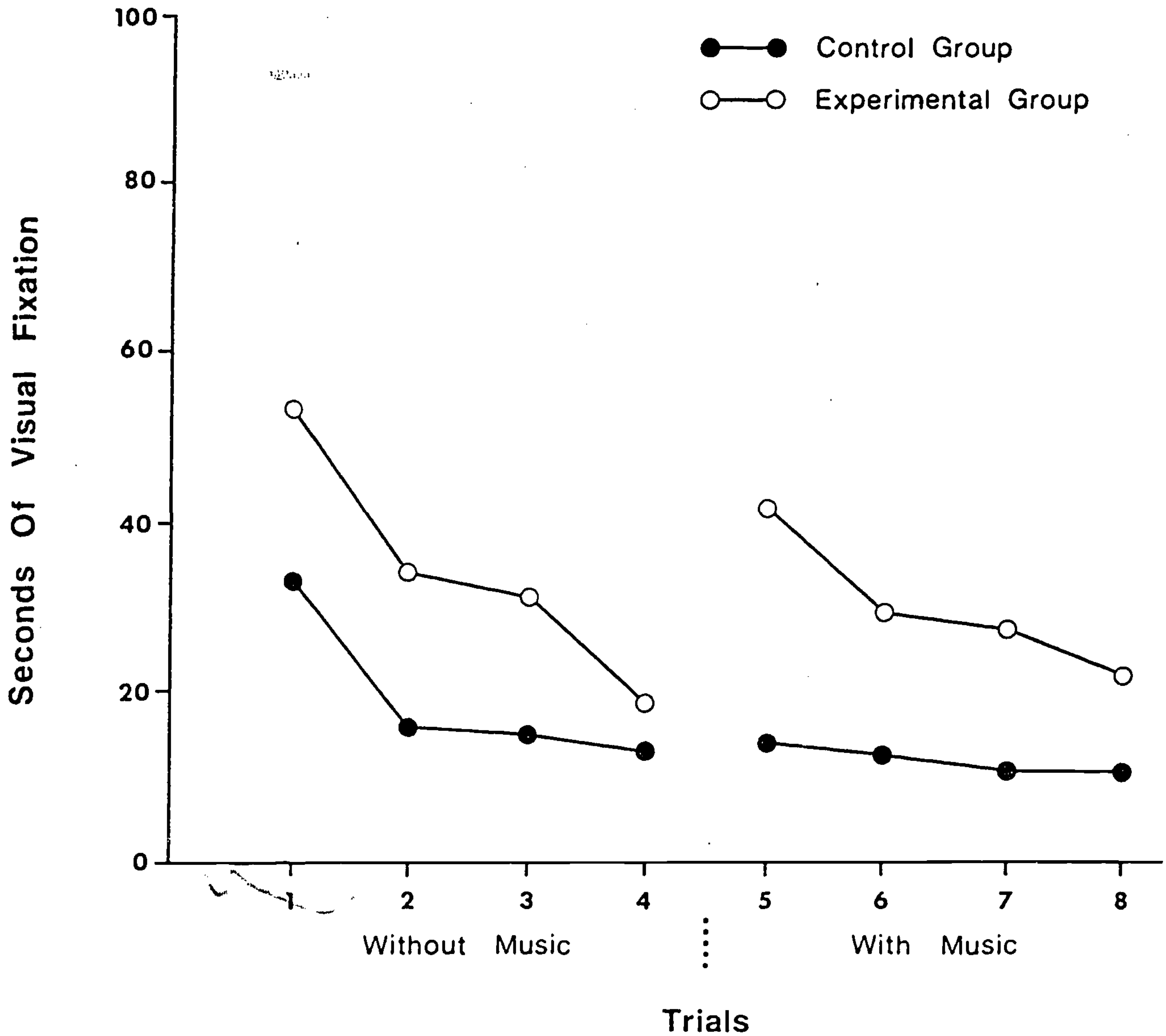

Control Group
Experimental Group
Seconds Of Visual Fixation
100
80
60
40
20
0
1
2
3
4
5
6
7
8
Without Music
With Music
Trials

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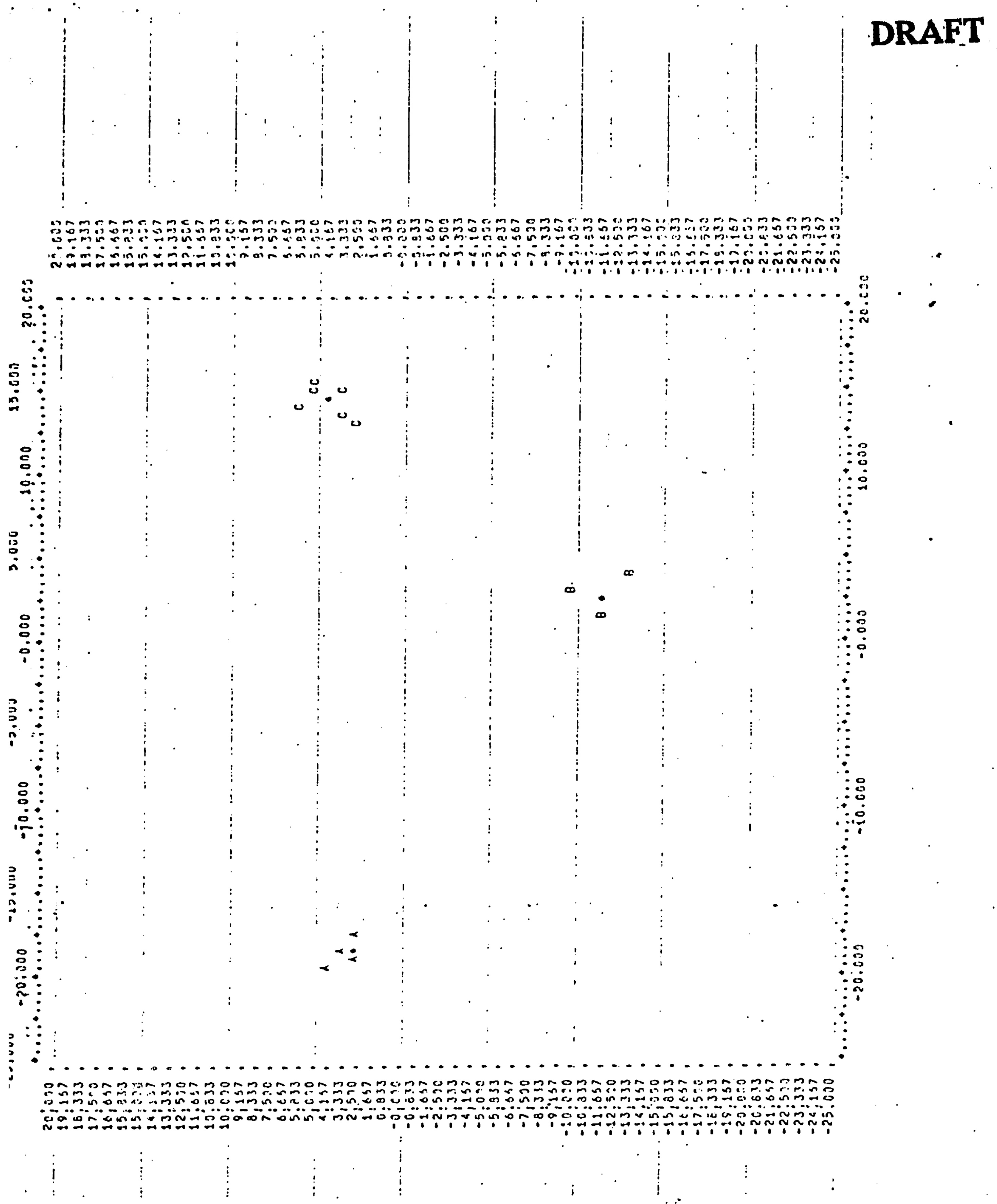

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The Effects of Variations of Auditory Stimulation (Music) and Interspersed Stimulus Procedures on Visual Attending Behavior in Infants[1]

Lucile York Paden

The Menninger Foundation

The results reported by Self (1971) raised several questions. The demonstration of recovery of visual attention with the addition of auditory stimulation looked very much like the habituation-dishabituation patterns established in visual attention studies with older infants, though technically Self's (1971) procedures would not qualify as a demonstration of habituation in five and six week old infants. One purpose of the present study was to replicate Self's (1971) experiment with older infants in an age range where visual response decrement and recovery entirely in the visual modality had been clearly demonstrated. If the same patterns of results could be shown with twelve to fourteen week old infants the case for claiming a wider definition of habituation might be strengthened. Another purpose of the present study was to vary the presentation of the auditory stimulus, relative to the repeated and interspersed stimuli. Self (1971) had presented music only with the repeated (target) stimulus. In this study the effect of music with the target stimulus and the effect of uninterrupted music with both the target and interspersed stimuli was investigated.

There has been no systematic study of the effects of continuous versus intermittent stimulation on infant behavior. However, Brackbill (1971) demonstrated that continuous stimulation in several sense modalities had a state reducing effect in a hospital nursery. Vlietstra and Wright (1971) found that intermittency of visual and auditory stimuli increased the salience of the stimuli in a cross modal transfer problem for preschool children. Kovach, Paden and Wilson (1968) found a flickering (intermittent) visual stimulus was more potent than a steady stimulus in eliciting following responses in domestic chicks.

These studies suggest that the intermittent characteristic of Self's (1971) stimuli might have affected the course of infant fixation behavior. If the auditory stimulus acted as an arousal or novelty stimulus one would expect greater visual attention only with each introduction of the auditory stimulus. That is, fixation time would increase at the first introduction but would subsequently become less if the music addition continued uninterrupted. If the music was interrupted between stimuli to which it was added then decrement of fixation times would be somewhat delayed. If, furthermore, the addition of music had a reinforcing function, then increased fixation times should affect both the target and interspersed stimuli when music is uninterrupted or continuous but increase only to the target stimuli when added only to those stimuli.

Finally, two programs of interspersion were investigated - one replicating Self's (1971) procedure exactly, and one which involved an alternation of the target stimulus with a single other stimulus - in effect providing for two repeated stimuli.

The present study was thus undertaken as a systematic replication of Self's (1971) study at an older age and extended to (1) compare the effects on fixation time recovery of music played continuously with music played only during the presentation of the target stimulus and to (2) investigate conditions of simple alternation compared to interspersing varied stimuli. Because of the important individual difference patterns reported by Self (1971) and others (McCall and Kagan, 1970) it seemed advisable to have each subject act as his or her own control for the auditory comparions of no music, target music, and continuous music. Also, because many investigators have reported sex differences, a more persistent effort was made to include an even sex distribution in this study. The fully counterbalanced design that was used required each subject to participate three times. The design and analyses of this study were therefore more complex than Self's (1971).

Method

This experiment was designed as a replication of Self's (1971) response decrement and recovery study with extensions to investigate the role of the between-target stimuli and of the addition of music as a response recovery stimulus. These extensions consisted of adding a second group of infants who received alternating visual stimuli (ABABABAB) in the same way the replication group received Self's interspersed stimuli (ABACADAE), and to expose every infant to all the auditory input conditions no music control, music with the target visual stimulus, and uninterrupted continuous music. The comparison of alternating and interspersed visual stimuli is hereafter referred to as the Visual Program and the variations of auditory inputs as the Auditory Program.

Subjects

Twenty-four infants, 12 males and 12 females, were tested at 12, 13, and 14 weeks of age. Subjects were obtained by telephone solicitation of the parents of infants whose births were announced in the local newspaper. Only infants with no apparent abnormalities were included.

In order to obtain 24 complete sets of data, 41 infants were scheduled into the laboratory. Twenty-nine completed all three sessions, but data from five of those had to be excluded because of equipment or procedural errors. Failure to keep appointments accounted for five more subject losses. The remaining seven exclusions were due to crying (6) and sleep (1). These seven exclusions indicated subject loss attributable to behavioral problems associated with the procedures at less than 17%.

Apparatus

The equipment used was functionally the same as used by Self (1971), a Kodak Carousel 750 projector, an Esterline-Angus multichannel event recorder, a Panasonic audio tape recorder, and a solid state programmer. Because the infants tested were old enough to sit in an infant seat, the infants were tested in the experimental booth described by Horowitz in this monograph and shown in Figure 2 in her article.

The visual stimulus slides were mounted ina Kodak Carousel tray and were rear-projected onto the screen in the experimental booth. Auditory stimulation (music) was taped and played through a monaural speaker below and in front of the infant but out of view.

Stimuli

The visual stimuli used in this study were the same as those used by Self as described in this monograph. The auditory stimulation consisted of taped selections of the Walter Carlos recording of Switched on Bach (Columbia, MS7194). Sound levels were closely similar to those used by Self (1971).

Design

The distinguishing features of each of the conditions and the counterbalancing of conditions are shown in Tables 1, 2, and 3. Table 1 shows the

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Insert Table 1 about here

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two visual stimulation programs employed in this study. The Interspersed Program is an exact replication of the one used by Self (1971) while the alternating program is special to this experiment. Table 2 describes the six

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Insert Table 2 about here

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different orders of the Auditory Stimulation programs, while Table 3 presents

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Insert Table 3 about here

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the overall experimental design. As in Self's (1971) experiment, the first half of every session was a baseline period in which visual stimuli were presented without any auditory stimuli, followed by the same visual stimuli with the appropriate pairing of music or, if it was a control session, no music.

The overall design thus included three major between/subject variables: visual stimulation program, order of auditory program, and sex. The auditory programs of all No-Music, Target Only Music, and Continuous Music were the major within-subject variables. Once assigned to one of the two visual programs a subject received the same visual program on each visit to the laboratory. However, all three auditory programs, one each week, were presented to every subject. The order of the Auditory programs was counterbalanced over sessions, producing the six orders shown in Table 2. Additional within-subject variables were weeks and trials.

Every session began with an eight trial block of baseline to establish the degree of response decrement. In the interspersed visual program the stimuli were presented in the exact manner as reported by Self in this monograph. In the alternating visual program the checkerboard stimulus was alternated with the flower pattern slide. After the eight trials and without pause, one of the three auditory conditions was instituted and continued for eight trials, followed by three trials without any auditory stimulation. Thus, each session involved 19 trials.

Procedure

As the infants reached 12 weeks of age, an appointment was made to have them brought into the laboratory. Once in the laboratory and when awake-alert, the infant was seated in the infant seat, and placed in front of the screen. Stimuli were presented in accordance with the appropriate program assigned to the subject for the week and the infant control procedure as described by Horowitz in this monograph was used with a .5 second hold procedure that required a minimum fixation of at least .5 second before a trial could be terminated. When a successive non-fixation of approximately 2 seconds had been recorded the stimulus was offset and the next stumulus presented, with an inter-stimulus interval of approximately 2 seconds. Infants were allowed to use pacifiers if they normally used one.

Two observers served during each session drawn from a bank of nine different trained observers.[2] Observers noted fixations, pacifier use, and the onset and duration of fussing behavior. These were recorded through key depressions on the Esterline Angus Recorder.

In the control room the program operator wrote on the Esterline Angus tape the stimulus being presented, reasons for any interruptions, and identifying information as to date, subject, age, session, programs presented, and identity of the observers. Immediately following an experimental session, the observers recorded on a 5-point scale the judged state of the infant, initially, predominantly, and at the end of the session.

Results

Reliability

Three measures of reliability were taken. These are fully described elsewhere (Paden, 1973).

A trial by trial reliability of the number of half second intervals the observers agreed the infant was or was not looking at the stimulus during a session resulted in an overall mean of .88 with a range of .69 to .98.

The reliability of termination of a trial was calculated for whether the reliability observer agreed at the time the control observer terminated the trial. One disagreement per trial was possible for 1152 trials. The reliability observer agreed 91% of the time with the control observer for the 2 second interval of not-looking time that marked the end of a trial.

A third possible error concerned 2 second intervals in which the reliability observer judged the infant to be not-looking when the control observer did not. These disagreements could range from none to infinity for any trial. Actually 70% of the 72 sessions of 16 trials each had no disagreements and 90% had as few as six.

Group Data Analyses

Initial inspection of the data by a histogram analysis (Kansas University Computation Center Program UKANCC, 1972) indicated that the fixation durations recorded were extremely variable and that the variability was much greater than those recorded by Self (1971). On advice from statistical consultants[3] it was decided to apply a log transformation to the data to reduce the effect of the extreme scores. A simple log transformation was performed and the resulting transformed scores were stored on magnetic tape in an order accessible to the UCLA Biomedical Computer Programs (Dixon, 1968). The means and standard deviations for each subject were then calculated from the transformed scores and compared. While there was considerable variability reflecting individual differences, plots of the standard deviations from the two visual programs were similar and clustered.[4]

Several major analyses of the data were performed. In order to simplify the analyses the factors of order of presentation by weeks were counterbalanced and collapsed. The analyses to be reported here were concerned with equivalence of subject groups, the effects of the auditory and visual programs on looking behavior recovery, and an assessment of individual subject-type differences. Full details of additional analyses of these data can be found in Paden (1973).

Analysis to test for equivalence of subject groups. The first three trials for every subject in his or her first session were exactly the same: 576 checkerboard, flower, and 576 checkerboard with no music. In order to determine whether subjects assigned to the two visual programs (alternating vs. interspersed) were equivalent the looking durations on these first three trials were examined by means of an analysis of variance (UCLA Biomedical Computer Program BMD08V, Dixon, 1968) that included the main effects of visual program, sex, and trials. There were no significant main effects and the only interaction effect that was significant was program x trials but a Tukey B test for multiple comparisons (Wike, 1971) failed to show significance even for the most extreme pair. Thus, visual behavior for subjects assigned to the interspersed and alternating visual programs was essentially similar at the outset of the experiment.

Analysis of auditory and visual program effects. The data from 16 trials for each sessions were included for analysis of auditory effects, visual program, sex, blocks, and trials. The overall summary of the results is shown in Table 4 (BMD08V Analysis of Variance, Dixon, 1968). None of the over-

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Insert Table 4 about here

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all main effects was significant and only one of the interactions was significant: Trials x Auditory Program x Block. The means involved in this interaction are shown in Figure 1. This significant interaction factor was further

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Insert Figure 1 about here

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analyzed in two ways: Each individual curve in each Block for conditions was subjected to an overall F test and the means of the three auditory conditions at each trial were subjected to an F test. The result of the F tests for the curves over trials in each Block for each condition was significant only for the Continuous Music condition in the Second trial block (F=2.06, df=7, 184, p=$<$.05). Further analysis of this result by means of the Duncan test for multiple comparisons (Edwards, 1963) indicated that Trials 9 and 10 were significantly higher than Trial 16.

When the Auditory conditions were compared for each trial, there were no differences significant at the .05 level or less but the three Auditory conditions approached significance on Trials 1, 9, and 11 (F=2.99, 2.39, and 2.88, df=2.69, p=$<$.10). In Trials 9 and 11 the No Music condition was lower than the two music conditions, although it was higher initially, suggesting that during the course of the No Music control condition looking became shorter than under the other conditions when music was added to the stimulus.

Analysis of auditory effects for subject types. The subjects were divided into three groups according to their individual performance on the first eight trials of the first session of the experiment. The total fixation time for the second four trials. If the result was .5 or less, the subject was categorized as a Response Decrement subject. Subjects not meeting the Response Decrement requirement and having less than 30 seconds on every one of the first eight trials or a mean of less than 20 seconds with no more than one trial over 30 seconds were put in a Short Looker category. All other subjects were classified as No Decrement subjects. Among the 24 subjects in this study, there were 13 Response Decrement, six Short Looker, and five No Decrement subjects.

Across trials 7 to 10 the transition from no music to music added was made. A one-way analysis of variance (BMDO1V, Dixon, 1968) was applied to the data for these trials for each group. No across subject type comparisons were possible because these data included two trials on which the classifications were made. The means and these trials for the three subject type groups are shown in Figure 2. Only the Continuous Music condition of the Response Decre-

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Insert Figure 2 about here

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ment subjects reached significance, $F=12.043$, $df=3, 48$, $p < .005$. A Duncan's New Multiple Range Test for significance of paired means indicated that trial 7 was significantly different from trial 10 and that trial 8 was different from trials 9 and 10.

An examination of the means of the transformed scores indicated that all three subject types appeared to decrease from trial 7 to trial 8, all three to increase on trial 9 with the introduction of music, but only the Response Decrement subjects continued the increase on trial 10. The apparent greater increase for No Decrement subjects was countered by the smaller number of subjects and a large variance.

A second series of one-way analyses of variance was applied to compare the three subject-type groups on fixation time to trial 9 and to trial 10. Unequal group size increases probability of Type I error (Wike, 1971), or probability of rejecting a true null hypothesis. Therefore, only .01 or less probability was accepted. Only the Continuous Music Condition distinguished the subject types on trial 9 ($F = 11.63$, $df = 2, 21$, $p < .005$) and trial 10 ($F = 7.56$, $df = 2, 21$, $p < .005$). The Tukey B Test for multiple comparisons (Wike, 1971) indicated that for trial 9 each mean was significantly different from the other two. For trial 10 only Response Decrement subjects were significantly different (higher) from Short Lookers.

Discussion

Though the design of this study was more extensive and complicated than Self's (1971) and though the data were considerably more variable, the results provided some interesting replications of Self's (1971) findings. Some of the differences in the data between the two studies are suggestive.

The fact that the alternating and interspersed visual program conditions proved not to be significantly different for the target stimuli was somewhat surprising[5] since it might have been expected that response decrement in the alternating pattern might have been faster than in the interspersed pattern. When the subjects were divided into subject types it emerged that eight of 12 infants assigned to the Interspersed and only five of 12 assigned to Alternating Visual Programs were classified as Response Decrement subjects. It is not possible to tell from these data whether this was a function of the Visual Programs or if the infants were by chance differentially assigned. Moreover, it is possible that the fixed number of trial presentations in each phase were too few in number and when combined with individual difference rates in response decrement any possible differences might have been obscured. The individually fashioned response decrement criterion reported on by Bhana (1970) and Laub (1972) may be a more suitable technique for investigating the question inherent in the alternating and interspersed visual program comparison. Because of these factors the failure to find differences here should not be taken as conclusive.

The failure to find response decrement in the first eight trials for the group data may have influenced the findings relative to the onset of music. Obviously, without decrement, it is difficult to talk of "recovery" of a response. It is likely that with subjects at 12, 13, and 14 weeks the fixed number of trials during baseline were not sufficient to allow response decrement whereas with younger subjects the fixed trial procedure and the interspersed procedure does produce response decrement. The lack of clean response decrement seriously curtails the implications that can be drawn from the current data. As discussed below it may be particularly important in studies involving response decrement for the criterion of response decrement to be individually fashioned especially with subjects in the age range used here.

The main results of this study relate to the replication of Self's (1971) findings with five and six week old infants. Compared to the control condition of no music, the addition of music resulted in greater visual fixation times. The groups were equivalent during baseline while during the auditory manipulation block there were significant increases in fixation time when music was added and a significant response decrement over trials for the continuous music condition occurred.

An interesting phenomenon shown in Figure 1 is the discrepancy between the course of visual attention during the music added trials of the Target Music Condition compared to the Continuous Music Condition. The 12 to 14 week

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old infants failed to show any response decrement to the 576 checkerboard when they were interspersed with non-music stimuli while response decrement for the continuous music condition occurred for all the stimuli. In Self's (1971) results decrement did occur when music was added only with the target stimuli and thus the results in this study do not fully replicate Self's findings.

One possible explanation is the age difference of the subjects which seems not to have affected the "recovery" phenomenon with the addition of music but may be a factor in slower decrement in an interspersed procedure when one stimulus set is marked as different by auditory stimulation. Younger infants may respond to the different sensory aspects of the stimulus complex in a simple reflexive way as each is presented whereas older infants may be able to respond to the relational aspects of present and past stimuli. Thus, the younger infants may show response decrement first to the visual stimuli alone, recovery to added music and decrement again to the complex. The older infants may be responding to the pattern of the interspersion or alternation as well as to the discrete stimulus complexes.

The results were entirely consistent with the findings of Brackbill (1971), Vlietstra and Wright (1971), and Kovach, Paden, and Wilson (1968) regarding the effects of continuous and intermittent stimuli.

In agreement with Self (1971) and with McCall and Kagan (1970) three groups of subjects were identified. Since the Continuous Music condition gave the clearest response "recovery" and then decrement, it is of interest to determine the degree to which individual subjects exhibited the pattern described by the grouped data. Nine of the 13 Response Decrement subjects showed increased fixations on Trials 9 and 10, three of the five No Decrement subjects, and only one of the six Short Looker subjects exhibited the pattern. If one looks just at whether an increase in looking occurred on Trial 9, the first music trial, then seven of the 13 Response Decrement subjects showed an increase, all of the No Decrement subjects, and none of the Short Lookers exhibited an increase on the first music trial. Thus, performance of individual subjects was consistent with the grouped data results.

The failure to find a significant increase to the Target Music condition requires some attention, for on Trial 9 this condition could not be distinguished from the Continuous Music condition. The small values for Short Lookers and great variance for a small n of No Decrement subjects reduced their individual influence in the data. Three of the six Short Lookers and four of the five No Decrement subjects showed increased fixations on Trial 9 but only five of the 13 Response Decrement subjects exhibited an increase suggesting some inconsistency in the behavior of the Response Decrement subjects in the two conditions. However of the eight who showed no increase on Trial 9 in the Target Music condition, four of these were among the five in the Response Decrement group who also showed no initial increase to the onset of music in the Continuous Music condition. It would thus appear that the onset of the auditory stimulus was responded to or not responded to somewhat reliably as far as individuals were concerned - a finding consistent with that of Self (1971).

Because of the findings of Self (1971) and others regarding individual differences in looking and recovery patterns a totally within-in subject comparison for comparing the auditory programs was selected. This necessitated a complex design and an experiment involving three sessions per subject. However, as our subsequent studies have suggested, a better procedure to deal with the effects of individual differences in order to evaluate recovery may lie within procedures that bring each subject, individually, to a response decrement criterion, prior to introducing the "change" [illegible].

The results of this study and the results of Self (1971) when taken together suggest that visual attending behavior can be recovered and/or maintained by the onset of an auditory stimulus (music) without changing the visual stimulus. Compared to the control conditions, where no music stimulus was added, the visual inspection of the pattern of the data both on an individual and group basis, overriding the individual differences, strongly supports the conclusion that Self's (1971) basic finding was replicated in this study and that the phenomenon can be demonstrated at both five and six weeks of age as well as at 12, 13, and 14 weeks of age. The several qualifications that must be made concerning this conclusion have already been stated in this discussion. Nevertheless, as with Self's (1971) data, the possibility is suggested that on the behavioral level an habituation- dishabituation-like phenomenon can be demonstrated cross-modally. The intermittency introduced by adding only to the target stimulus of habituation in an interspersed program retards the phenomenon of response decrement to the recovery stimulus complex at least for 12, 13 and 14 week old infants.

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Footnotes

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2. The author wishes to thank and acknowledge the individuals who served as observers during this study: Elizabeth Boyd, Sue Tims (R.N.), Rex Culp, Karen Laub, Kathy Mabbett, Victoria Powell, Patricia Self, and Malca Aleksandrowicz.

3. The statistical advice was received from Jeff Bangert and Edward Wike and contributed enormously to the analyses of the data reported here. James Frame assisted with the computer analysis.

4. Full details of this analysis can be found in Paden, 1973 or upon request to the author.

5. The Visual Programs did differ in respect to the interspersed sets of stimuli and sex. For these analyses see Paden, 1973.

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Table I

Stimuli for Visual Stimulation Programs

Interspersed Program	Alternating Program
Sx = 576 black and white checkerboard	Sx = 576 checkerboard
S1 = flower pattern	S1 = flower pattern
S2 = peg toy	
S3 = Jayhawk	
S4 = turkey	

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Table 2

Order of Auditory Programs Across Weeks

Order	Weeks					
	1		2		3	
	Phase		Phase		Phase	
	Initial	Recovery	Initial	Recovery	Initial	Recovery
1	No Music	No Music	No Music	Target	No Music	Continuous
2	No Music	No Music	No Music	Continuous	No Music	Target
3	No Music	Target	No Music	No Music	No Music	Continuous
4	No Music	Target	No Music	Continuous	No Music	No Music
5	No Music	Continuous	No Music	Target	No Music	No Music
6	No Music	Continuous	No Music	No Music	No Music	Target

Table 3

Overall Experimental Design

	Order	Sex of Subject	Subject Number	Within Factors, 3 Weeks, 3 Auditory Programs, 19 Trials (not shown)		
				Week 1	Week 2	Week 3
Interspersed Visual Program	1	m f	1 2	No Music	Target	Continuous
	2	m f	3 4	No Music	Continuous	Target
	3	m f	5 6	Target	No Music	Continuous
	4	m f	7 8	Target	Continuous	No Music
	5	m f	9 10	Continuous	Target	No Music
	6	m f	11 12	Continuous	No Music	Target
Alternating Visual Program	1	m f	13 14	No Music	Target	Continuous
	2	m f	15 16	No Music	Continuous	Target
	3	m f	17 18	Target	No Music	Continuous
	4	m f	19 20	Target	Continuous	No Music
	5	m f	21 22	Continuous	Target	No Music
	6	m f	23 24	Continuous	No Music	Target

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Table 4

Analysis of Variance Summary of Fixation Scores Analyzed by Visual and Auditory Programs, Sex, Block and Trials

Between Subject Factors			
Visual Program (V)	1	9770	.0591
Sex (S)	1	1243	.0075
V x S	1	153019	.921
Error 6	20	165308	
Within Subject Factors			
Auditory Program (A)	2	21127	.460
V x A	2	20515	.446
S x A	2	475	.001
V x S x A	2	42903	.935
Error W_1	40	45903	
Block (B) x A	3	53446	1.64
V x B x A	3	18311	.575
S x B x A	3	2979	.093
Error W_2	60	31866	
Trials (T) x A x B	42	23849	1.66*
V x T x A x B	42	22383	1.56
S x T x A x B	42	13111	.915
V x S x T x A x B	42	10078	.700
Error W_3	840	14363	

*For df 42, 840. $F = 1.66$, $p < .05$.

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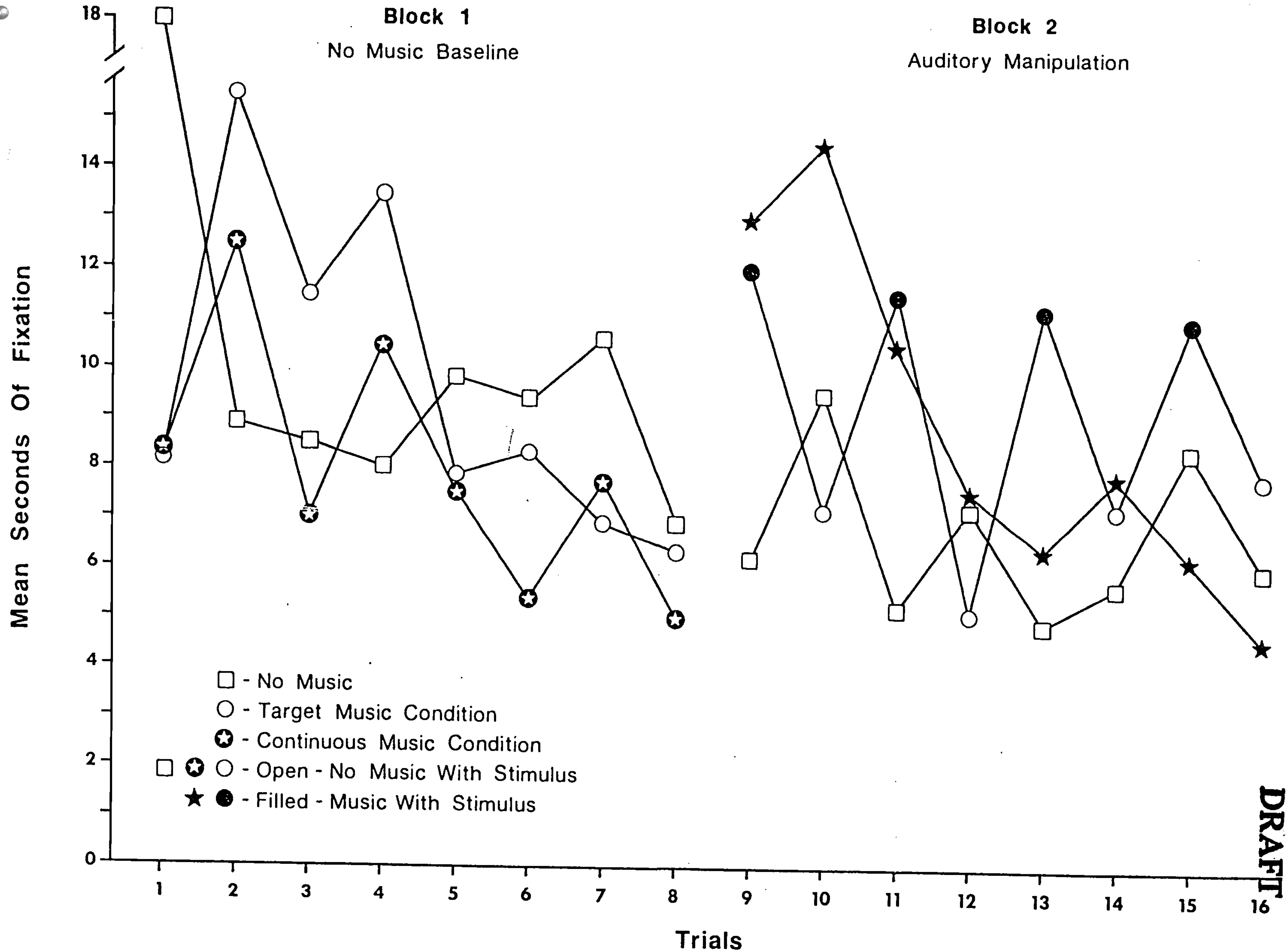
Figure Captions

1. The interaction of auditory program, blocks, and trials. Mean log scores were converted to seconds for plotting. (On trials 1, 3, 5, 7, 9, 11, 13, & 15 the 576 checkerboard was presented.)
2. The comparison of mean fixation times of subject type groups during each auditory condition at the transition from baseline to auditory manipulation.



Block 1
No Music Baseline
Block 2
Auditory Manipulation
Mean Seconds Of Fixation
18
14
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Trials
- No Music
- Target Music Condition
- Continuous Music Condition
- Open - No Music With Stimulus
- Filled - Music With Stimulus
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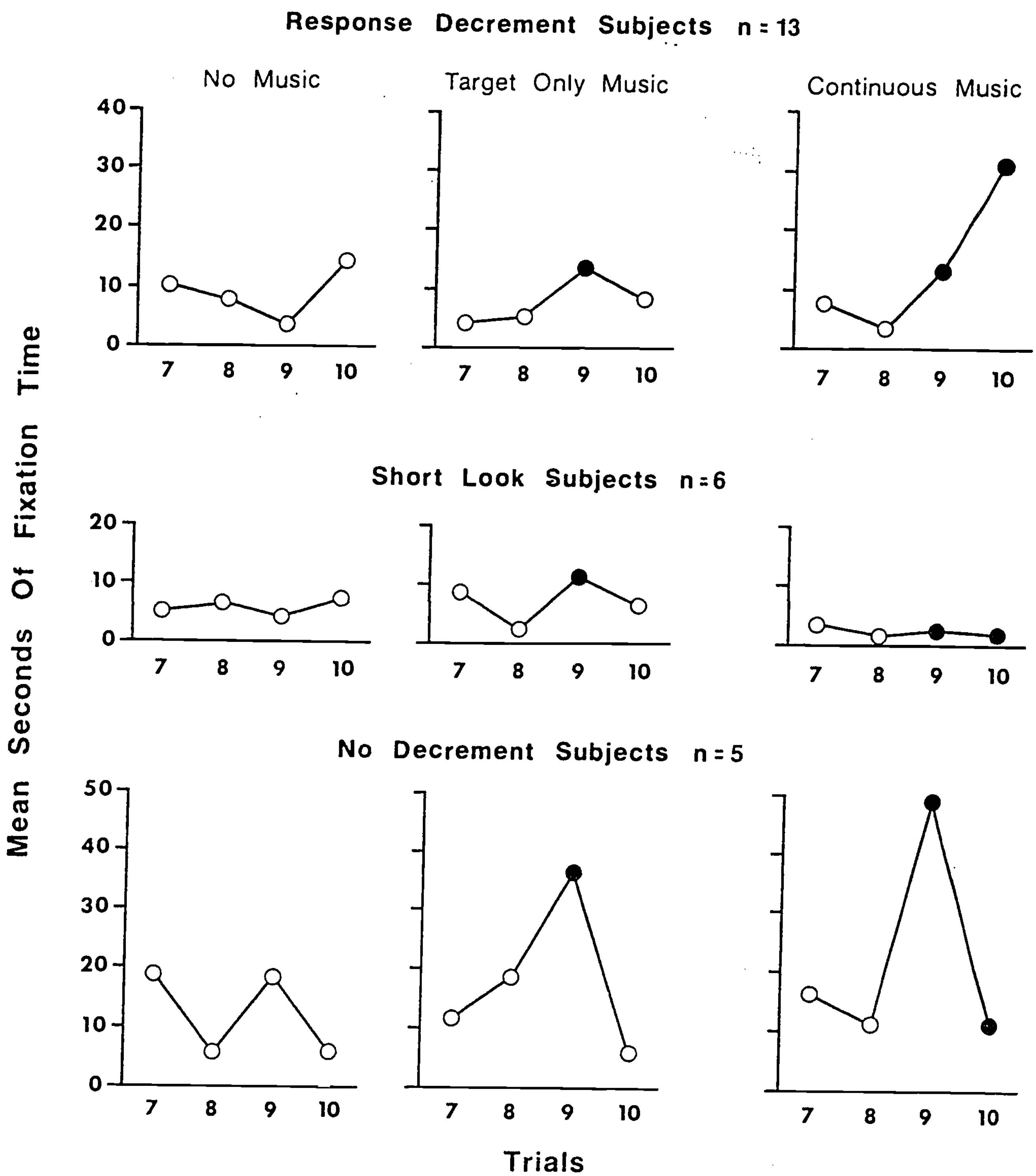

Trials 7 & 8 = No Music Baseline
Trials 9 & 10 = Recovery Block
● = Music Added

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The Use of the Mother's Voice to Control Infant Attending Behavior[1]

Rex E. Culp[2]

The University of Kansas

Introduction

The demonstration by Self (1971) and then again by Paden (1973) suggested that the presence of music could effectively re-recruit and influence visual attending behavior when no change in the visual stimulus occurred. Both of these demonstrations were shown within-session. That is, the change of added visual stimulation occurred during the same session that the baseline behavior was assessed. With Paden's (1973) subjects it was apparent that the baseline period might not have been sufficiently long to produce response decrement. Both Paden (1973) and Self (1971) used music as the auditory stimulus. Because of this author's interest in language stimuli and in early listening experiences for young infants two studies were executed that tried to determine whether voice stimuli acted in a similar manner to music stimuli in recovering and maintaining infant visual attention. In addition it was decided to try to use an across-session design in which each infant would, over a series of laboratory sessions, be brought to a criterion level of response decrement prior to the introduction of the auditory stimulus change. The first study reported here involved the addition of a tape recording of the mother's voice while the second study involved beginning with the mother's voice present and subtracting the voice at the criterion change point.

While these two studies were undertaken because of the author's interest in the voice of the mother as an effective auditory stimulus in relation to the findings with music the design of these studies were seen as answering a question that could not be satisfactorily resolved in the Self (1971) and Paden (1973) experiments. It is possible that the "sudden" occurrence of the auditory stimulus within a session, after no specific presentation of auditory stimuli acted as an "arouser" or had a startle effect that heightened the level of attending behavior. In the studies reported here, the addition or subtraction of the auditory stimulus occurred at the very beginning of the session for which it was slated thus eliminating the possible arousal contrast role of the sudden onset in an otherwise relatively quiet auditory surround.

Experiment I

Method

Design. Beginning at eight weeks of age infants participated in laboratory sessions once a week in what was essentially an ABAB design for experimental subjects and an AAAA design for control subjects. During each week of the A phase of the experiment subjects saw the same set of five stimuli (four checkerboard stimuli and one grey square) until for two successive weeks no fixation to any stimulus totaled more than 120 seconds. During each week of the B phase of the experiment experimental subjects received the same visual stimuli the week following the attainment of this criterion but with two of the five stimuli they heard a tape recording of their mothers' voice. This phase continued until response criterion had been met at which time, the next week A phase was reinstituted again until criterion, followed by B phase the next week. Control subjects received A phase continuously each week from eight weeks of age until they reached the age of 14 weeks.

Subjects. A total of 23 infants were seen in the course of this experiment with the final data reported here from 16 infants. Of the seven who did not complete the study five were excluded because of scheduling problems and only two because of non-cooperative behavior during the experiment. All the infants were eight weeks of age at the beginning of the experiment, and were assigned to either the experimental or control group. Because of the uneven sex distribution of available subjects in Lawrence, Kansas at the time this experiment was being conducted there were three males and one female in each group.

Apparatus. The apparatus used in this experiment was that described by Horowitz and shown in Figure 2 in her article in this monograph with the instrumentation exactly the same as that used and described by Paden (1973).

Stimuli. The visual stimuli were four black and white checkerboard slides containing 4, 64, 256, and 1024 squares and one slide that was a uniform grey color. These slides when projected measured 6 inches square. Each of the stimuli was presented twice in a session in a modified random order in which the first five presentations contained all five stimuli, as did the second five presentations.

The auditory stimuli consisted of a tape recording of each infant's mother talking to her infant "in an ordinary manner" which had been previously recorded in the home of the infant. Repetition on each mother's tape varied from one half minute to two minutes. During the auditory stimulus condition, the tape was presented simultaneously with the 4 and 64 checkerboard stimuli only.

Procedure. Subjects were contacted by phone and recruited for participation in the study. Prior to the beginning of the first session, a visit to the home was made and the mother was asked to talk into the tape recorder as if she were talking to her infant.

Starting at eight weeks of age infants visited the laboratory once a week. Stimuli were presented under the infant control procedure as described by Horowitz in this monograph and essentially similar to that described by Horowitz, Paden, Bhana, and Self (1972). A no hold procedure was used in which the recording equipment began counting fixation and non-fixation after an initial fixation of any duration (i.e., without requiring a fixation of a half to a full second before the non-fixation cumulative counting could be started). Essentially, then, a checkerboard stimulus or the grey stimulus was shown for as long as the infant looked at it. Any recording of a fixation was sufficient to begin the count of non-fixation. When two successive seconds of non-fixation had been recorded the stimulus was offset and a different stimulus appeared. In Phase A, the visual stimuli alone were presented. Phase A was completed when, for two successive weeks, no slide in a single presentation recruited more than 120 seconds of fixation. The following week Phase B was instituted for Experimental subjects and Phase A continued for control subjects. In Phase B the tape recording of the mother's voice occurred with the presentation of the 4 and 64 checkerboard slides. Thus, during each Phase B session the tape recording of the mother's voice occurred four times. Phase B continued until for two successive weeks no stimulus slide recruited more than 120 seconds of fixation. The next week Phase A was reinstituted and continued until the same response criterion had been met at which point, the following week, Phase B was reinstituted. Group 2 (Control) subjects were presented the slides, in the same order as Group 1 for seven weeks without any introduction of auditory stimulation. All sessions were observed by two independent observers. During this study eleven different individuals served as observers.

Except for the above details all other details of the procedure were exactly the same as described by Horowitz in this monograph. The standard procedure for breaks was followed with observers recording fussiness, sleeping or crying. Whenever 15 continuous seconds of these behaviors were recorded, a break was automatically called.

Results

The response measure was the total fixation time in seconds for each stimulus presentation. The data were statistically analyzed for group differences and individual subject performance was inspected.

Reliability. The mean over-all reliability for all subjects was .95, with a range from .84 to .99. The mean reliability of the observations of fixation behavior (on-time) was .87 with a range from .47 to .97; the mean of the reliabilities for non-fixation behavior (off-time) was .81 with a range from .33 to .99.

Grouped data. The mean looking time to each stimulus for the two criterion sessions of the first A phase and the mean looking time to each stimulus for the first two sessions of the first B phase are shown in the upper half of Figure 1 for experimental and control subjects. The first bar

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Insert Figure 1 about here

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in each graph represents the first Phase A data for the two criterion sessions while the second bar is for the first two sessions of the first Phase B. The open bars during Phase B indicate the stimuli with which the voice stimuli occurred. As can be seen in Figure 1, visual fixation for experimental subjects to the voice accompanied stimuli was considerably higher than to those same stimuli for control subjects.

The Mann-Whitney U Test (Siegel, 1956) was used to analyze the group data since there was a lack of homogeneity of variance (Bartlett's Test: $F = 6.74$, $df = 3/1000$, $p < .01$). During criterion sessions of Phase A there were no significant differences in looking time to any of the visual stimuli between control and experimental subjects. However, during the first two sessions following criterion (introduction of voice for experimental infants) significant differences were revealed for looking times to the 4 and 64 checkerboard stimuli. Experimental infants looked longer than control infants to these stimuli but not to the stimuli where no voice was presented. Table I presents the results of the Mann-Whitney U tests and the probabilities.

Insert Table I about here

Voice paired stimuli recruited longer fixation times among experimental subjects than these same visual stimuli did without voice pairing among control subjects. In addition, other stimuli presented during the same sessions without voice pairing did not recruit significantly different visual fixations in experimental subjects compared to control subjects.

Individual data. Individual subject performances were inspected to determine the degree to which the grouped data results were reflected in individual data. All of the experimental subjects exhibited an increase in looking to the voice paired stimuli while no control subjects show an increase to the 4 and 64 checkerboard stimuli following attainment of the decrement criterion. Figures 2 and 3 show typical performance of an experi-

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Insert Figure 2 about here

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mental and a control subject. As seen in Figure 2, the recovery of looking

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Insert Figure 3 about here

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time during the second A phase is not as dramatic as during the first A phase. This was true of all the experimental subjects. All control subjects showed a continuing decrease in looking time over sessions.

Thus, the results indicated by the grouped data were individually replicated for each experimental and control subject.

Experiment II

The second experiment was carried out to determine whether a reversal of procedure whereby the voice accompanied two stimuli initially and then was removed would produce results similar to those reported above. Accordingly, the exact same procedure and design as in Experiment I were used only the tape of the mother's voice was paired with the 4 and 64 checkerboard stimuli initially and then removed.

Method

Subjects. Four infants served as control subjects starting at eight weeks of age and four as experimental, also beginning at eight weeks of age. In order to keep the sex distribution similar to that of Experiment I, three males and one female served as subjects in each group.

Stimuli. The stimuli were exactly the same as in Experiment I.

Procedure. The procedure was exactly the same as in Experiment I with the exception that Phase B occurred first. The voice was paired with the 4 and 64 checkerboard stimuli until two consecutive sessions had occurred in which no stimulus recruited a fixation longer than 120 seconds. The following week Phase A was introduced in which the same visual stimuli were shown but without any voice stimulus. Phase A continued until the criterion of no stimulus fixated longer than 120 seconds was met after which, the following week, Phase B (voice pairing) was reinstituted. Control subjects received Phase B for seven consecutive weeks.

Results

The results are reported in terms of reliability of the data, group data analyses and individual subject performance. The data used in the group analyses consisted of an averaged looking time score for each of the five stimuli. For both Group 1 and Group 2, the looking time score for Condition B was an average of the looking time for the two criterion sessions. For Condition A, the looking time score was an average of the first two sessions immediately following the two criterion sessions (first two sessions of Condition A). These sessions were the first two sessions when the mother's voice had not been paired with the four and 64 stimuli for Group 1 subjects. For Group 2 subjects, these sessions were the first two sessions when the mother's voice would not any longer have been paired with the four and 64 stimuli, had the subjects been in the experimental group.

Reliability. The mean over-all reliability was .90 with a range from .70 to .99. The mean on-time reliability was .85 with a range from .61 to .98, while the mean off-time reliability was .88 with a range from .46 to .99.

Group data. The mean looking times for the two criterion and two recovery sessions are shown in the bottom half of Figure 1. A Mann-Whitney U test (Siegel, 1956) was used to analyze the group data since there was a lack of homogeneity for variance (Bartlett's test: $F = 7.34$, $df = 3/1000$, $p < .01$). There was no significant difference between the experimental and control groups in mean looking times of the two criterion sessions prior to experimental manipulation. The results of the Mann-Whitney U test also indicated that neither the subtraction of the voice or the control condition (voice throughout) resulted in an increase in looking behavior to any of the stimuli in the two sessions following achievement of the response decrement criterion.

From these results it is possible to conclude that the subtraction of the auditory stimulus did not affect visual fixation behavior when this subtraction occurred over sessions.

Individual data. A review of the performance of the individual subjects revealed that no experimental subject exhibited any increases in visual fixation behavior in the first two sessions without the voice stimulus. Similarly, control infants also showed no increases during the sessions when the voice stimulus would have been removed but was not.

Discussion

The two studies reported here indicate that with a week of separation between one condition and the other, the addition of an auditory stimulus but not the subtraction can successfully recover looking behavior to unchanging visual stimuli. Further, the phenomenon of increased fixation time was strongly demonstrated at the first change point but was not replicated a second time within subjects. The second change point typically occurred after eight or nine weeks of consecutive visits to the laboratory when all behavior was decreased and a general habituation to the entire setting had possibly occurred.

There are several interesting points to be made about the results of the two experiments. Firstly, response decrement and recovery over sessions was demonstrated in Experiment I on the first manipulation in contrast to the totally within session demonstration reported by Self (1971) and by Paden (1973). Secondly, recovery was selective of those stimuli with which the voice was paired. Thirdly, an auditory stimulus consisting of a natural flow of language had an effect similar to that of music. While the stimulus was the mother's voice, no conclusions can be drawn about the fact that it was a maternal stimulus as opposed to a non-maternal stimulus. Finally, in comparing the results of Experiment I and Experiment II, an explanation for recovery of looking behavior among experimental subjects in Experiment I cannot be made in terms of sheer stimulus change since the subtraction of the voice did not produce results similar to the addition of the voice at the first change point. Since the addition of the voice in Experiment I was made with an interval of a week between the no voice and voice conditions, it is also difficult to suggest that the addition of the stimulus acted as a sharply contrasting arousal event of the same magnitude that a within-session addition might be. However, some support for a general heightened arousal phenomenon with auditory stimulation accompanying visual stimulation is found in the fact that during Experiment II with experimental subjects who had the voice from the beginning it took on the average half a session longer to reach the first criterion point compared with experimental subjects in Experiment I where no specific auditory stimulus was employed in the initial phase.

Taken in aggregate, the results of the two experiments reported here and those reported by Self (1971) and by Paden (1973) indicate that looking behavior to unchanging visual stimuli can be recovered with the addition of auditory stimuli. This phenomenon appears to hold whether the auditory stimuli are music or a tape recording of a voice; it can be made to occur within session or between sessions that occur a week apart; it appears to occur with a variety of different visual stimulus programs and it is demonstrable in infants as young as five weeks of age.

In the next experiment reported in this monograph an attempt was made to refine the infant control technique in the study of visual habituation. The results of this next study were then used in combination with the results of the present study and those of Self (1971) and of Paden (1973) to investigate voice and language discrimination in young infants.

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Footnotes

1. This paper is based upon a thesis submitted by the author to the University of Kansas, Lawrence, Kansas in partial fulfillment of the requirements for the degree of Master of Arts. This study was supported in part by grant #OEC-0-70-4152 (607) from the U.S. Office of Education.

2. Requests for reprints should be sent to Rex E. Culp, 130 Haworth Hall, University of Kansas, Lawrence, Kansas 66045.

TABLE I

Mann-Whitney U Test Probabilities Comparing

Looking Times of Experimental and Control Infants

Stimulus	Condition A	Condition B
4	p = .557	p = .014*
64	p = .057	p = .029*
256	p = .171	p = .100
1024	p = .443	p = .171
Grey	p = .443	p = .243

*indicates rejection of null hypothesis since the score is less than .05.

Condition A: comparison between experimental and control groups for the two sessions of decrement criterion.

Condition B: comparison between experimental and control groups for the two sessions after the decrement criterion.

Figure Captions

1. Group mean fixation times for Experiment I (conditions A and B) and Experiment II (conditions B and A).
2. Mean visual fixation times for all of Subject AP's.
3. Mean visual fixation for all subject KK's sessions.

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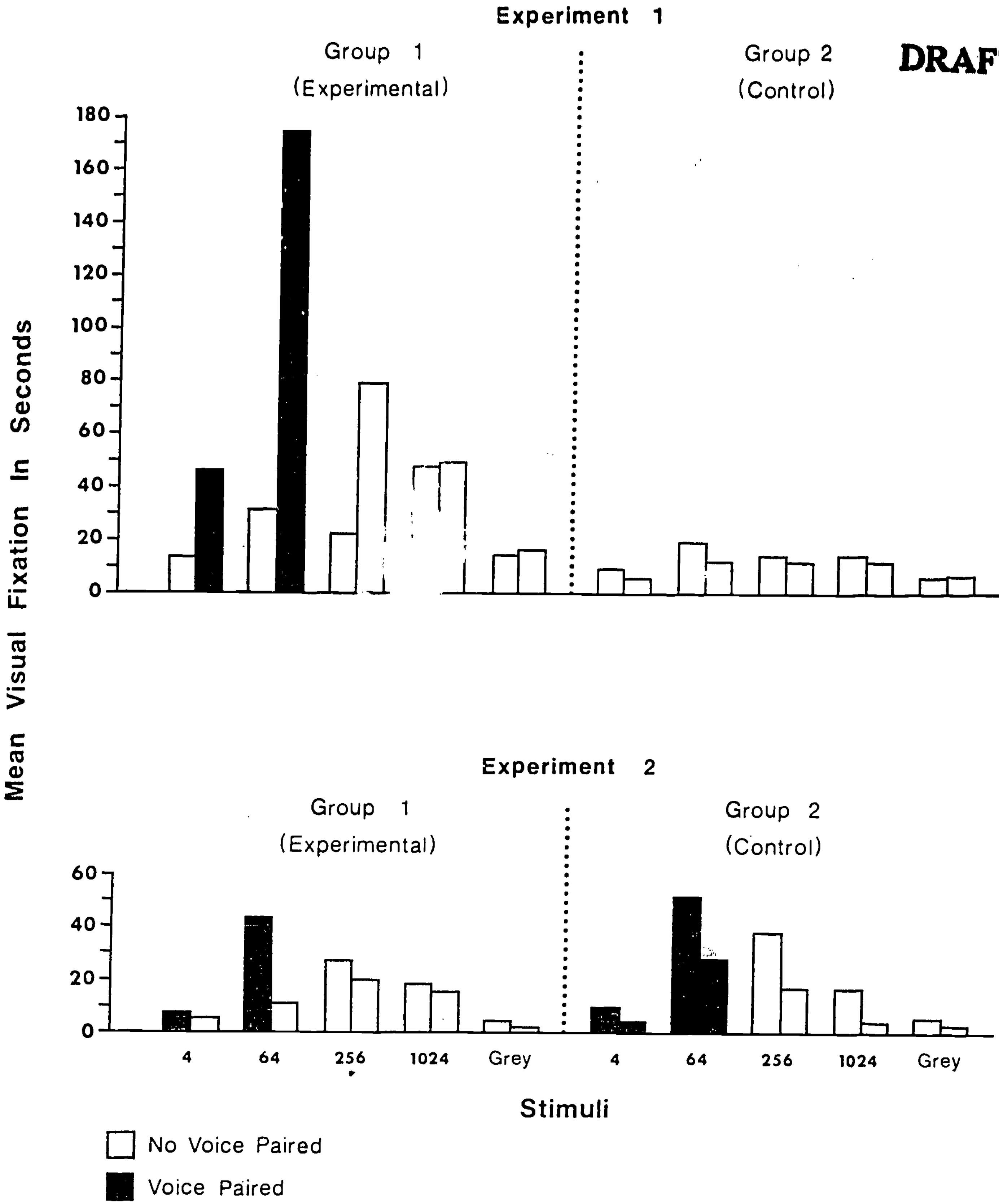

The First Bar Of Each Pair Represents Average For Two Sessions Of Criterion
The Second Bar Of Each Pair Represents Average For Two Sessions After Criterion

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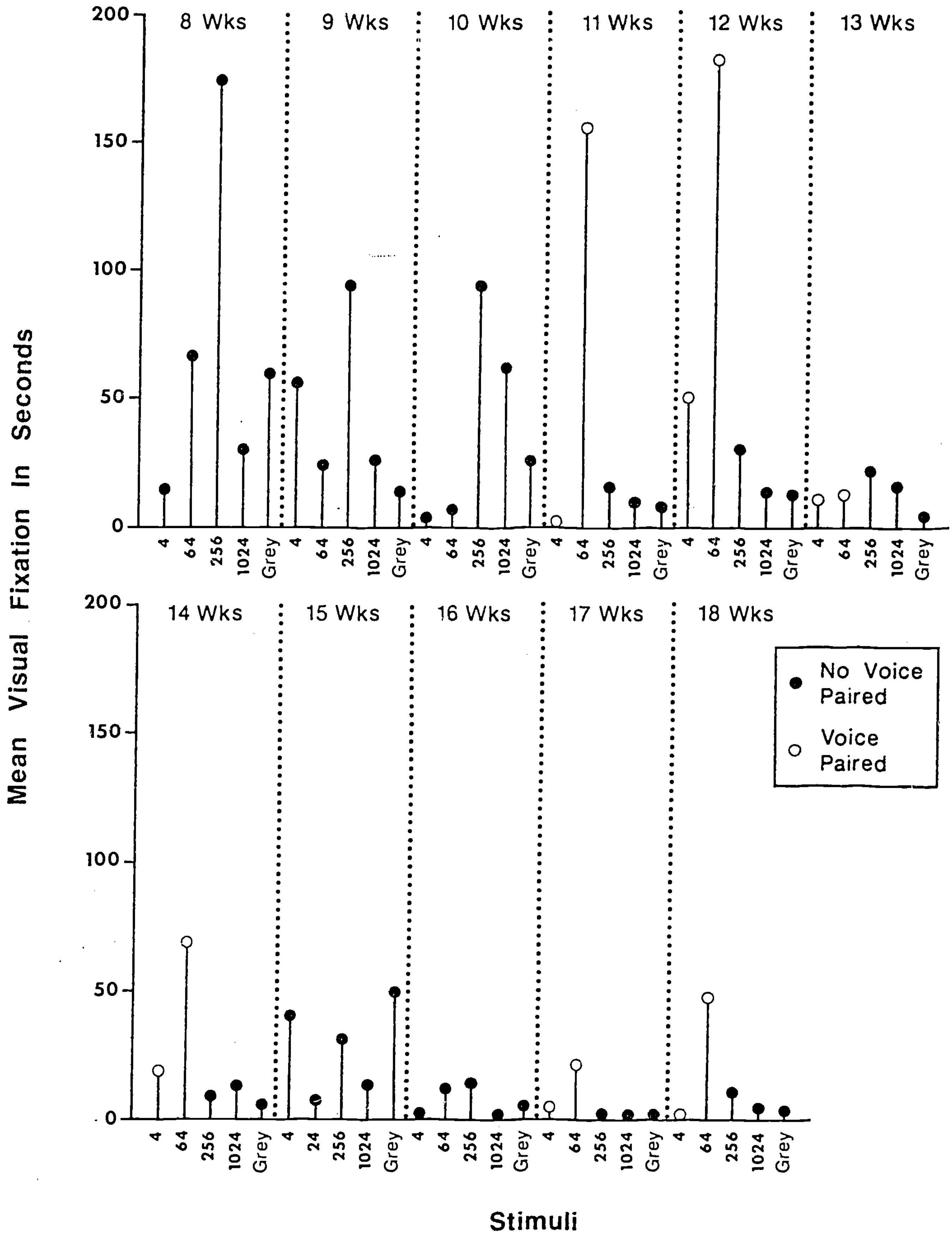
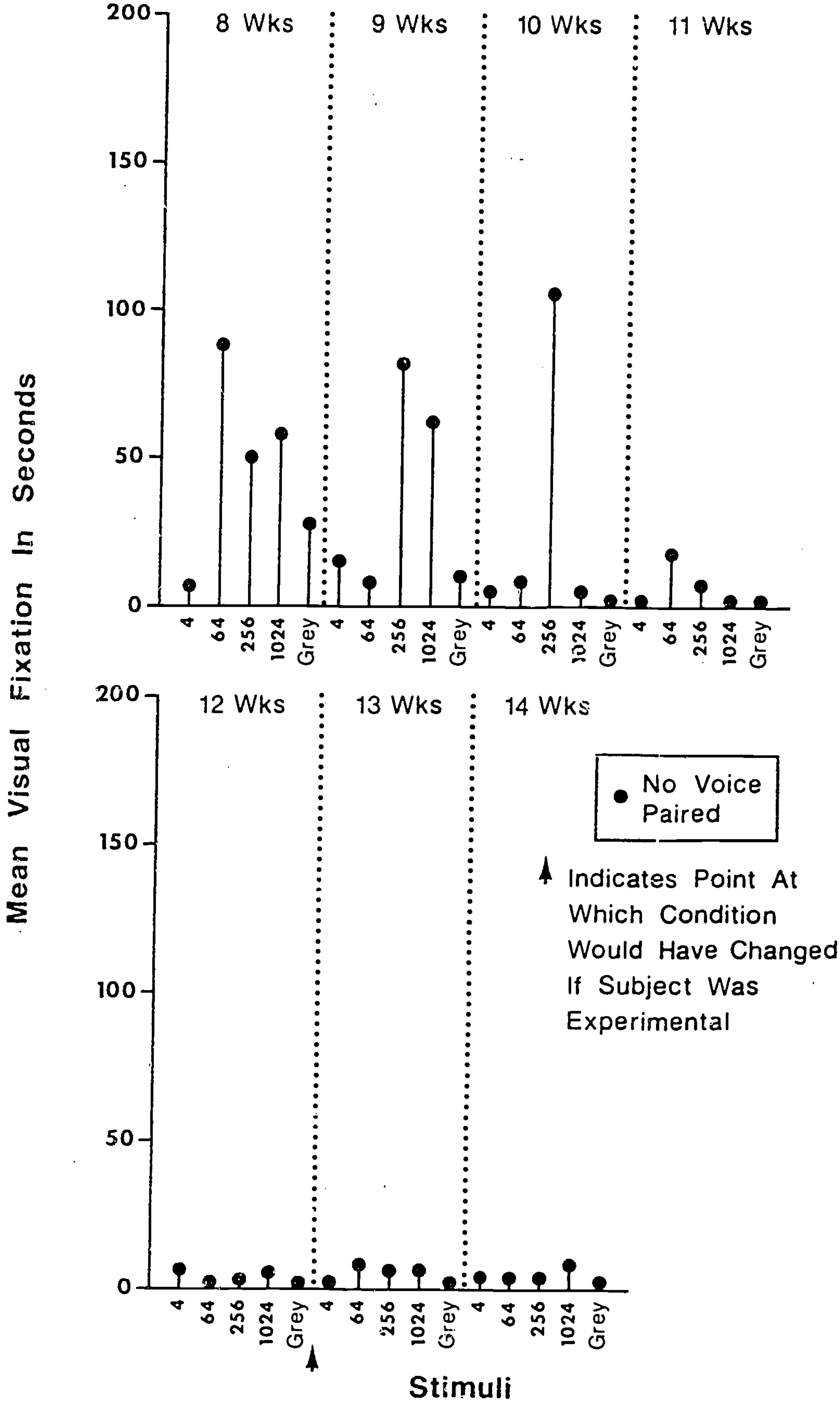


Mean Visual Fixation In Seconds
200
150
100
50
0
8 Wks
9 Wks
10 Wks
11 Wks
12 Wks
13 Wks
4
64
256
1024
Grey
14 Wks
15 Wks
16 Wks
17 Wks
18 Wks
24
No Voice Paired
Voice Paired
Stimuli



Mean Visual Fixation In Seconds
200
150
100
50
0
8 Wks
9 Wks
10 Wks
11 Wks
12 Wks
13 Wks
14 Wks
4
64
256
1024
Grey
No Voice Paired
Indicates Point At Which Condition Would Have Changed If Subject Was Experimental
Stimuli

DRAFT

INFANT CONTROL AND RESPONSE DECREMENT AND RECOVERY AS AN INDEX OF VISUAL DISCRIMINATION IN YOUNG INFANTS

Kastoor Bhana
Durban University, South Africa

Karen Laub
Western Carolina Center, North Carolina

and Frances Degen Horowitz
University of Kansas

Introduction

The demonstrations by Self (1971), Paden (1973) and Culp (1971) of the ability of the addition of auditory stimulation to re-recruit visual attending behavior to an unchanging visual stimulus was an encouragement to consider the possibility of utilizing visual attention to study auditory stimulation in young infants. In reviewing the results of these studies, however, several problems were apparent. Firstly, because auditory stimulation was always introduced after a period of no specific auditory stimulus presentation or in contrast to visual stimuli without auditory stimulation it was not possible to rule out an arousal factor fully in the recovery of visual behavior with the introduction of auditory stimulation. Secondly, the three studies cited above did not provide a clear set of results with regard to methodology. Both Self (1971) and Paden (1973) employed the infant control procedure but with a fixed trial presentation procedure which, in the case of Paden's (1973) results, was not always sufficient to produce clear response decrement in an initial phase. Culp's (1971) procedure of using infant control and also bringing each infant to a criterion of response decrement before introducing the change came closer to the individual fashioning of a response decrement criterion but that procedure, over weeks, was very costly. However, the basic rationale of bringing all subjects to a similar depth of response decrement in visual attending remained attractive. If this could be perfected to a within-session technique for the study of infant visual and auditory discrimination, it might prove to be significant.

The first experiment conducted in our laboratory to determine the feasibility of studying infant discrimination using a combination of the infant control procedure and bringing response decrement to a criterion level within-session was conducted by Bhana (1970) in a study of habituation and visual discrimination. The subjects in that study were shown the picture of a 4 x 4 checkerboard square repeatedly with stimulus duration of each exposure determined by the infant's looking behavior. That is, it remained on until a consecutive period of 2 seconds of non-fixation of the stimulus was recorded at which point it was off-set and then re-presented. This continued until the infant's looking behavior met an habituation criterion of either three consecutive fixations of 10 seconds or less or a total of six consecutive fixations each of 10 seconds or less. Once habituation criterion had been reached on the checkerboard square stimulus, a second stimulus was introduced. It was a slide of a picture of an infant that included the head and shoulders of the infant. This slide was shown repeatedly until one of the habituation criteria had been met and then the checkerboard was shown again, followed in similar fashion by the slide of the infant once again. Each of the 16 subjects in the study came to the laboratory at 12 and 13 weeks of age. If on the first visit they had received the checkerboard-infant stimuli, then on the second visit the same procedure was repeated only with stimuli that were a slide of a red circle alternating with a slide of a blue rectangle. Session and order of presentation were counterbalanced.

The results of this study were interesting but problematical. The interesting and encouraging aspects were as follows: Response decrement to the checkerboard or to the infant stimulus was generally followed by an increment in looking to the other stimulus after criterion had been met. Similar results were found for the blue rectangle and red circle though the recovery was not as consistent. The largest recovery was when the infant stimulus followed the checkerboard. The mean difference between the criterion looks to the habituation checkerboard stimulus and the first three fixations to the infant stimulus was 18.71 seconds while the infant-checkerboard sequence and the blue rectangle to the red circle had mean differences of 5.02 and 6.64 seconds respectively. The recovery to the blue rectangle following habituation to the red circle was essentially zero. Statistical analyses of the data indicated significance in recovery for all the pairs but the blue rectangle to red circle. The problematical aspects of the results, however, were serious: Firstly, subject loss was high. Of the 29 infants who entered the study, only 16 completed both sessions. With the infants who completed both sessions there was a high incidence of crying, fussing, and drowsiness. These are typical problems in infant research but we had learned previously that the infant control method tended to reduce these problems significantly and in this study they had seemingly returned. When we examined the sessions where the problems had occurred, it became clear that the arbitrary characteristic of the habituation criterion being used obviated the individual characteristics of the infant control procedures. Infants who began with long fixation times often showed a dramatic decrease in looking behavior to the stimulus but not low enough to meet the habituation criterion of three consecutive fixations of 10 seconds or less. These infants had a high incidence of behavior incompatible with the experimental procedure and this was reflected in the reliability of the observations. While the mean reliabilities for looking were over .90, the mean reliability of the non-fixation observations was as low as .56 for Session One.

Several alternative approaches are possible. In attempting to alleviate the possible boredom factor engendered by constant repetition of the same visual pattern one could intersperse a non-repeated stimulus similar to the procedure employed by Self (1971) or by Paden (1973), but with the number of trials not fixed.

A second alternative is to make the habituation criterion variable and individually fashioned much as the infant control procedure is geared to individual difference behavior in fixation durations since the fixed habituation criteria used by Bhana appeared to create some of the same problems that the infant control procedure had overcome. A fixed habituation criterion assumes that the level of habituation between two subjects is the same when one habituates from 500 seconds of fixation time to 10 seconds and the other from 100 seconds to 10 seconds. A similar assumption is often made in studies that use fixed exposure times and a fixed number of habituation trials.

Thus, while Bhana (1970) concluded that the infant control and response decrement and recovery was a useful procedure for studying visual discrimination in young infants, procedural refinements and alternative approaches needed investigation before the technique could be unequivocally recommended for use in studying infant discrimination behavior. This report is concerned with the investigation of one of the above alternatives - the individually determined criterion for habituation combined with infant control of stimulus duration as an index of visual discrimination.

Method

Subjects

Sixteen males and 16 females completed both sessions of this study. They were approximately 7 and 10 weeks old and ranged in age from 1 month, 22 days to 2 months, 6 days for the first session and from 1 month, 29 days to 2 months, 19 days for the second session. An additional 13 subjects (five males and nine females) failed to complete the two sessions and their data were not included in the analyses.

Stimuli and Apparatus

The stimuli used were slides that projected to an image of 6 inches square and that showed either a color photograph of a little girl (about 3 years of age, with sandy hair, white skin, brown eyes, and blue playsuit) and a black and white checkerboard square containing 64 squares.

The apparatus used was that described by Horowitz in this monograph and shown in Figure 2 on page 23.

Design and Procedures

Each infant participated in two sessions, scheduled at an interval of approximately a week, where possible. The interval between the sessions varied from 4 to 14 days, with a mean interval of 7.75 days.

The infants were divided into four groups, balanced for sex. Group 1 infants saw the checkerboard stimulus first and the girl stimulus second during the first session, and in reverse order during the second session. Group 2 infants counterbalanced session by having the girl stimulus and then the checkerboard during the first session and the reverse during the second session. Groups 3 and 4 were control groups: Group 3 infants saw only the checkerboard slide during the first session and the girl slide during the second session while Group 4 counterbalanced Group 3 with the girl only in the first session and the checkerboard only during the second session.

Stimuli were shown to the infant repeatedly using the infant control criterion of offset of stimulus when two consecutive seconds of non-fixation behavior were recorded with the stimulus then being re-presented until a response decrement criterion had been met. The response decrement criterion was individually determined for each infant in the following manner: response decrement criterion was defined as two consecutive stimulus fixations each with durations of less than half the duration of the first fixation of that stimulus.

Infants in Groups 1 and 2 were brought to criterion twice during each session, once for each stimulus, while infants in the Control Groups 3 and 4 were brought to response decrement twice also, with the second response decrement criterion determined by two consecutive stimulus fixations each with durations of less than half the duration of the first fixation after the initial criterion had been met. All infants received a 10 second presentation of a "starter stimulus" at the beginning of each session. This was a black and red plaid slide and it was thought this would help locate the screen for the infant before the first measured stimulus presentation.

Results

Reliability

Agreement and nonagreement on the occurrence of fixation and on failure to fixate the stimulus was determined for each half-second interval throughout the session. Interobserver reliabilities were computed by summing the agreements and dividing that figure by the total number of agreements plus disagreements. The interobserver reliability for all sessions was .88 for occurrence of fixation and .75 for occurrence of the non-fixation of the stimulus.

Grouped Data

The question of discrimination of the two stimuli can be evaluated by analyzing the difference between the last two fixations to one stimulus (the response decrement criteria responses) and the first post-criterion fixation when the stimulus was changed (for subjects in Groups 1 and 2) as compared to the difference obtained when no stimulus change occurred (as for control subjects in Groups 3 and 4). Visual inspection of the data indicated extreme variability and this was confirmed in the significant result when homogeneity of variance was tested using Hartley's (1950) Test: Fmax = 1120.99, df = 7, k = 8, $p > .02$. The heterogenity of variance was too extreme to be adequately modified by transforming scores. Extreme scores were not dropped or Winsorized since they were frequent in these data (and in other data produced using the infant control procedure). Recovery of looking behavior after response decrement criterion had been met was therefore evaluated using Wilcoxon's Rank Sum Test (Siegel, 1956). For each session the difference between the mean of the first two criterion fixations and the next fixation was taken. (While the number of presentations per session varied from 6 to 65, no session consisted of fewer than 6 presentations). Sign tests were also used to compare difference scores during the first session with those during the second session ($N = 32$, $r = 13$, $p <> .50$) and to compare difference scores when the girl was the recovery stimulus with those when the checkerboard was the recovery stimulus ($N = 32$, $r = 15$, $p > .50$). The comparisons based on session or on stimulus thus yielded no significant differences.

In the analysis to evaluate discrimination a mean difference score was computed for each subject by averaging his or her two difference scores. The Wilcoxon Rank Sum Test applied to these mean scores yielded a significant difference ($n = 16$, $m = 16$, $W_n = 219$, p .05) between the experimental (stimulus change) and control subjects (no stimulus change). The mean difference scores of experimental subjects were greater than the mean difference scores of control subjects, indicating longer fixations following stimulus change (mean = 52.91 seconds) than were found when no stimulus change occurred (mean = 9.52 seconds). Figure I illustrates the mean number of

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Insert Figure I about here

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seconds of visual fixation for the experimental and control subjects.

There were no significant differences in recovery between males and females. The stimuli did not differ much in their ability to recruit fixation. The mean duration of fixation per stimulus presentation was 32.31 seconds for the girl and 39.79 seconds for the checkerboard. The average number of trials required to reach criterion per habituation series was 5.05 for the girl stimulus and 7.38 for the checkerboard stimulus.

<u>Individual Data</u>

If habituation and discrimination are to be eventually used to understand individual development, the demonstration of a phenomenon must also be evaluated for individuals as well as for groups. The individual data graphs in this study were inspected for the degree to which the course from initial fixation to a stimulus to the achievement of response decrement was regular and the degree to which, once response decrement had been reached, the subject in the experimental group showed an increase in fixation with stimulus change and the subjects in the control group showed a pattern of no increase in fixation when there was no change in stimulus after the achievement of response decrement. Of the 48 individual sessions (each subject had two sessions) an irregular pattern of response decrement to the first stimulus in the session was observed in only eight sessions. Of the 24 experimental sessions the pattern of decrement and recovery shown in Figure 2 was typical

Insert Figure 2 about here

of 17 sessions. Of the 24 control sessions the pattern of decrement and no recovery shown in Figure 3 was typical of 13 sessions.

Insert Figure 3 about here

In 15 sessions (8 experimental and 7 control) the sessions began with mean fixation times during the first habituation period of less than 30 seconds, which indicates the stimulus was a relatively weak stimulus for recruiting attention. It is difficult to talk about habituation or response decrement unless the response initially occurs at some level of strength. Only two subjects, however, produced such initially low fixation times in both sessions.

There were wide individual differences in the number of trials necessary to reach criterion. The range was from 3 to something in excess of 45 presentations (an incomplete session). If a subject had an initially short fixation at the beginning of a habituation series, the achievement of response decrement tended to be particularly difficult. For some of the experimental subjects recovery after stimulus change tended to occur more strongly on the second presentation than on the first.

When habituation criterion is used which requires a sequence of very short fixations, the first post-criterion fixation is likely to be longer than the criterion fixation. In 15 of the 24 experimental sessions and in 8 of the 24 control sessions, the first post-criterion fixation was longer, in absolute terms, than the preceding criterion fixations. Thus, the determination of recovery of failure to obtain recovery is a matter of <u>relative</u> durations of fixation with and without stimulus change. In this sense the group data shown in Figure I accurately reflect the patterns of the majority of the individual infants. Of the 9 experimental sessions where an absolute increase was not observed on the first post-criterion fixation, an absolute increase was observed on the second post-criterion fixation in 5 sessions attesting to the possibility of a delayed recovery.

In 3 of the 24 control sessions the increase in fixation after criterion for response decrement was relatively large even with no stimulus change. Thus, it appears that recoveries similar to that found with stimulus change will occur spontaneously without stimulus change about 12% of the time.

Discussion

The use of the infant control procedure in combination with an habituation procedure where the criterion for the occurrence of response decrement was individually defined produced encouraging results. Not only was there significance in the analysis of group data but inspection of individual performance indicated the recovery of visual attending behavior was frequent among experimental subjects and relatively infrequent among control subjects. It appeared, from an inspection of individual performances and from an analysis of subject loss that a major improvement in the procedure would be to individually fashion the habituation criterion using the mean of the visual fixations of the first two trials rather than the first trial alone. This seemed particularly relevant for the definition of the second criterion for habituation where on the first presentation of the changed stimulus, the fixation was short. It was almost as if the infants had developed a pattern of responding with repeated stimulation where, finally, at the end of the first habituation series there was only a brief glance and a head turn away. This pattern would be employed for the first presentation of the changed stimulus with the quick look and head turn sufficient to off-set the first presentation of the new stimulus before the difference in the new stimulus was recognized. Typically, in such cases the second fixation to the new stimulus was much longer. Thus, the second response decrement criterion would probably be more valid if it were determined by the first two presentations of the new stimulus.

The results of this study encouraged the additional refinements of the technique suggested above and became the basis of the subsequent research in the Kansas Infant Laboratory on the ability of infants to discriminate language stimuli, using visual attending behavior and its recovery and non-recovery as an index of discrimination. The proceudre has also been used to further study discrimination of visual stimuli with encouraging success but that research is not included in this monograph (Gallas, 1973; Laub, 1973).

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Figure Captions

1. Comparison of mean visual fixation times with and without stimulus change (averaging across subjects, sessions, and stimuli, with sixteen subjects per group and two scores per subject).
2. Infant's visual fixation of two slides repeatedly presented.
3. Infant's visual fixation of two slides repeatedly presented.

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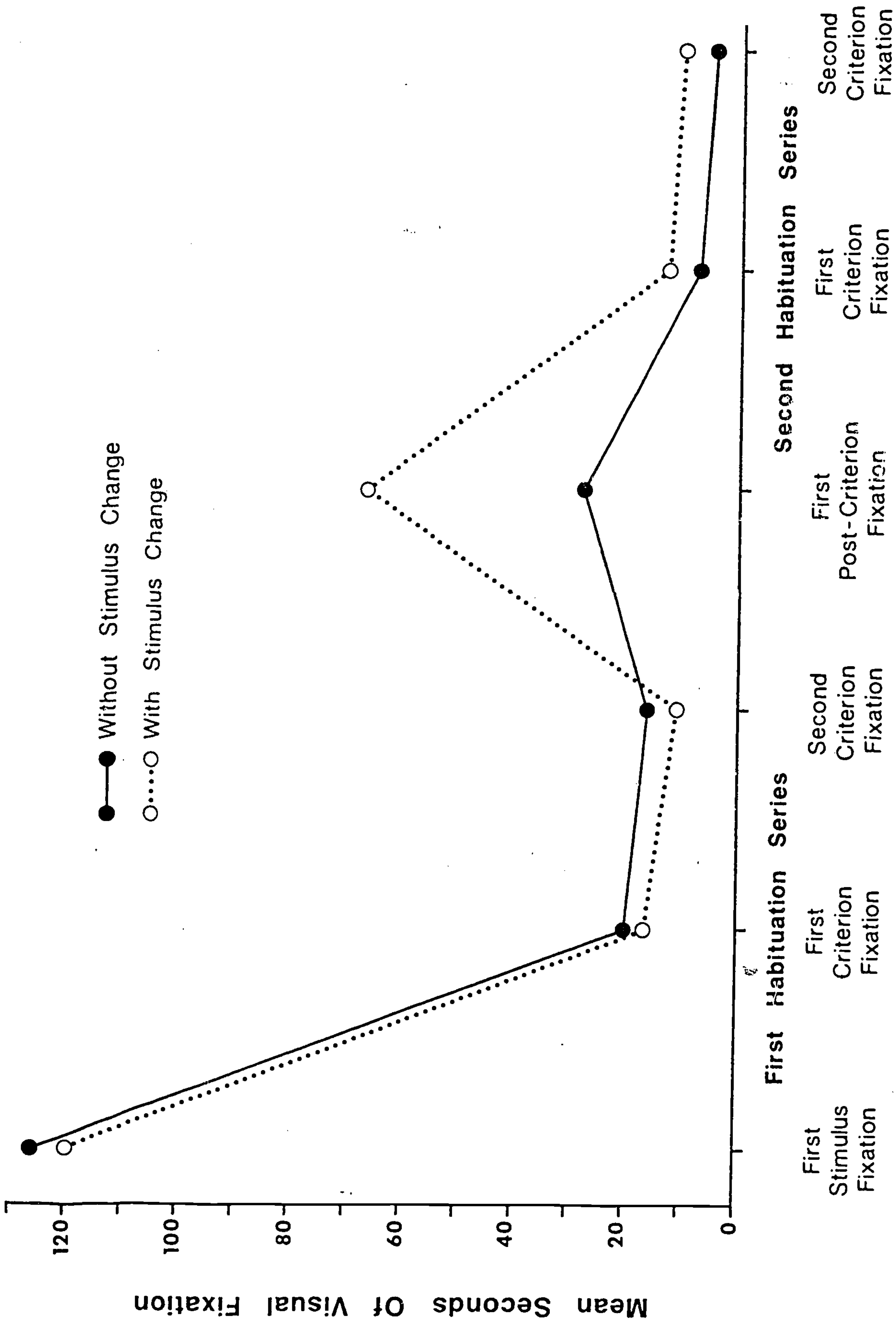
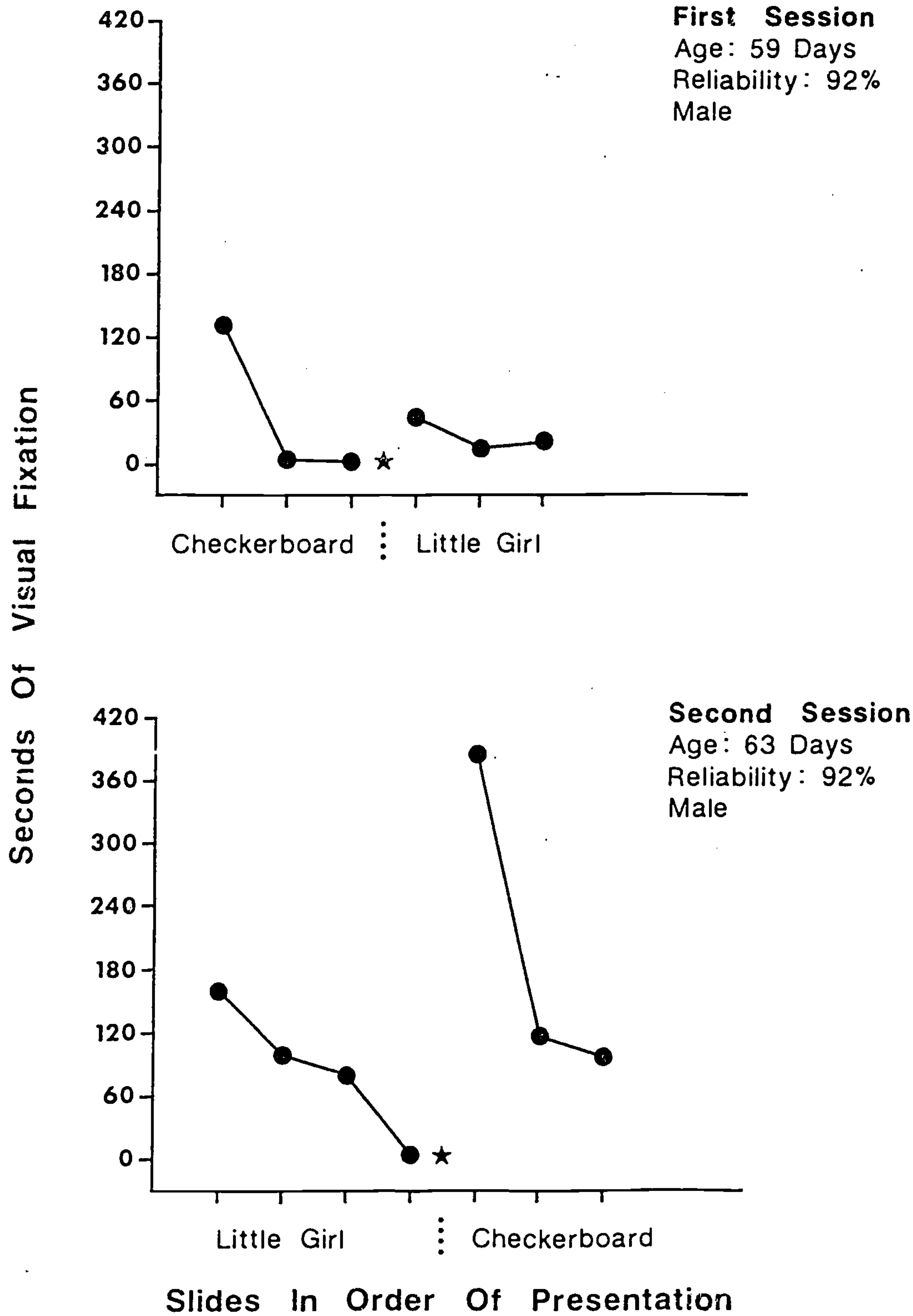


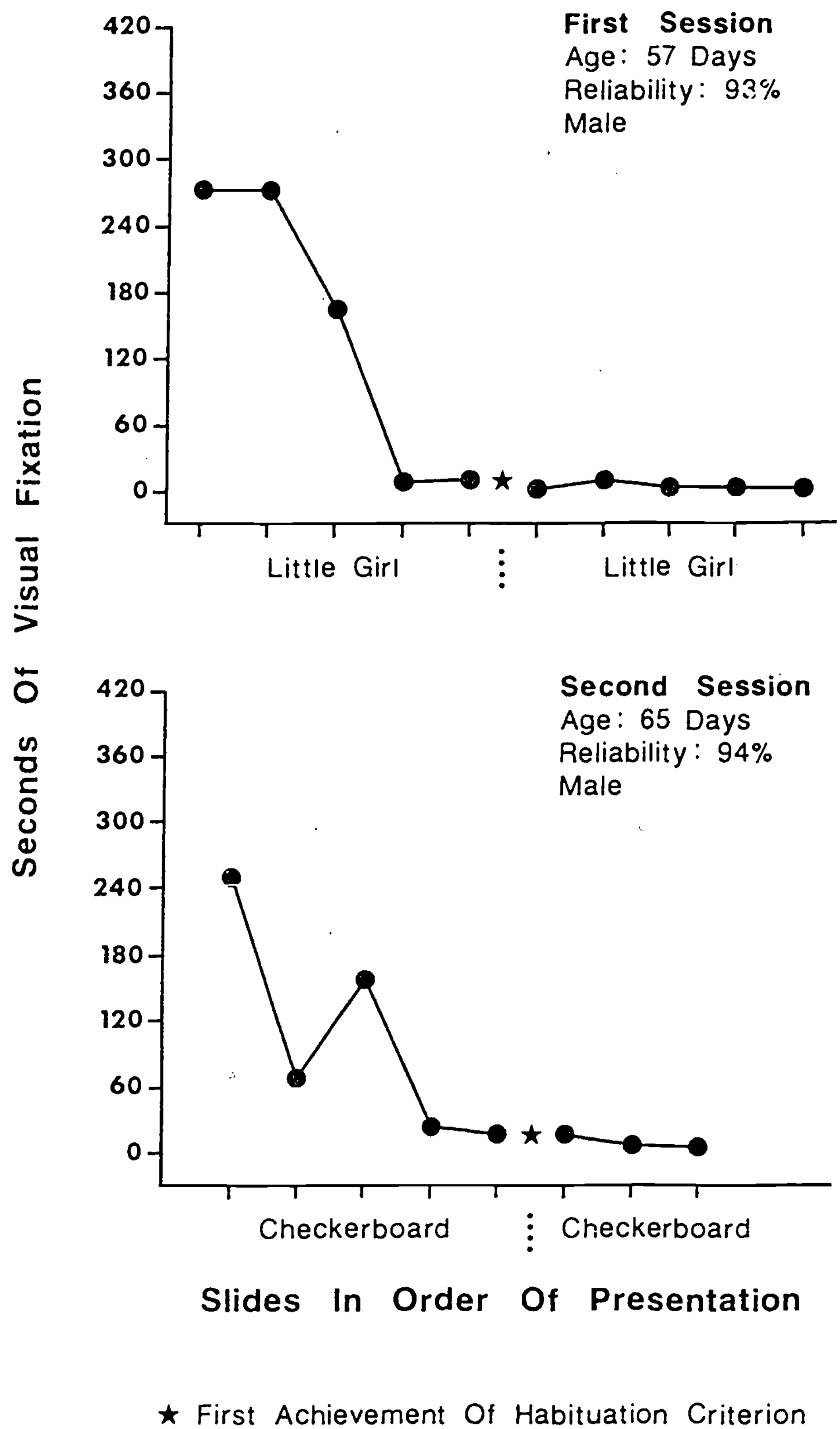
Without Stimulus Change
With Stimulus Change
Mean Seconds Of Visual Fixation
0
20
40
60
80
100
120
First Stimulus Fixation
First Habituation Series
First Criterion Fixation
Second Criterion Fixation
Second Habituation Series
First Post-Criterion Fixation
First Criterion Fixation
Second Criterion Fixation

DRAFT



★ First Achievement Of Habituation Criterion

DRAFT



First Session
Age: 57 Days
Reliability: 93%
Male
420
360
300
240
180
120
60
0
Little Girl
Little Girl
Second Session
Age: 65 Days
Reliability: 94%
Male
420
360
300
240
180
120
60
0
Checkerboard
Checkerboard
Seconds Of Visual Fixation
Slides In Order Of Presentation
★ First Achievement Of Habituation Criterion

DRAFT

Visual Fixation and Voice Discrimination in Two Month Old Infants[1]

Elizabeth F. Boyd[2]
National Institutes of Health

Introduction

Though the response repertoire of the young infant is limited and variable, the visual fixation response is in the repertoire of most normal infants at birth. It is a response that does not disappear in the course of maturation and it is easily available for reliable measurement. The significance of habituation of visual attending behavior in terms of developing and understanding cognitive development in young infants has been recognized by many investigators. To date, it has been used mainly to increase our knowledge about the infant's ability to process visual information and to trace some developmental patterns both in the contents and strategies of such information processing. However, as Self (1971), Paden (1973) and Culp (1971) demonstrated, it is possible to use the visual attending response as an index of recognition of the onset of auditory stimulation. These data gave rise to the possibility that the procedures could be adapted to the study of the infant's ability not only to respond to the onset of auditory stimulation, but to the study of the infant's ability to discriminate auditory stimuli. Such a demonstration could provide an exciting entré to investigation of the early development of receptive language.

Until recently research on language acquisition during the first year of life has been primarily concerned with the productive aspects of language acquisition. The infant's receptive and discriminatory capacity for language inputs had received relatively little attention (Friedlander, 1970). Listening experience to a particular language is very likely a prerequisite for the acquisition of that language, although the necessary and sufficient conditions of this experience are not known. It is generally assumed that receptive language development precedes productive language development. That is, some time before the infant appropriately produces adult-like intonation and sound patterns, he responds appropriately and differentially to some adult language inputs (Brown & Berko, 1961; Leopold, 1947; Lewis, 1951).

Recent studies of the responses of young infants to language stimuli have suggested that the first year of life is a fruitful period for the investigation of receptive language capacity and development. Several studies have reported the discrimination of discrete adult phonemes by young infants. Moffitt (1971) demonstrated the discrimination of the bilabial stop, "bah", and the velar stop, "gah", by 5- to 6-month old infants in a paradigm of habituation of heart-rate deceleration. Eimas, Siqueland, Juscyk and Vigrito (1971) found that 4-month-old infants could discriminate the synthetic voiced and voiceless stops, /b/ and /p/, in a paradigm of habituation of non-nutritive sucking. One-month old infants tended to respond in the same manner, but the recovery of the sucking rate was less marked. Trehub and Rabinovitch (1972) reported positive results of a partial replication of Eimas, et. al. (1971) with infants ranging in age from 4 to 17 weeks of age. In addition, these authors demonstrated that the infants could discriminate natural speech versions of the voiced and voiceless stops, /b/, /p/, and /d/, /t/; as well as the synthetic versions of /b/, /p/. While these studies have demonstrated the infant's sophisticated capacity to respond differentially to discrete adult phonemes, the relevance of this capacity for the process of receptive language development and listening experience that occur in the natural environment may be questioned since the natural language environment is not programmed as a sequence of discrete, repetitive sounds.

Several studies have investigated the infants' capacity to respond differentially to language inputs that more closely simulate those inputs that occur in the natural language environment. Koch (1965) reported that a stranger's face and voice maintained a greater percentage of head turns in 2- and 3-month-old infants than did the mother's face and voice; however, the effect of the voices was not separated from the effect of the visual components. Turnure (1971) monitored bodily activity, smiling, frowning, crying, mouthing, vocalizations, and limb-mouth contact of infants of 3, 6, and 9 months of age during presentations of mother's normal and distorted voice and a strange female's voice. Turnure (1971) found greater motor quieting with age to all of the voices and interpreted this finding as an indication of increasing attentiveness to the human voice with age. The only evidence of differential responding to the voices of mother and stranger were the observations of more mouthing during the mother's voice at 3 months and more crying during the mother's voice at 6 months than at 3 months.

Tulkin (1971), in a study of class differences in responsivity to the voices of mother and strange female, found that 10-month old infants of middle-class homes quieted significantly more to the mother's voice than to the stanger's voice and vocalized more during intervals following presentation of the stranger's voice. Infants of working class parents did not respond differentially to the two voices. Further, middle-class infants were significantly more likely to look at their mother during presentation of the mother's voice and at the coder during presentation of the stranger's voice. Tulkin (1971) speculated that these results may be related to the findings of Tulkin and Kagan (1972) that middle-class mothers vocalize more frequently to their infants and engage in more face to face vocalization than do working-class mothers.

The studies of Tulkin (1971) and Tulkin and Kagan (1972) demonstrated the co-occurrence of differential visual fixation and differential attention to language stimuli. The studies by Eimas, Siqueland, Juscyk and Vigrito (1971) and by Trehub and Rabinovitch (1972) demonstrated discrimination of discrete speech sounds using the response of sucking. As reported in this monograph the results of Self (1971), Paden (1973) and Culp (1973) suggested the possibility of using the visual fixation response to study discrimination of auditory stimuli and as Culp successfully showed that the onset of auditory stimuli involving language could recover visual attending behavior the further implications for the study of voice discrimination was encouraged. The present study was therefore undertaken to accomplish three things: (1) The replication of Culp's findings within-session rather than across sessions as to the ability of voice stimuli to recover looking behavior that had declined; (2) the extension of Culp's findings to voice stimuli that were not those of the infant's mother; and (3) the demonstration of discrimination of voice stimuli by infants using the within-session habituation paradigm similar to that developed by Bhana (1970) and Laub (1972).

The present study consisted to two sessions for each infant. During the first session the ability of each voice stimulus to elicit a recovery of visual fixation was determined. Following response decrement in a baseline presentation of a visual stimulus without an auditory stimulus, a tape recorded voice was presented. Two voices were used: A tape recording of the mother's voice and a tape recording of a stranger's voice. Because Culp's (1971) experience was that mothers asked to be spontaneous into a tape recorder often produced a paucity of verbal content, in this study mother's were asked to read into the tape recorder the first stanza of Robert Louis Stevenson's poem "The Swing." The person whose voice served as the "stranger voice" stimulus recorded the same poem.

During the first session experimental infants received the repeated presentation of the same visual stimulus accompanied by a voice stimulus (mother's voice or stranger's voice). Control infants received a comparable series of phases of repeated presentation of the visual stimulus to rule out the explanation of response recovery due to cyclical or random changes in visual fixation.

The second session served as the discrimination session in which the relatively traditional habituation paradigm was employed in order to assess discrimination. The visual stimulus component was changed across three successive phases of repeated presentations of the visual stimulus accompanied by the mother's voice, the stranger's voice, and the mother's voice. Control infants were presented with a single voice stimulus, the stranger's voice plus the visual stimulus throughout the voice phases of the second session to eliminate the explanation of response recovery due to cyclical or random changes in visual fixation accompanied by a voice stimulus. Given greater response recovery in the experimental group following the change in the voice component than is evidenced in the control group, it may be inferred that the voice stimuli were discriminable.

Method

Subjects

A total of 24 infants (12 males and 12 females) provided the data reported here. Half were assigned to the control group and half to the experimental group with the sexes evenly distributed. The average age of the infants during Session 1 was 7 weeks, and 1 day while during Session 2, the average age was 8 weeks. In addition to the final sample of 24 infants, 16 other infants entered the study. Nine of these 16 were lost due to behavioral problems (crying, fussiness, taking a break because of fussiness at the change point in the procedure). Of these nine, four were in the experimental group and five were in the control group. The remaining seven were lost due to experimenter error, equipment failure, or failing to return for the second session due to illness. Of these seven, four were in the experimental group and three were in the control group. Thus, there was an overall subject loss of 40% and a subject loss of about 23% due to behavioral problems during the experimental session.

Stimuli

The visual stimulus used throughout the study was a slide presentation of a 4 x 4 or 16 black and white checkerboard square that measured approximately 6 inches square when projected.

The auditory stimuli consisted of the tape recording of each infant's mother's voice reading the two stanzas of the Robert Louis Stevenson poem "The Swing" and the tape recording of another voice (the stranger's voice) reading the same stanzas. The stimulus designated as the stranger's voice was constant.

Observers received separate auditory stimulation. In order to mask the presentation of the auditory stimuli given the infants, auditory stimuli were presented, via earphones, to the two observers. The stimuli consisted of taped recordings of stereophonic instrumental and vocal music played continuously without interruption for the duration of each laboratory session.

Apparatus

The apparatus used in this study was that described by Horowitz in this monograph and shown in Figure 2 of her article. However, several details were added to its operation for this study. The onset and offset of the auditory stimuli were programmed to co-occur automatically with the onset and offset of the viusal fixation of the visual stimulus (rather than with the onset and offset of the stimulus itself) by use of the programming equipment connected to the control observer's observation key. The voice stimuli were presented by Uher tape recorders through a speaker located below and directly behind the stimulus screen. A Panasonic tape recorder presented stereophonic, instrumental and vocal music to the observers through earphones worn by the observers.

Procedure

In this study each infant visited the laboratory twice. In Session I, the experimental subjects received four phases of stimulus repetition an ABAC design. During the first phase (A) a single visual stimulus (16 checkerboard) was presented until the subject met the criterion of response decrement. This criterion (for both experimental and control subjects) was two consecutive looks of less than 50% of the mean of the first two looks of the phase. In the event that this criterion was less than 10 seconds, two consecutive looks of 10 seconds or less constituted criterion. Criterion was calculated "on-line" by the equipment operator from the Esterline Angus record of the pre-selected control observer. In the second phase of Session I (Phase B) the checkerboard was presented and whenever the control observer indicated the infant was fixating the stimulus, one of the recorded voice stimuli automatically was onset. The third phase of Session I was a return to baseline of Phase A during which only the visual stimulus was presented until criterion had been met (criterion being agin determined as half the mean of the first two looks of that phase). In the final phase, Phase C, fixation of the 16 checkerboard stimulus was accompanied by the second voice stimulus until criterion was met. The order of presentation of the mother's and stranger's voices was counterbalanced between subjects so that half received the ABAC sequence described above and half received an ACAB sequence.

During Session 1, control subjects were given successive presentations of the 16 checkerboard stimulus (AAAA) throughout four phases to criterion.

During Session 2, approximately one week following Session 1, the question of the discrimination of the voices was assessed. All experimental subjects received four phases of stimulus repetition in an ABCB design. Phase A was baseline with the presentation of the visual stimulus alone until criterion was met. This was followed by Phase B in which fixation of the visual stimulus was accompanied by a tape recording of the mother's voice which continued until criterion was met. Then, without interruption, Phase C occurred where fixation was accompanied by a tape recording of the stanger's voice unitl criterion had been met and then Phase B was reinstituted where fixation of the visual stimulus was accompanied by a tape recording of the mother's voice. Control subjects were given a baseline phase during Session 2 without voice and then three successive phases of C where visual fixation was accompanied by a tape recording of the stranger's voice throughout in an ACCC design.

There were two main procedural features other than the design that differed in this study in comparison to others reported in this monograph. The first involved making the presentaion of the auditory stimulus contingent upon the visual fixation response rather than upon the presentation of the visual stimulus. The second was the definition of criterion for response decrement as two consecutive looks that were less than half the mean of the first two fixations in each phase. In addition, observers were instructed to signal that a break should be taken due to sleeping, fussiness or crying by depressing a key on their key panel. Whenever 15 continuous seconds of this signal was recorded by either observer, the equipment operator called a break. In accordance with the standard procedure, subjects who received a break just prior to a condition change were eliminated from the study.

All other aspects of the procedure were exactly similar to those described by Horowitz in the first article of this monograph.

Results

The results of this study are presented in terms of the reliability of the data, the analysis of the group data and a review of individual subject performance. Group data from Session 1 were analyzed to evaluate the effectiveness of stimulus change, the addition or subtraction of a voice stimulus, in recruiting visual fixation. Also of interest was the comparable ability of the mother and stranger voice stimuli to recover visual fixation following decrement of response to the visual stimulus without an auditory component. Group data from Session 2 were analyzed to assess whether the voices of the mother and stranger were discriminable. The examination of individual subject data was guided by two questions: 1) Whether the voice stimuli served to effectively recruit visual attention in individual subjects and 2) whether an individual subject showed evidence of discriminating the two voices.

Reliability

Eleven persons who had been trained to a criterion of .90 reliability served as observers in this study. Reliability co-efficients were figured separately for the two sessions. The mean over-all reliability for Session 1 was .81 with a range of .70 to .89; for Session 2 the mean over-all reliability was also .81 with a range of .75 to .95. On-time reliability for Session 1 yielded a mean of .80 with a range of .52 to .91; the mean for Session 2 was .75 with a range of .52 to .91. The mean off-time reliability for Session 1 was .76 with a range of .54 to .92 while the mean off-time reliability for Session 2 was .79 with a range of .55 to .96.

Group Data Analyses

Session I. Effectiveness of stimulus change. To evaluate the effectiveness of stimulus change to recruit recovery of visual fixation, analyses were made of the increase in visual fixation in the experimental group following stimulus change as compared with corresponding increases in visual fixation in the control group. For the experimental group, the dependent measure was the difference between the mean of the two criterion fixations prior to stimulus change and the mean of the two trials immediately following stimulus change. For the control group, the difference between the mean fixation times of corresponding trials was computed. The experimental and control group mean fixations on these trials for each phase of Session I are shown in Figure I.

Insert Figure I about here

The within group variances of these difference scores were markedly heterogeneous ($F_{max} = 638.6$, $p < .02$), which precluded the use of the parametric analysis of variance. Therefore, the data for each experimental manipulation were analyzed separately with the Kruskal-Wallis one-way analysis of variance of six independent groups (two experimental orders - ABAC and ACAB - and one control group by sex). There were no significant differences among these six groups at either the onset of the first voice (Phase 2) or the onset of the second voice (Phase 4). The data for sex and experimental order were therefore pooled for the Mann-Whitney analyses of the experimental and control group differences. The responsivity of the experimental subjects to the initial presentation of the voice of the mother or stranger was significantly greater than the random or time-correlated responsivity of the control subjects (Mann-Whitney $U = 42$, $p < .05$, one-tailed test). Similarly, the experimental group's recovery of visual fixation to the addition of the second voice stimulus was significantly greater than the control group recovery (Mann-Whitney U = 25, $p < .01$, one-tailed test). In addition, seven out of the 12 experimental subjects responded above the group median to the presentation of both voices as compared to two out of 12 control subjects who responded above the group median at the outset of both Phases 2 and 4 (Fisher's Exact Test, $p < .05$).

The next analysis was a test of the effectiveness of the subtraction of a voice stimulus to recruit recovery of visual fixation (Phase 3). There were no significant differences among the six groups (ABAC, ACAB, Control, by Sex). The data were, therefore, pooled for an analysis of the differences between the experimental and control groups. A significantly greater recovery was demonstrated by the experimental subjects following the offset of a voice stimulus than was shown by the control subjects (Mann-Whitney U = 39, $p < .035$, one-tailed test).

Because there were some differences that approached significance in the Kruskal-Wallis analyses of recovery fixations between Phases 1 and 2; Phases 3 and 4, some additional comparisons were made to explore these possible sources of difference.

The Kruskal-Wallis one-way analysis of variance of the three treatment groups -- ACAB, ABAC, and Control -- pooled for sex, of the amount of recovery of visual fixation in Phase 2 following the onset of the first voice stimulus approached significance (H = 4.50, $p < .10$). Multiple comparisons of the differences among the three groups indicated that the response to the stranger's voice (ABAC) was significantly greater than the response to no change in the control group (Mann-Whitney U = 13, $p < .025$, one-tailed test). The other comparisons proved nonsignificant. The Kruskal-Wallis one-way analysis of variance of the difference scores between phase 3 and phase 4 of the six groups -- three treatment groups by sex -- also approached significance (H = 9.99, p $<$ .08). The results of multiple comparisons of the six groups showed that male and female subjects in the ACAB group recovered significantly more frequently than did their control counterparts (Male- ACAB and Male-Control, Mann-Whitney U = 2, p $<$ .048, one tailed test; Female-ACAB and Female-Control, Mann-Whitney U - 1, p $<$ .024, one-tailed test). None of the other comparisons were significant; however, the difference between Female-ABAC and Female-Control approached significance (Mann-Whitney U = 3, p $<$ .083, one tailed test).

The results of these analyses would be interpreted with reservation due to the absence of overall significance and the likelihood of significant differences emerging by chance when multiple comparisons are made. There was some suggestion that the infants were more responsive to the novel voice of the stranger than to the familiar voice of the mother, irrespective of order of presentation of the stimuli.

In the next series of analyses, the degree of delay of response recovery to the addition or subtraction of the voice stimuli was assessed. The difference scores between the mean of the two criterion fixations prior to experimental manipulation and 1) the first fixation following the experimental change and 2) the second fixation following experimental change for each phase were calculated. These difference score data were first analyzed for possible sex and experimental order effects by a series of Kruskal-Wallis one-way analyses of variance of six independent groups (ABAC, ACAB, Control by Sex). The Kruskal-Wallis analysis of the data of the first fixation following the onset of the second voice stimulus (Phase 3) was significant (W = 13.2, p $<$ .02). None of the other Kruskal-Wallis analyses were significant and the data were pooled for comparisons of the experimental and control groups.

The experimental group did not show significantly greater recovery of visual fixation than the control group on either the first or second fixation following the onset of the first voice stimulus. This result contrasts with the result based upon the mean of the two fixations following stimulus addition which was reported above. The apparent inconsistency may be attributed to the fact that nine out of the 12 experimental subjects demonstrated above median recovery on either the first or second fixation following stimulus addition.

The addition of the second voice stimulus in Phase 3 occasioned significant recovery in the experimental males (Mann-Whitney $U = 10$, $p < .002$) on the first fixation following stimulus change. The experimental females did not show significant response recovery on the first fixation. On the second fixation following the addition of the second voice stimulus, the recovery of both experimental males and females was significantly greater than that of the control subjects (Mann-Whitney $U = 24$, $p < .01$). The removal of the voice stimulus in Phase 2 did not recruit significant increase in visual fixation until the second fixation following the removal (Mann-Whitney $U = 42$, $p < .05$).

The results of Session I thus indicated that the experimental subjects were significantly more responsive to the 16 checkerboard following the addition of either the voice of the mother or stranger than were the control subjects who received the 16 checkerboard throughout Session I. Further following the removal of a voice stimulus in Phase 3, experimental subjects were significantly more responsive to the 16 than were control subjects. Control and experimental groups were not equated on mean fixation times of the initial fixations of Session I, Phase I (E C, Mann-Whitney $U = 40$, $p < .05$). It is, therefore, possible that these initial population differences accounted the obtained recovery differences attributed to the treatments. However, the groups were not significantly different at the points of manipulation, the criterion fixations. It is proposed that the appropriate baselines for the evaluation of treatment effects are the criterion response levels and not the initial fixation times of the session.

Recovery data on the first and second fixations following stimulus change indicated that response recovery on the first or second fixation was equally likely in the initial voice stimulus phase. However, in the second voice stimulus phase, experimental males showed significant response recovery on both the first and second fixations; whereas, experimental females did not demonstrate response recovery until the second fixation. For both experimental males and females, group responsivity to the removal of a voice stimulus was delayed until the second fixation following stimulus removal.

Session 2. Analysis of voice discrimination. To evaluate the discrimination of the voices of the mother and the stranger, the differences between the mean fixation times of the two trials prior to and following voice stimulus change in the experimental group were compared with the differences between the means of the corresponding trials in the control group. This comparison assesses differential visual fixation to the same stimulus complex -- the 16 plus the stranger's voice -- following differential voice experience in Phase 2. A less direct test of discrimination is a comparison of the amount of looking time recruited by the 16 plus the stranger's voice in the control group following two phases of repeated exposure to this stimulus complex and the recovery in looking time to the 16 and the mother's voice in the experimental group, following a single response decrement phase to the 16 and the stranger's voice (Phase 4).

The data were analyzed by nonparametric tests, as the within group variances of the difference scores were significantly heterogeneous

(F_{max} = 329.27, $p < .02$). Kruskal-Wallis analyses (ABAC, ACAB, Control by Sex) of the difference scores between mean fixation times at each of the three points of experimental manipulation were nonsignificant. The data for sex and order of voice presentation in Session I were pooled for the following analyses. The experimental group showed significantly greater recovery of visual fixation following stimulus change from the mother's voice to the stranger's voice throughout Phase 2 and Phase 3 (Mann-Whitney U = 37, $p < .05$, one-tailed test). Comparisons of the recovery data of experimental and control subjects from Phase 3 to Phase 4 revealed no significant differences. Further, control and experimental groups did not differ in the amount of recovery of visual fixation recruited by the onset of a voice stimulus in Phase 2. The experimental and control group means of criterion and two recovery fixations for each phase of Session 2 appear in Figure 2.

Insert Figure 2 about here

In the next series of analyses, possible differences between the mean of the criterion fixations and 1) the first fixation and 2) the second fixation following stimulus change were assessed. These results were essentially consistent with the analyses of the mean difference scores. None of the Kruskal-Wallis one way analyses of variance of the six independent groups (ABAC, ACAB, Control by Sex) were significant. Comparisons of the pooled data for Phase 3 indicated that significant recovery of visual fixation was evidenced on the first fixation following the change from the mother's voice to the stranger's voice in the experimental group (Mann-Whitney U = 42, $p < .05$). The experimental and control groups did not differ on the second fixation following the voice change. In Phase 4, there was no significant response recovery to the stranger's voice on either the first or second fixation following change from the mother's voice to the stranger's voice. There were no differences between the experimental and control groups on either the first or second fixation following voice onset in Phase 2.

In summary, the group data analyses from Session I indicated the voices of mother and a strange female were able to recruit increased visual fixation to an unchanging visual stimulus. During Session I, the subtraction of the voice stimulus also served to effectively re-recruit visual attention; however, the effect of voice removal tended to be delayed until the second fixation following stimulus removal.

The results from Session 2 indicated that the change from the mother's voice to the stranger's voice in Phase 3 of Session 2 elicited significantly greater differences in visual fixation in the experimental group than were elicited in the control group which received the stranger's voice throughout Phase 2 and Phase 3. On the basis of the group analysis, the voices of the mother and stranger proved discriminable.

Individual Subject Performance

In Session I, the significant group responsivity to the addition of the voice of the stranger was representative of 10 of the 12 experimental subjects. These 10 subjects showed increases in visual fixation, following voice addition, which were above the overall group median of response recovery. Seven out of the 12 experimental subjects responded above the group median recovery to the onset of the voice of the mother. Four additional infants responded above the group median to the addition of the mother's voice in Session 2 (Phase 2).

In Session 2, the group data showing discrimination of the two voices was clearly evidenced by eight out of 12 experimental subjects whose mean difference scores were above the group median for Phase 3, Session 2. An additional subject showed discrimination of the two voices by above median response recovery to stimulus change at the outset of Phase 4, Session 2. Two male subjects who failed to demonstrate discrimination of the two voices did respond to the two voices in Session 1 with above median recovery of visual fixation. The single experimental female who showed no evidence of voice discrimination in Session 2 was not responsive to either of the voices in Session 1. Five out of 12 control subjects responded above the group median at the outset of Phase 3, Session 2.

In an attempt to determine whether pitch differences between the voice of the infant's mother and that of the standard stranger voice would account for the individual experimental subjects who did and did not show the discrimination, the tape recordings were subjected to pitch analysis.

While there were pitch differences between mother and stranger for some pairs, but not others, these did not appear to be in any way systematically related to whether or not subjects exhibited the discrimination.

Discussion

The results of this study are strongly related to the experiments reported earlier in this monograph and extend the findings of these studies in possibly important ways. Firstly, it was again demonstrated that the onset of auditory stimulation can recover visual fixation that has previously declined. Secondly, from the Session 2 data of this study, the recovery is not dependent upon the contrast effect of no specific auditory stimulus in the prior phase since changing the auditory stimulus without interruption appears to produce the same effect. Thirdly, the data from Session 1 are in agreement with Paden's (1973) findings that removal of the auditory stimulus can also serve to recover visual fixation though the evidence in this study for this effect is stronger than in Paden's results. In contrast with Culp's (1971) results, this finding of the effectiveness of the subtraction of the auditory stimulus may well be demonstrable only with within-session removal and not across sessions given stimuli of the kind and intensity used here. Fourthly, the relative similarity of effect gained with the voice of the mother and with the voice of the stranger with infants of 7 and 8 weeks of age suggests that there was probably no special "motherness" characteristic responsible for Culp's (1971)results or the results of this study. However, the relative familiarity of the mother's voice over a stranger's voice cannot be assessed when the mother's voice has been tape recorded because of the distortions on a variety of parameters that occur with tape recordings of the ordinary kind used in these studies. And finally, the results of this study have some interesting implications for the study of auditory discrimination in young infants with respect to gross features of voices and of language stimuli. In particular, this demonstration suggest that infants as young as two months of age are capable of responding discriminatively to some features of voice stimuli that simulate those that occur in the natural environment. Exactly what those features are cannot be deduced from the present experiment though in the report that follows this one an attempt to investigate a problem in this area was made.

If visual fixation can be used to study auditory responsiveness and discrimination, then this technique could provide a useful tool in the study of receptive language abilities and development in young infants. Unlike the sucking response which undergoes extensive environmental shaping and is developmentally changing and unlike motoric responses such as those used by Fiedlander (1968) which are not reliably available as response measures for several months into post-natal development, visual fixation can be used from birth through the first several years of life and perhaps beyond in experimental settings. One feature of this study that was not experimentally investigated but that may be an important improvement in the technique that has been developed through the series of studies reported in this monograph is the contingent aspect of the auditory stimulation: The auditory stimulus occurred only during actual visual fixation of the visual stimulus.

It was noted in earlier studies in this monograph that the use of visual fixation decrement and recovery could not be technically called habituation since the effective stimulus at the recovery point was in a different sensory modality even though the response measure remained within a single modality. It was further noted, however, that the observed effect was similar to that obtained in situations that were closer to the technical definition of habituation. During Session 2 of this study, the transition from Phase 2 to Phase 3 and then again from Phase 3 to Phase 4 involved repeated stimulation of the same two sensory modalities though one was unchanging while the other changed. The effect appears similar both to the effects obtained in situations that fully meet the technical definition of habituation and to those that do not that characterize the earlier studies reported in this monograph. Thus, a more generalized use of the term habituation on the behavioral level may be justified.

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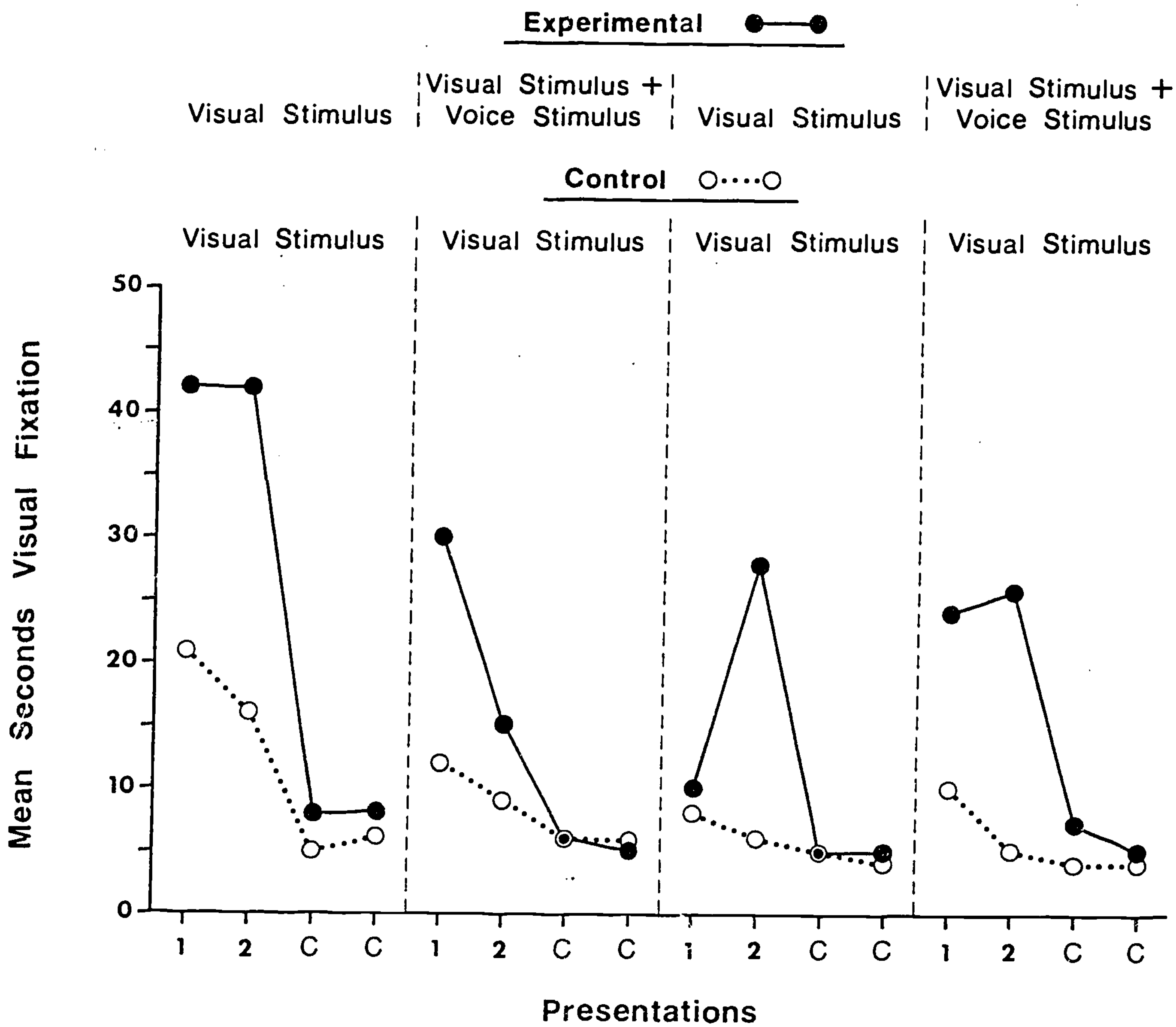
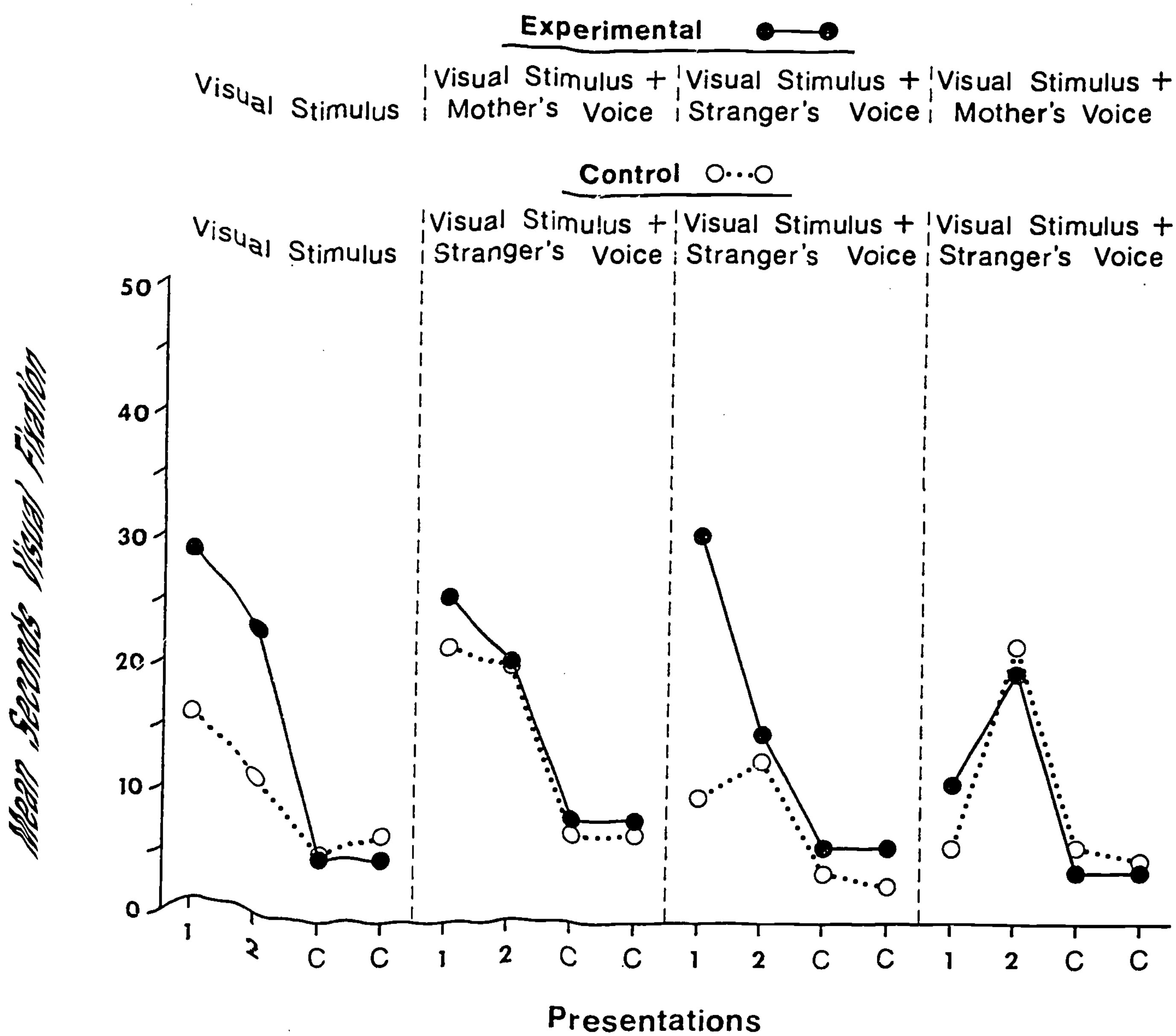
DRAFT

Figure Captions

1. Mean fixation times to criterion for experimental and control groups under four successive conditions in session 1.
2. Mean fixation times to criterion for experimental and control groups under four successive conditions in session 2.

DRAFT


Experimental
Visual Stimulus
Visual Stimulus + Voice Stimulus
Visual Stimulus
Visual Stimulus + Voice Stimulus
Control
Visual Stimulus
Visual Stimulus
Visual Stimulus
Visual Stimulus
Mean Seconds Visual Fixation
50
40
30
20
10
0
1 2 C C 1 2 C C 1 2 C C 1 2 C C
Presentations


Experimental
Visual Stimulus
Visual Stimulus + Mother's Voice
Visual Stimulus + Stranger's Voice
Visual Stimulus + Mother's Voice
Control
Visual Stimulus
Visual Stimulus + Stranger's Voice
Visual Stimulus + Stranger's Voice
Visual Stimulus + Stranger's Voice
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Presentations

DRAFT

Visual Fixation and the Effect of Voice Quality and Content Differences in Two Month Old Infants

Rex E. Culp

The University of Kansas

Introduction

The purpose of the two studies to be reported here was to extend the findings reported by Boyd (1972) to other gross characteristics of language stimuli using the same technique. It has been shown that young infants can make very fine distinctions in isolated language-related stimuli such as consonants (Eimas, Siqueland, Jusczyk, and Vigorito, 1971; Moffitt, 1971; Trehub and Rabinovitch, 1972). While it is possible that early language listening experience for the infant is characterized by some sort of systematic attention to single language elements, the environment, in fact, presents the infant with very complex and extended, though probably repetitious language samples. There have been several reports that have given evidence concerning the role of complex language stimuli in infant behavior (Tulkin, 1971; Tulkin and Kagan, 1972; Turnure, 1971). The most consistent findings seem to relate to social class variables. And, the subjects of these studies were all over three months of age and most of them older. Boyd's (1972) demonstration with seven and eight week old infants is probably the clearest evidence at the youngest age that infants can discriminate between two different voices with all the complexity and grossness involved in such stimuli. However, Lewis (1951) reported that infants respond to an adult voice by ceasing to cry and that the infant can discriminate intensities of sounds. Eisenberg and her colleagues (Eisenberg, 1965; 1966; 1967; 1970; Eisenberg, Griffin, Coursin and Hunter, 1964) have experimentally substantiated some of Lewis' observations with newborns.

Intonation has been one variable that has been suggested as playing a key role in language stimuli for young infants. As early as 1922 Schafer (reported in Lieberman, 1967) noted that a nine-month-old infant responded to intonation of a phrase, disregarding the word content of the phrase. Lieberman (1967) has also reported that Lowenfeld, in 1927, and Buhler and Hetzer in 1928 reported that infants from two months onward responded positively to the human voice, while infants from the age of three months onward responded positively to friendly tones and negatively to angry tones of voice using eye and head movements for the response indicators. Lieberman (1967) has suggested that pitch of voices and some aspects of intonation and content might be relevant cues used by infants in attending to language stimuli. Lewis (1951) and Leopold (1953) also suggested that intonation takes on a linguistic reference quite early and suggested, further, that phonetic pattern later replaces intonation as the dominant feature in evoking responses from the child.

There are really two separate questions that need to be answered before the leap can be made to what the developmental sequence might be in attention to dominant features of language stimuli and in the acquisition of a passive receptive language repertoire. One concerns the kinds of discriminations of language stimuli that infants can make and the second concerns the kinds of features that actually occur in the natural experience of infants which, in fact, infants use in some systematic way in receptive language acquisition. On the first question there is some indication that discreet, adult-like phonemes can be discriminated as young as one month of age (Eimas, et al., 1971) but there yet remains much work in replication and extension of these findings. On the second question the variety of reports noted above provide some tantalizing ideas about what might be occurring, especially in the work of Tulkin and Kagan (Tulkin, 1971; Tulkin and Kagan, 1971) where some of the gross differences as defined by socio-economic class groupings appear to yield differential behavior patterns in infants. But, this area of research still awaits the accumulation of a systematic data bank for a fuller understanding of what is involved.

Given the results of all of the research that has been reported in this monograph and given the data on features of language stimuli that might seem pre-potent in the natural experience of infants, two experiments were undertaken to investigate language disriminative abilities of infants at two months of age. In the first experiment the language stimuli differed in what might be grossly called intonation or tone quality. In the second experiment the language stimuli differed in verbal content. For both experiments the paradigm employed by Boyd (1972) in her second session was utilized.

Experiment I

Method

Four groups of subjects were used in this experiment. Experimental subjects constituted two groups and received both conditions A and B in either an initial ABAB design or a counterbalancing BABA design. Stimulus A consisted of the poem "The Swing" by Robert Louis Stevenson read in a "soft" voice and Stimulus B consisted of the same person reading the same poem in a "harsh" voice. Two control groups were run in an AAAA or a BBBB design.

<u>Subjects.</u> A total of 17 infants provided the data reported here. Ten (five males and five females) were assigned to the experimental groups and seven (four males and three females) were assigned to the control groups. The mean age of the infants was 8.15 weeks for the first session of the experiment and 9.18 weeks for the second session of the study.

An additional eight infants began the study but did not complete both sessions. Five of these eight were control subjects. Four of these five were dropped because of crying or fussiness causing a break at the change point in the session. One of the three experimental infants did not return for the second session because of illness while of the other two, one was dropped because of very low reliability and one was dropped because of incomplete session due to crying. Overall there was a 32% subject loss in this study. The subject loss due to behaviorial problems during the experiment was 28%. Seventy percent of the subject loss due to behaviorial problems occurred among infants assigned to the control groups (where the stimulus situation is totally unchanging).

<u>Stimuli.</u> The visual stimuli were black and white checkerboard slides. Some infants saw a checkerboard stimulus containing 16 squares, while others saw one containing 256 squares. The stimuli measured approximately six inches square when projected.

The auditory stimuli were tape recordings of a female unfamiliar to the infant reading the first two stanzas of "The Swing" by Robert Louis Stevenson. Upon instructions, the reader was tape-recorded reading in a "soft" tone (Stimulus A) and also in a "harsh" tone (Stimulus B). Spectographic analysis of the tapes indicated that the two recordings had the same fundamental frequency (average of 190 cycles per second) and intensity. The original recordings were re-recorded to make an hour-long recycling tape. The duration of repetition on each tape was 14 seconds.

Apparatus. The apparatus used in this experiment was the same as that described by Horowitz in this monograph and shown in Figure 2 on page 23. Its operation and arrangement were exactly the same as that reported by Boyd (1972) including the contingency of the voice stimulus on the onset and offset of the infant's visual fixations.

Procedure. Each infant visited the laboratory twice, once at eight weeks of age and once at nine weeks of age. The visual stimulus used with each subject and the auditory stimulus order for each session is shown in Table I. ll aspects of the procedure were exactly the same as that used

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Insert Table I about here

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by Boyd (1972) for Session 2.

Results

The results are presented in terms of the reliability of the observations, group data analyses and inspection of individual subject performance.

Reliability. Eleven different observers provided the data for this study paired by convenience and compatibility of schedules to the laboratory sessions. The mean overall reliability in this study was .87 with a range from .80 to .98. The mean on-time reliability was .85 with a range from .75 to .97 while the mean off-time reliability was .83 with a range from .75 to .99.

Group data. To evaluate the effectiveness of stimulus change (soft to harsh or harsh to soft voice) to recruit recovery of visual fixation, analyses were made of the increase in visual fixation following stimulus change in the experimental groups compared to changes in visual fixation in the control groups at the point when stimulus change should have, but did not occur. The dependent measure used for these analyses was the difference between the mean of the two criterion fixations prior to stimulus change and the mean of the two trials immediately following stimulus change in the experimental groups and the difference between the mean fixation times of corresponding trials in the control groups.

The group variances of the mean difference scores were markedly heterogeneous (Hartley's test: $F_{max} = 124.2$, $p < .01$) which precluded the use of the analysis of variance. Therefore, the Kruskal-Wallis one-way analysis of variance by ranks (Siegel, 1956) was employed to determine the differences on experimental and control performances by sex and slide groups. No significant differences were revealed and the factors of sex of subject and slide used were pooled.

A Kruskal-Wallis analysis of the difference scores comparing the criterion and recovery fixations for Phases I to II, II to III, and III to IV for the two experimental groups and the two control groups was significant ($H = 9.86$, $p < .02$). A series of Mann-Whitney U tests were then performed which revealed no significant differences between the two experimental groups nor between the two control groups. These groups were, therefore, pooled and a test for differences between Session I and 2 was made. It was also non-significant.

With the factors of sex, session, stimulus, and order of stimulus presentation combined, the Mann-Whitney U comparisons (Siegel, 1956) of the difference scores for each phase of experimental and control subjects was significant ($U = 0$, $p < .05$, one-tailed test). The data contributing to this analysis are graphed in Figures I and 2. Thus, following visual fixation

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Insert Figure 1 about here

Insert Figure 2 about here

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response decrement to an unchanging visual stimulus, a significant recovery to that same visual stimulus occurred each time the auditory stimulus was shifted from a soft voice tone to a harsh voice tone and back again.

Individual data. The individual subject performances were each inspected to determine to what extent individual infants showed the same pattern of responding as represented by the grouped data graph in Figure 1. In the experimental group, seven of the ten subjects showed an absolute increment of at least ten seconds from criterion to change point on half or more of the possible six change points over the two sessions. No experimental subject exhibited an absence of an increase of at least ten seconds on all of the change points. By contrast, four of the seven control subjects had no absolute increases of at least ten seconds on any of the change points; only one subject had such an increase on half the change points with the two remaining subjects showing such an increase on only a third of the possible change points. The individual data from one experimental and one control subject who had comparable initial fixation times at the beginning of each session are shown in Figure 3. A characteristic of the experimental

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Insert Figure 3 about here

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subjects that was not supported in the statistical analyses of the group data is evident in Figure 3: the experimental effect tended to be weaker in the second session than in the first session. However, six of the ten experimental subjects showed equally strong recoveries at the change points in the second session as they did in the first session while in only two control subjects was there any evidence of recovery at what would have been a change point in the second session. After the initial phase, looking time declined to a very low level for all control subjects with no recovery or criterion fixation above 15 or 20 seconds. This was not true of any experimental subject - even for those who were, characteristically, similar to the "short-lookers" identified by Self and by Paden in their experiments.

Thus, the individual data appears to mirror the pattern of performance revealed in the grouped data results.

Experiment II

Method

Experiment II consisted of four groups. Experimental subjects were assigned to either a CDCD or a counterbalancing DCDC group while control subjects were assigned to either a CCCC group or a DDDD group. Stimulus C consisted of the first stanza of the poem "The Swing" used in Experiment I recorded in the soft voice tone while Stimulus D consisted of the second stanza of the poem "The Swing", also in the soft voice tone recording by the same speaker. The recording was the same one that was used in Experiment I as the "soft tone" stimulus.

Subjects. A total of 17 infants, ten assigned to the experimental groups and seven to the control groups provided the data for this experiment. The sex distribution and distribution of assignment to groups was exactly similar to the distribution and assignment in Experiment I (see Table I).

An additional four subjects began the experiment and all were lost due to incomplete sessions because of crying. Two of the four were experimental subjects, and two were control subjects. There was, thus, a 19% subject loss due to behavioral problems in this experiment.

The mean age of the 17 infants was 8.08 weeks for the first session and 9.34 weeks for the second session.

Apparatus. The apparatus was exactly the same as used in Experiment I.

Stimuli. The visual stimuli were the same as used in Experiment I. The auditory stimuli were taken from the tape recording of the soft voice tone stimulus used in Experiment I and divided into a tape loop consisting of the first stanza of the poem (Stimulus C) and the second stanza of the poem (Stimulus D). The original recordings were re-recorded to make an hour long recycling tape. The duration of the stimulus sample on each tape was 7 seconds before repetition.

Procedure. The procedure in this experiment was exactly the same as that in Experiment I, except that only the first stanza of the poem read in the soft voice tone substituted for Stimulus A and the second stanza of the poem read in the soft voice substituted for Stimulus B.

Results

The results of this experiment are presented in terms of the reliability of the data, analyses of the grouped data, and inspection of individual subject performance.

Reliability. A pool of eleven observers, the same as those who served in Experiment I were involved in this experiment. The mean overall reliability was .80 with a range from .80 to .94. The mean on-time reliability was .88 with a range from .76 to .95 while the mean off-time reliability was .89 with a range from .75 to .97.

Group data. To evaluate the effectiveness of stimulus change (Stanza 1 to Stanza 2 and vice versa) to recover visual fixation once it had declined to a criterion point, analyses were made of the increases in visual fixation for experimental groups at the change points as compared with the increase in visual fixation in the control groups at comparable points when the stimulus would have, but did not change. The data points used in the analyses were similar to those used in Experiment I: the mean of the two criterion fixations compared with the mean of the first two fixations following a change in the auditory stimulus.

Due to the heterogeneity of the group variances (Hartley's Test: $F_{max} = 24.67$, $p < .01$), a Kruskal-Wallis one-way analysis of variance by ranks was employed to evaluate the experimental and control groups as a function of sex and visual stimulus slide for both sessions. No significant differences were revealed and the data for sex and slide were pooled and the data from the four subject groups (two experimental groups and two control groups) were subjected to Kruskal-Wallis Analyses of the difference scores for the shift from criterion to recovery phases for the two experimental and two control groups. The outcome of this analysis was significant ($H = 7.03$) but only at a probability of less than the .10 level. A series of Mann-Whitney U tests were performed that indicated no significant differences between the two control groups or between the two experimental groups and these were then combined to determine whether there were session differences for the experimental and control groups. The results of this analysis were also not significant.

The Mann-Whitney U test was then employed to analyze the difference scores for the three shift points, from phase 1 to 2, 2 to 3, and 3 to 4, for the Experimental and Control groups. The differences between the

Experimental group, combined for order of stimulus presentation, sex, session and slide, and the Control group, combined for stimulus, session, sex, and slide was significant ($U = 0$, $p < .05$, one-tailed test). The grouped data involving these comparisons are shown in Figures 4 and 5.

Insert Figure 4 about here

Insert Figure 5 about here

The results of the analyses and the graphs of the grouped data revealed that a stimulus change involving the content of the words spoken was sufficient to recover visual attending behavior to an unchanging visual stimulus. However, because of the borderline level of the last Kruskall-Wallis test, caution is advised in interpreting the results.

Individual data. Caution in accepting the results of the analysis of the grouped data is supported in an inspection of the individual subject performances. Only half of the experimental subjects showed absolute increases in visual fixations of more than ten seconds on at least half of the six change points. While only one experimental subject showed no evidence of fixation increases at any of the change points, the effect in the experimental group, as compared to individual performances in Experiment I, is somewhat weaker. No control subject showed an absolute increase of at least ten seconds of visual fixation at what would have been the change point on more than two of the possible six points; three subjects had only one such increase in the six points and three subjects had no such increases at all across the two sessions. Thus, from the individual data it is possible to say that the experimental subjects, compared to control subjects exhibited more of the experimental effect, but that effect was the weakest of any of the experimental effects reported in this entire monograph.

Discussion

On the basis of the group data from the two experiments it is possible to conclude that infants at the age of eight and nine weeks show reliable increases in visual fixations with a change in auditory stimuli that involves voice tone quality or verbal content. However, such increases are more clearly apparent with stimuli that differ in tone quality than in stimuli that differ in verbal content. The results of the two experiments provide further evidence that auditory changes produce increases in visual fixation behavior in young infants. As such, they encourage the further use of visual attending behavior in the study of auditory discrimination. This has possibly especial import for research on receptive language development. The successful use here of the paradigm of habituation of visual fixation in combination with the infant control procedure and with the individually defined criterion for response decrement may be particularly suited to the investigation of the abilities of infants to respond selectively to language stimuli.

Researchers attempting to assess receptive language development in so-called "pre-verbal" infants have been faced with two major problems. The first has been to develop procedures for measuring behavior that accomodate individual differences in infants and that can be used over a relatively extended developmental period. The second has been to tease out the parameters of the human voice and of language stimuli that affect receptive language development and/or behavior. The results of these experiments, in combination with the results of the experiments preceeding in this monograph offer a procedure relatively well suited to individual difference problems in infant research and one that is suitable for infants from the early weeks of life - and perhaps from birth - onwards.

With regard to the parameters that are involved in receptive language development, the contribution of these experiments is, for the present, only limited to indicating that infants as young as seven and eight weeks of age can discriminate different voices, different tone qualities of the same voice, and possibly different verbal content spoken by the same voice in the same tone quality. These experiments shed no light upon whether such abilities "develop" in the course of post-natal growth and environmental experience or are present at birth. However, with the procedures developed over the course of the studies reported in this monograph, it may now be possible to begin some systematic developmental tracings of auditory and particularly language discrimination abilities in infants. This issue is discussed in more detail in the article that follows.

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Table 1 Representation of Design. **DRAFT**

SESSION 1 Phase	I	II	III	IV
Group AB:				
256 checkerboard	Voice A	Voice B	Voice A	Voice B
2 males				
2 females				
16 checkerboard	Voice A	Voice B	Voice A	Voice B
2 males				
2 females				
Group BA:				
256 checkerboard	Voice B	Voice A	Voice B	Voice A
1 male				
1 female				
Group AA:				
256 checkerboard	Voice A	Voice A	Voice A	Voice A
1 male				
1 female				
16 checkerboard	Voice A	Voice A	Voice A	Voice A
1 male				
1 female				
Group BB:				
256 checkerboard	Voice B	Voice B	Voice B	Voice B
1 male				
1 female				
16 checkerboard	Voice B	Voice B	Voice B	Voice B
1 male				
SESSION 2 Phase	**I**	**II**	**III**	**IV**
Group AB:				
256 checkerboard	Voice B	Voice A	Voice B	Vocie A
16 checkerboard	Voice B	Voice A	Voice B	Voice B
Group BA:				
256 checkerboard	Voice A	Voice B	Voice A	Voice B
Group AA:				
256 checkerboard	Voice A	Voice A	Voice A	Voice A
1				
16 checkerboard	Voice A	Voice A	Voice A	Voice A
Group BB:				
256 checkerboard	Voice B	Voice B	Voice B	Voice B
16 checkerboard	Voice B	Voice B	Voice B	Voice B

Figure Captions

1. Mean initial and criterion fixations to visual stimuli with soft and harsh tone auditory stimuli (sex, slide, weeks, and order combined).
2. Difference scores (mean of two criterion fixations minus mean of initial two fixations) at stimulus change point for experimental subjects and at corresponding points for control subjects.

   Comparisons:

   I - II = mean of two criterion fixations of Phase I minus mean of initial fixations of Phase II.

   II - III = mean of two criterion fixations of Phase II minus mean of initial fixations of Phase III.

   III - IV = mean of two criterion fixations of Phase III minus mean of initial fixations of Phase IV.
3. Initial fixations and criterion fixations for two representative subjects.
4. Mean initial and criterion fixations to visual stimuli with first stanza and second stanza auditory stimuli (sex, slide, weeks, and order combined).
5. Difference scores (mean of two criterion fixations minus mean of initial two fixations) at stimulus change points for Experimental subjects and at corresponding points for Control subjects.

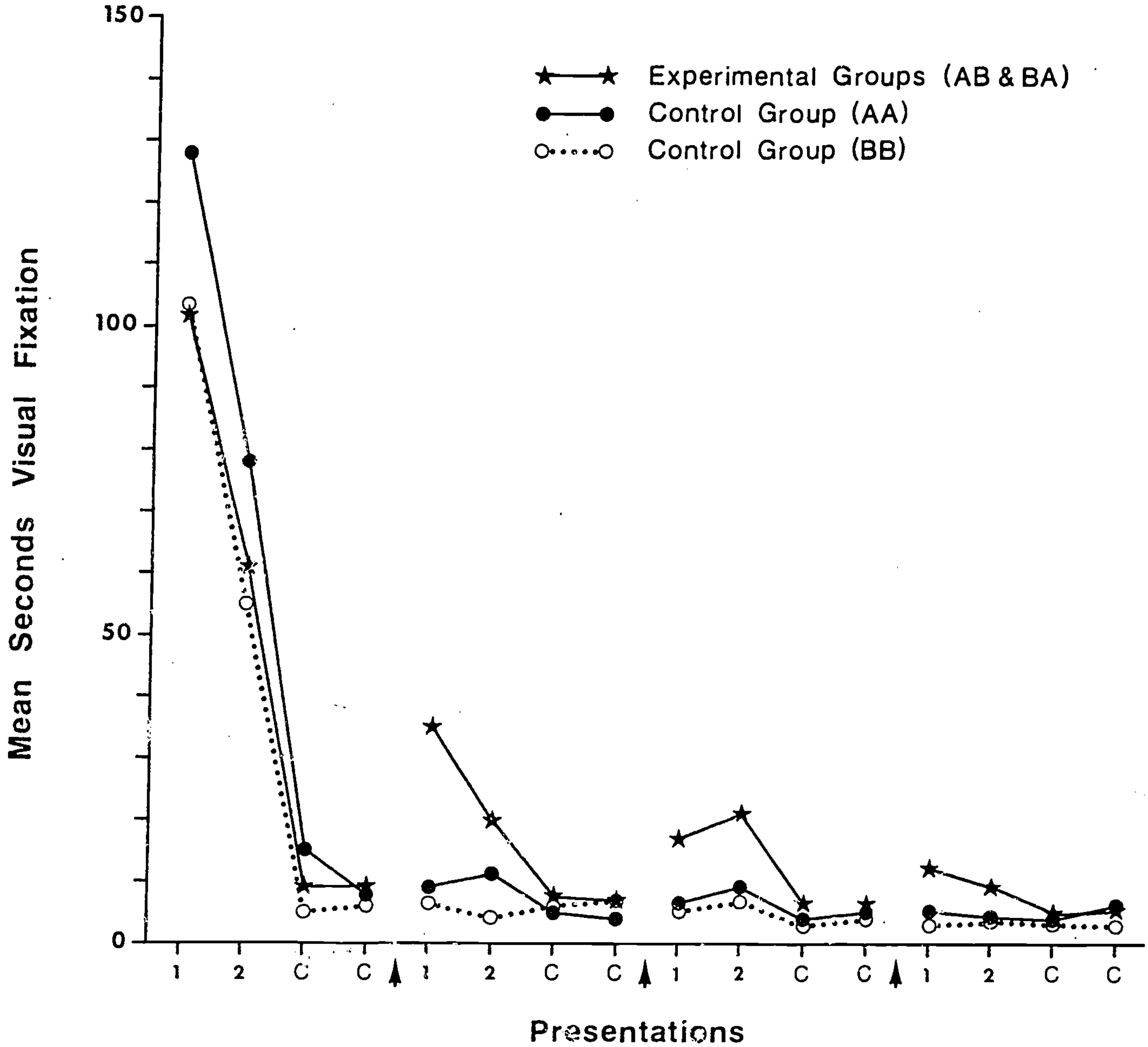
   Comparisons:

   I - II = mean of two criterion fixations of Phase I minus the mean of initial two fixations of Phase II.

   II - III = mean of two criterion fixations of Phase II minus the mean of initial two fixations of Phase III.

   III - IV = mean of two criterion fixations of Phase III minus the mean of initial two fixations of Phase IV.

DRAFT



▲ Indicates Point Of Stimulus Change For The Experimental Group And Point At Which The Stimulus Would Have Changed For The Control Group

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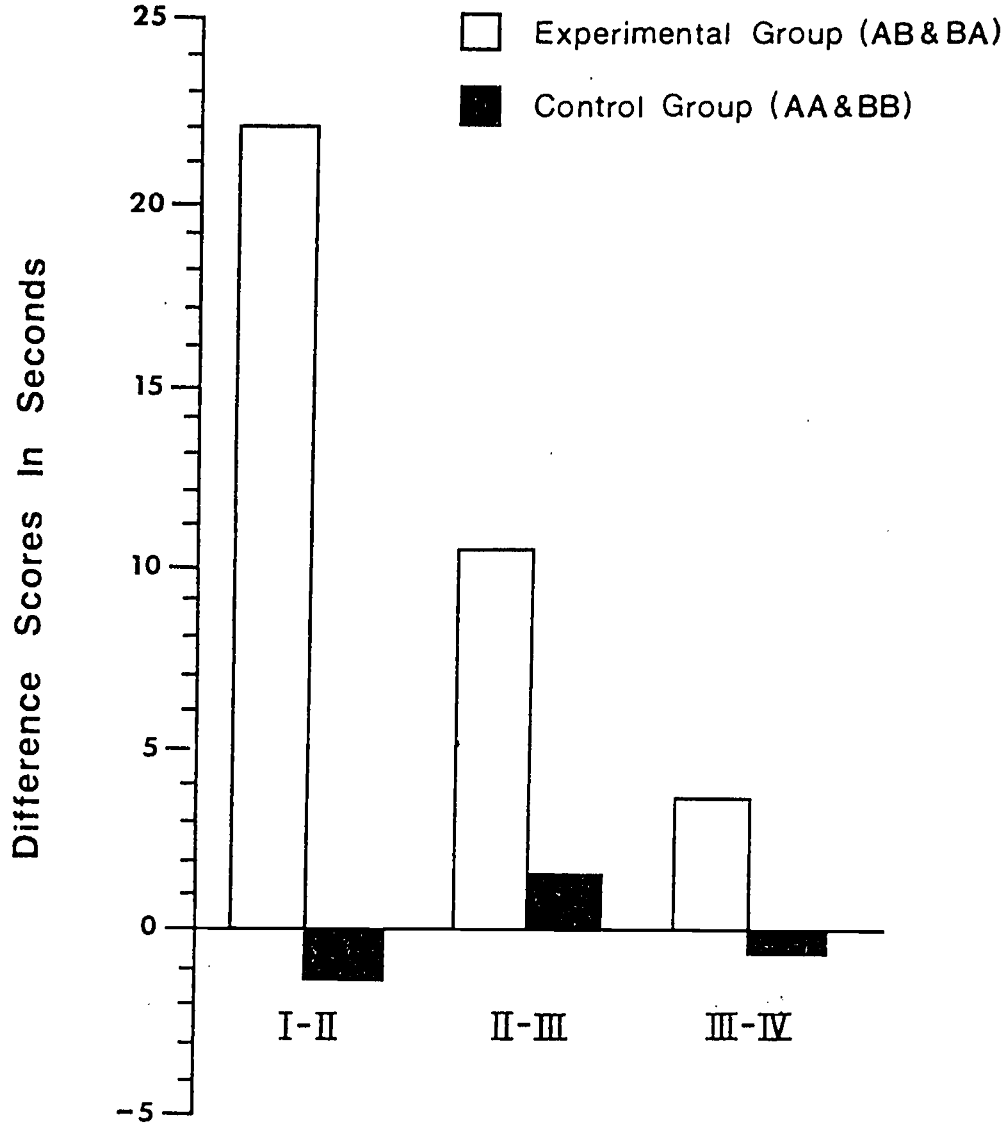
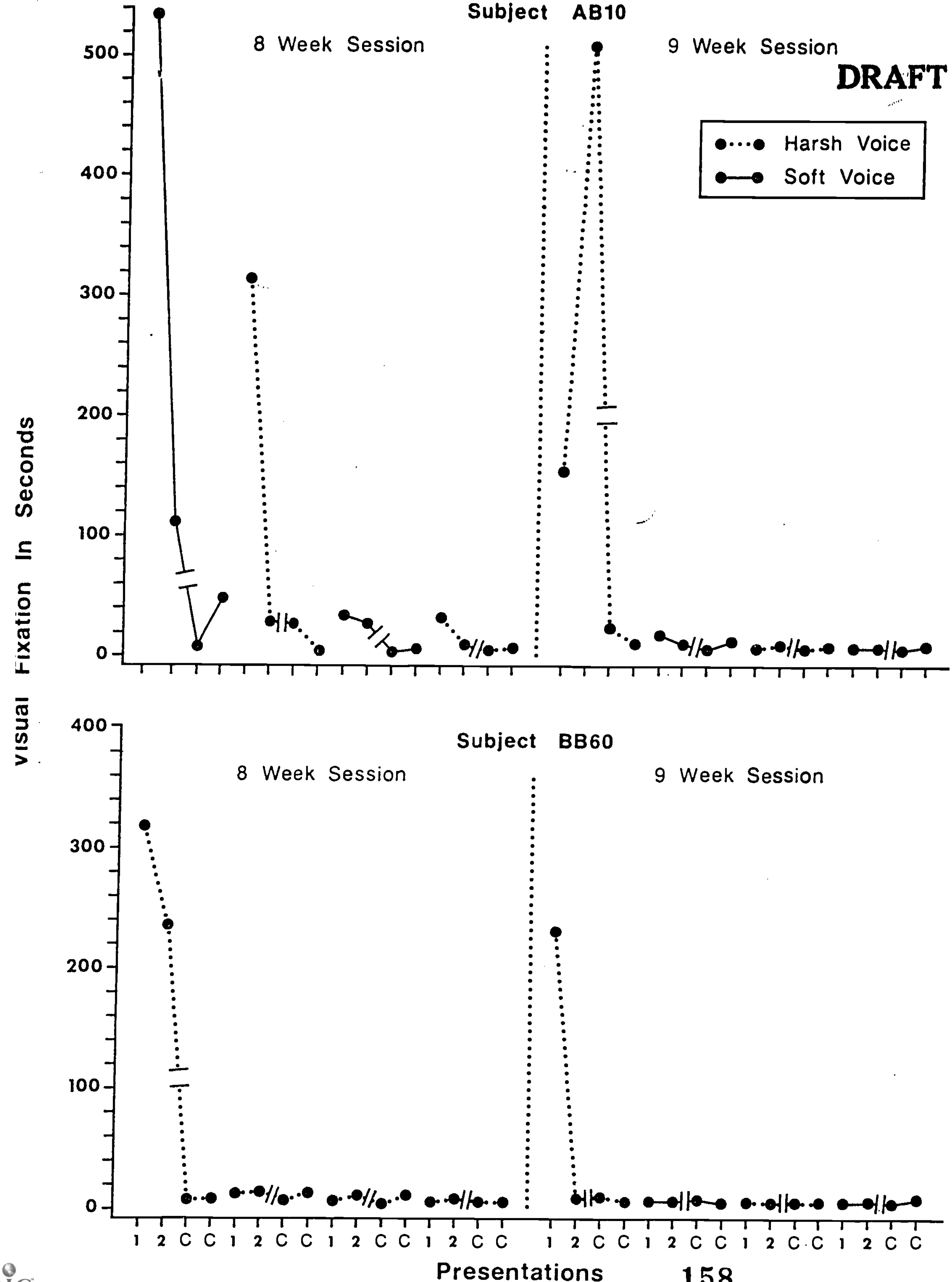


Experimental Group (AB & BA)
Control Group (AA & BB)
Difference Scores In Seconds
25
20
15
10
5
0
-5
I-II
II-III
III-IV



Subject AB10
8 Week Session
9 Week Session
Harsh Voice
Soft Voice
Visual Fixation In Seconds
500
400
300
200
100
0
Subject BB60
8 Week Session
9 Week Session
400
300
200
100
0
1 2 C C 1 2 C C 1 2 C C 1 2 C C 1 2 C C 1 2 C C 1 2 C C 1 2 C C
Presentations

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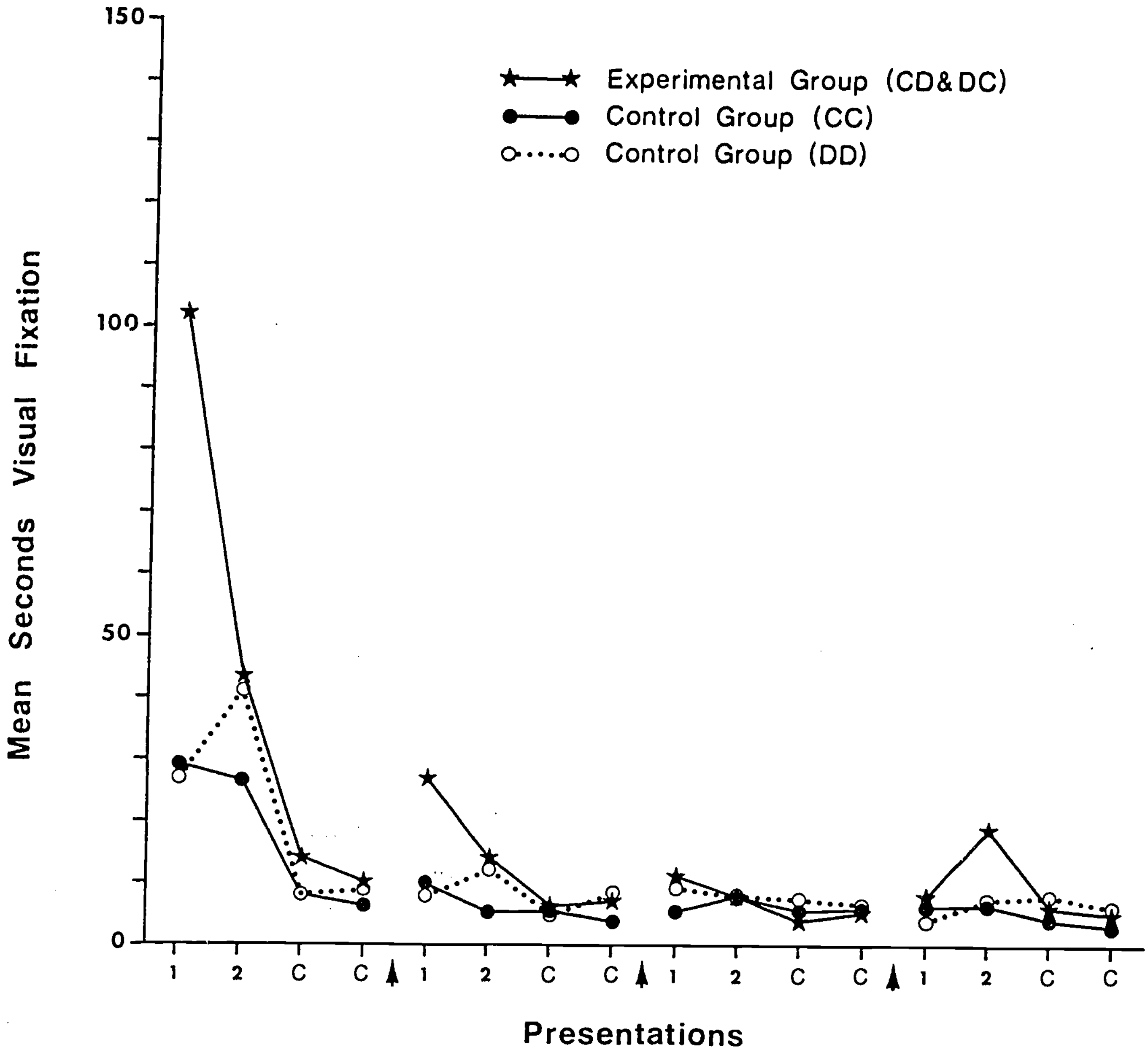
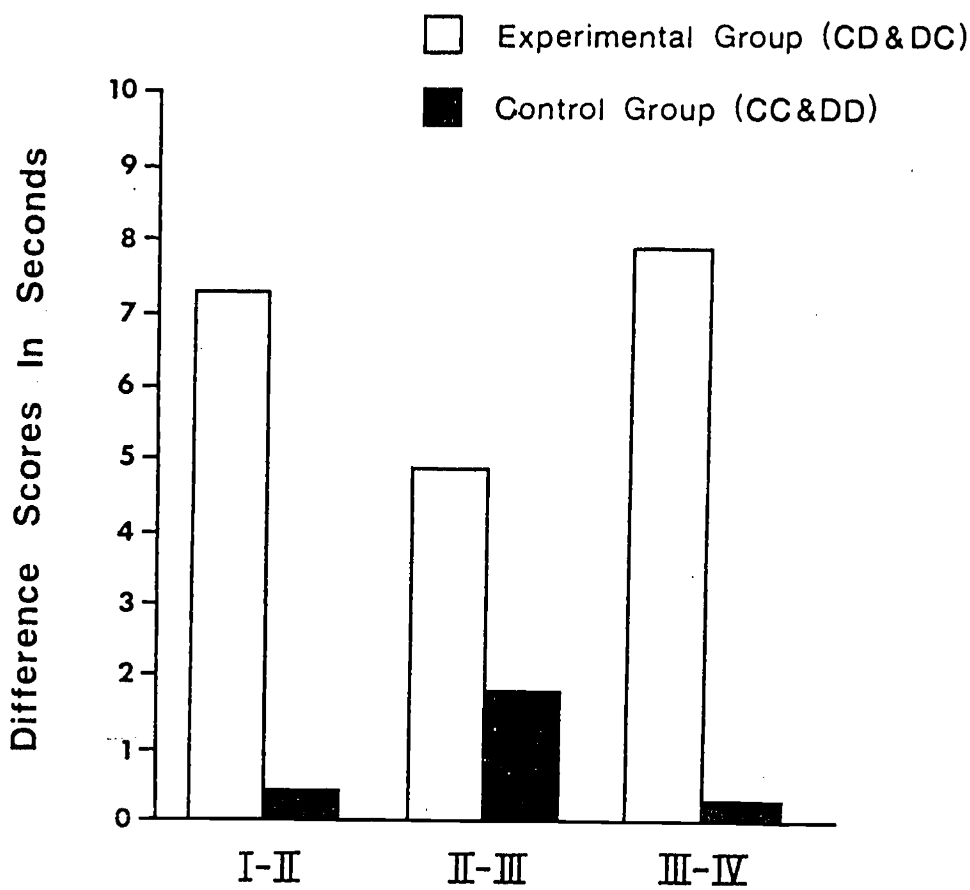


Indicates Point Of Stimulus Change For The Experimental Group And Point At Which The Stimulus Would Have Changed For The Control Group


Experimental Group (CD&DC)
Control Group (CC&DD)
Difference Scores In Seconds
10
9
8
7
6
5
4
3
2
1
0
I-II
II-III
III-IV

DRAFT

Discussion & Conclusions

Frances Degen Horowitz
The University of Kansas

This monograph reports the procedures and results of eight experiments and is basically the story of a loosely related series of studies aimed at developing and refining procedures for the study, initially, of conditions that retrieve attending behavior in young infants. The results were then put to use in the study of discrimination of voices and language stimuli, ending, finally, with some implications for studying infant receptive language development. As noted in the first article, no study involves a very large number of subjects. Yet, in each study there is a partial replication of effects from one or more preceeding studies that, in aggregate, suggest more confidence in the findings than might be warranted from any one of the individual studies. As also noted in the first article, a fair amount of attention has been given over to methodological matters in the conduct of the experiments, in the belief that it was necessary to examine a variety of procedures and to attempt to refine procedures so that it would be possible to accomodate to individual differences in infants. This author has had the conviction that there has not been sufficient attention to procedural issues in infant research and that the accumulation of a really stable data bank describing phenomena that could be undeniably replicated over and over again has therefore been impeded. This has resulted, in part, from the emphasis upon the "design of experiments so that the critical analysis of experiments rested more on the adequacy of control groups rather than on the reliability of procedures for demonstrating a phenomenon. Because of the problems of state in infants the emphasis upon design without a comparable emphasis on procedures and the reproducability of phenomena has left the data bank more disorganized than was possibly necessary, even given the fact that the modern era of experimental infant research is relatively young.

The results reported in this monograph may be summarized as follows: Self (1971) demonstrated that, using a procedure in which a repeated stimulus was interspersed with varying stimuli, response decrement of visual fixation was obtained to the repeated visual stimulus with five and six week old infants. The pairing of music to the repeated visual stimulus resulted in a recovery of visual fixation to the unchanging visual stimulus. Individual difference characteristics appeared to influence the likelihood of the recovery. Paden (1973) partly replicated Self's results. The most important aspect of the replication was the repeated demonstration that pairing music with an unchanging visual stimulus was sufficient to recover the visual fixation response. However, with 12, 13, and 14 week old infants the limited number of repetitions of the visual stimulus during the baseline condition did not produce as clear a decrement in attention as that procedure had done with younger infants. It was possible in both Self's (1971) and Paden's (1973) experiments that the recovery of visual fixation with the onset of music was the result of a general "arousal" phenomenon. The paradigm also violated the technical definition of habituation so that decrement and recovery of visual attention in these studies could not be labeled habituation, though the form of the obtained phenomenon was similar. In Paden's (1973) study there was some suggestion that the removal of the auditory stimulus as well as the addition produced recovery of visual fixation. This result was not replicated by Culp (1971) when removal of the auditory stimulus occurred across, rather than within, sessions. However, Culp (1971) did replicate the effect of the ability of the addition of auditory stimulation to recover visual fixation. This phenomenon was demonstrated in a rather different paradigm for it involved an across session design. The issue of the auditory stimulus acting as a general "arouser" could not be dismissed, though if it was a general arousal stimulus it was specific to the visual stimulus with which it was paired rather than generally heightening visual attending behavior in the session, irrespective of the paired visual stimulus. The auditory stimulus used by Culp (1971) was a tape recording of the mother's voice, in contrast to the music stimuli used by Self (1971) and by Paden (1973). Self's (1971) initial demonstration had been a between-subject demonstration while Paden (1973) had shown the phenomenon within subject. Culp's (1971) procedures were also involved with a between-subject demonstration. However, the adoption of an individually determined definition of response decrement appeared to be an improvement over the fixed trial procedures used by Self (1971) and by Paden (1973) with regard to accommodating individual differences. On an individual basis the effect of the addition of the auditory stimulus was more strongly demonstrated in the first manipulation with the individually determined level of response decrement that Culp (1971) used. Whether the voice is a more effective stimulus than music remains to be determined. The across-session procedure coupled with the individual criterion procedure was, though, extremely expensive in terms of laboratory time. Additionally, the effect was really only clearly demonstrable on the first manipulation and could not be recovered by the time several more weeks had passed. The refinement of the individual criterion procedure for determining visual response decrement to visual stimuli that was reported by Bhana, Laub, and Horowitz incorporated the infant control procedure with a standard habituation procedure plus an individually fashioned response decrement criterion all within one session. This became the basic prototype for the experiments reported by Boyd (1972) and by Culp (1973) on response to language stimuli. Boyd (1972) was able to demonstrate a replication of the first phenomenon reported by Culp (1973) and to extend his findings. She showed that both the voice of the mother and the voice of the stranger reading a poem could each recover visual attending behavior following response decrement of that behavior to an unchanging visual stimulus. Her results also demonstrated recovery with the withdrawal of the auditory stimuli, thus replicating the tendency first noted in Paden's (1973) results. It is likely that this phenomenon is more easily demonstrable in a within-session manipulation than in a between session manipulation. Boyd (1972) then demonstrated that it was possible to utilize this phenomenon to explore the infant's ability to discriminate between the two auditory stimuli. From her results it appeared that infants at the age of seven and eight weeks could discriminate between two voices. Though one of the voice stimuli was that of the infant's mother, no conclusions could be drawn about the effect of "mother" voice, per se, on the infant's behavior since the voice of the stranger was equally effective in recovering visual fixation behavior. The final experiments reported in this monograph by Culp (1973) provided a replication of Boyd's (1972) evidence that the recovery of visual fixation to an unchanging visual stimulus was a useful technique for studying auditory discrimination. The experiments also demonstrated that using recovery of visual fixation as an index of discrimination eight and nine week old infants could be said to discriminate between two voice tone qualities of the same voice reading the same poem, and possibly between verbal content.

This latter conclusion is not strongly supported by the individual subject performance and is possibly a developmental phenomenon that would be better demonstrated at a older age level in young infants.

The results of these experiments have some implications for four different areas related to research on infant development. They include the topics of habituation, inter-modal behavior, receptive language discrimination, and finally, individual differences and clinical applications. These are each discussed below.

Habituation

The results reported in this monograph relate in a variety of ways to the entire topic of habituation as it has been used to study early infant development. Taking the matter of response decrement alone, without concern for the demonstration of recovery of response to rule out fatigue and other factors, there are two observations of possible importance. The first is the issue of age. In an otherwise carefully qualified review Jeffrey and Cohen (1971) state somewhat unequivocally: "It would appear. . .that infants under 2 months of age do not habituate to visual stimulation." Subsequent to this statement Friedman (1972a, b) did demonstrate response decrement in newborns though Wetherford and Cohen (1973) did not obtain response decrement in six and eight week old infants and in this their findings agreed with Fantz (1964). In this monograph Self's results indicated response decrement in five and six week old infants while Paden did not get significant decrement, with the same procedure, in 12 to 14 week old infants. But, in the remainder of the studies in this monograph, involving within-session repetition using infants who ranged in age from seven to nine weeks, response decrement was invariably obtained - almost by definition of the procedure.

Thus, it would appear plausible to suggest that whether response decrement is obtained to repeated stimulation is a function of the procedure used at any particular age and its rate and depth a function of the particular set of stimuli rather than the age of the infant per se.

The second issue thus relates to procedures and not age. What is implied is that the experimenter could exert extensive control over whether or not response decrement is obtained by the careful selection of procedures and stimuli. One could then purposely produce or not produce the phenomenon depending upon the experimental question under investigation. It is quite possible that age interacts with procedures and stimuli in a way to reveal facts about developmental sequences in information processing. This has been exactly the intention of studies attempting to manipulate familiarity and novelty dimensions. However, instead of the procedural aspects being carefully chosen in such a way as to aid the experimenter in investigating this problem it is quite possible that the typical procedures of most infant habituation experiments, involving standard exposure times and fixed trials, have served to confound the results. Given the fact that habituation is demonstrable in the newborn organism and given the fact that response decrement was obtainable in a large number of both the experimental and control subjects used in this monograph ranging in age from five to nine weeks of age (excluding Paden's subjects and subjects involved in the across-session experiment) it makes sense to suggest that one should start with the premise that response decrement is obtainable with repeated stimulation at any age. An important aspect of obtaining it may be the employment of the infant control procedure for determining the duration of any given stimulus exposure. With infants around five and six weeks of age the interspersed stimulus procedure with fixed trials produced response decrement for the group but not for all individuals. Our subsequent procedural development that discarded the fixed trials procedure tended to produce "cleaner" response decrement on an individual basis. This has some implications for the study of individual differences in attending behavior that are discussed below. It remains to be seen whether the combination of the infant control procedure and the individually fashioned criterion for response decrement would show similarly consistent results with infants at five and six weeks of age. On a group basis using the sucking response to study auditory discrimination Eimas, Siqueland, Jusczyk, and Vigorito (1971) and others involved in similar research have essentially approximated these characteristics in their research. In this Eimas, et al. have demonstrated response decrement and recovery in infants as young as one month of age. There is no reason to believe that this phenomenon is not reliably obtainable in the visual modality as well.

Jeffrey (1968; 1969) and others have suggested that early development in the natural environment involves successive habituation to increasingly larger sets of stimulus components. Since, in the natural environment, the onset and offset of attending is typically under the infant's control the procedures in the experiments reported here may more fully mirror natural environmental conditions. Their use in the laboratory may thus enable us to gain a fuller understanding of some of the natural developmental processes and sequences.

Response decrement with repeated stimulation and the subsequent recovery of the response with stimulus change has proven to be a very attractive tool for studying cognitive development in young infants. The research reported here has not been directed at some of the more traditional questions related to the general area of cognitive development. The issues of novelty, familiarity, and degree of stimulus discrepancy have not been investigated per se. Rather, the initial studies were more related to just the simple questions of conditions that are successful in recovering visual attending behavior once it has declined. It would appear that the addition and (in a within-session comparison) the subtraction of auditory stimulation is sufficient to recover visual attention to an unchanging visual stimulus. Because of the cross-modal nature of this phenomenon it is not technically "habituation" and "dishabituation" as it has been defined in terms of physiological structures. However, with the general form of the phenomenon independent of whether the two modalities of vision and audition are or are not present throughout the session it would appear that on the behavioral level habituation is, as Jeffrey and Cohen (1971) have noted "a very pervasive aspect of behavior". The cross-modal or inter-modal aspects of these experiments as well as some of the interesting implications for understanding learning and individual differences will be discussed below.

Inter-modal Behavior

The bulk of the research on infants has typically been concerned with behavior within a single modality. The interesting but unrecognized exception to this has been in research on learning and conditioning in infants where stimuli and responses from more than one modality are typically utilized. While it is often necessary to make the research questions as simple and limited as possible (i.e., one modality at a time) it is conceivable that more attention to simple and limited questions that involve more than one sensory modality will provide us with some significant information about infant development. As has been noted earlier in this monograph casual observations of infants and caretakers in the natural environment reveal that behavioral control is often exerted by stimulation from several modalities concurrently and sometimes successively. This seems to be possibly especially true of the sequence involved in what might be colloquially called "keeping the baby's attention". This may have particular importance for our understanding of cognitive development in infants. If cognitive development involves successive habituation it probably also involves successive associative acquisitions that may approximate some of the learning paradigms that have been demonstrated with infants. In an interesting way the data reported by Zeaman and House (1963) may offer an entré to some fruitful speculation. Zeaman and House demonstrated that retarded and normal children did not differ in acquisition of a response once attention to the relevant stimulus components was equated. If that is the case then it is quite possible, as Jeffrey and Cohen (1971) suggest, that a fruitful alliance of the active processor and the conditioning models will be found in trying to understand how attention is maintained until a sufficient level of associative characteristics are accumulated which, then, using Sokolov's notion of the establishment of a "model" allow for long term successive habituations to occur. These may, as Jeffrey has proposed, account for the occurrence of much of "development" in what has been called the cognitive realm. Thus, rather than dismissing the learning model it may be more fruitful to try to see the interaction of active processing of environmental information and conditioning. There may be important consistencies in the frequency with which different sensory modalities interact to maintain attending behavior to a stimulus or a stimulus configuration which, at a certain point, permits conditioning of new responses to occur. The interaction of sensory modalities would obviously not be limited to vision and audition. However, the results reported in this monograph might well be used to encourage further research on inter-modal behavior in infants both for understanding attention and for illuminating the complex processes involved in cognitive development.

One of the concerns frequently expressed about the data reported here was whether the addition of the auditory stimuli could be seen as an arousal phenomenon. Since in within-session arrangements the subtraction of auditory stimulation also appears to be able to recover visual attending behavior the effect is probably more related to the issues involved in stimulus discrepancy as they have been discussed by McCall and Kagan (1967; 1970) and others. The addition and subtraction of auditory stimuli are very large and obviously noticeable discrepancies but what is very interesting from the research reported here is that discrepancies involving addition and subtraction of stimulation in one modality can dishabituate or recover a response to a stimulus in another modality. Stimulus discrepancy probably is involved in general aspects of "arousal" but it would appear that it may be very fruitful to intensify research on inter-modal aspects of arousal and attention behavior in young infants since the frequency of these interactions in the natural environment is probably very high. Whether, in fact, such research will help to marry the active processor and conditioning accounts of development beyond mere speculation into the domains of data remains to be demonstrated.

Receptive Language Discrimination

There are two major observations to be made on the import of the results reported in this monograph for understanding receptive language behavior in young infants. The first has already been discussed in the research reports themselves. It involves the notion that the visual response decrement and recovery may be a very useful procedure for studying infant receptive language abilities. The fact that visual attention is a response available from birth makes the procedure especially attractive for investigations of developmental changes and differences.

The second observation has to do with the data reported here. Eight week old infants appear to discriminate two different voices and this is one of the clearest demonstrations at one of the youngest ages of this phenomenon. Eight week old infants also appear capable of discriminating two different voice tone qualities in the same voice. Some eight week old infants also gave evidence of discriminating different verbal content but this was much less convincingly demonstrated. The parameters investigated in these studies are exceedingly gross and in their grossness are in sharp contrast with the finely different characteristics of the speech stimuli used in the recent studies of discrimination of language stimuli by infants done by Eimas, et al. (1971) and others (Moffitt, 1971; Morse, 1972; Trehub & Rabinovitch, 1972). For the understanding of just what is involved in receptive language development both the fine and gross features may be simultaneously or sequentially important but this is not known at the present time. Whether, in the natural environment the infant is attentive to consonant sounds when they occur in the "noise" of natural speech flows is an empirical question. The evidence that infants as young as eight weeks can discriminate gross features of language stimuli that do occur in the natural environment is an encouragement to the point of view that maintains that during the pre-verbal period in early infancy some of the most important aspects of language development may be occurring in the realm of receptive language. The studies reported here do not in any way aid our understanding of whether or not there is a developmental sequence in receptive language similar to that of productive language but they do suggest, both by their methodology and by their results, that moving up and down the developmental scale looking for points when discriminations cannot be made and then when they can be made may be a fruitful direction for research in this area. One can use as fine or gross stimulus features as one wants. The important thing to try to discover is whether there are any sequential aspects in the kinds of discriminations that can and cannot be made. The possibility that there may be a sequence and that the sequence may have some relation to the sequence observed in productive language development is an exciting one. Our laboratory is now aimed on this research path and hopefully others will be able to utilize the methodology developed here for similar kinds of pursuits. The simple demonstration that infants at a particular age can make discriminations must be buttressed by more developmentally oriented research concerned with sequential aspects of such capabilities. The acquisition of a reliable data bank on this will enable us to understand the possible importance of receptive language for productive language. If there is a sequence and if it is related to productive language development then individual differences in receptive language development may allow early identification of children with subsequent speech and language problems. The relationship of the studies reported in this monograph to individual differences is broader than this, however, and thus the topic of individual differences deserves a separate treatment.

Individual Differences and Possible Applications

Any attempt to finally apply our basic knowledge of human development must eventually involve an understanding of the parameters of individual differences that determine the functionality of any particular procedure or stimulus complex. Thus, data such as those reported by McCall and Kagan (1970), by Self (1971) and by Paden (1973) and by Greenberg, O'Donnell, and Crawford (1973) may be extremely useful in identifying distinct groups of children in relation to what would seem to be a basic phenomenon such as habituation. There are several comments that can be made about individual differences, infant development, and infant research.

The first pertains to choosing methodology carefully depending upon the kind of question being asked. If one wants to identify two groups such as rapid and slow habituator it may not make any difference which set of procedures are used - unless you are interested in very very young infants. Self (1971) and Paden (1973), using very different procedures than McCall and Kagan (1970) or Greenberg, et al. (1973), were equally successful in picking out different groups. However, if one wishes to go further and investigate factors such as the conditions under which dishabituation can occur so that attention can be recovered, then it may be very important to pay particular notice to the problem discussed earlier - that of making sure each infant has been brought to the same depth of response decrement in order to evaluate the effectiveness of the stimulus or conditions being used to bring about dishabituation.

A second observation concerns the utility of having reliable procedures that can bring h infant to a similar depth of response decrement. It may allow for a more reliable assessment of the ability of the infant to make a discrimination. Assuming recovery of visual attention is an index of discrimination, it is interesting to note that in Boyd's (1972) experiment almost all of the infants were able to make the discrimination between the two voices and similarly, Culp (1973) found almost all the infants able to discriminate between two voice tone qualities. But, with the two different stanzas of a poem only some of the infants demonstrated the discrimination. It is possible that if we can discover a sequence in the kinds of receptive language discriminations infants make then the techniques developed in these studies could be utilized as a diagnostic procedure to identify individual infants who are making normal progress or slow or advanced progress. Should it prove the case that slow receptive language development predicts difficulties in productive language development we might then turn our attention to developing training techniques that will remediate the rate of receptive language acquisition. This is all, admittedly, quite speculative at this stage in our knowledge. However, this is one of the reasons why we have been so concerned to investigate the degree to which individual subjects exhibited the experimental effects in the same pattern and degree that the grouped data described. If one can be certain that an experimental effect is highly replicable between subjects then it is possible to forsee the use of a procedure for diagnostic purposes. The results of much infant research have been exciting because infants appear to have capacities and capabilities beyond most expectations. However, the understanding of these behaviors in their developmental orderliness, to the extent that there is order, is essential if the information is ever going to be applied to helping the cognitive development of individual infants. At the present time such aid is given in a global manner to grossly selected populations because our knowledge is limited to very general milestones in development. Yet, the basic research in cognitive development has been concerned with very fine and discreet behaviors. The meeting of basic research and application requires attention to individual differences and that attention may be most powerful and allow for more steady progress if researchers adopt a style of research that inquires into individual replications as well as group effects. The physical sciences would probably be much less well developed if they had been satisfied with saying "on the average" without also saying "the effect can be demonstrated X% of the time under these conditions". There is no reason to think that such an approach in infant research and possibly in behavioral research in general would not yield to similarly encouraging rates of progress.

Summary

Ten different experiments are reported in this monograph. In aggregate they demonstrate that response decrement can be reliably achieved to visual stimulation with infants as young as five weeks of age. The visual response can be recovered to the same visual stimulus by the addition of auditory stimuli and, within-in the same session, by the subtraction of auditory stimuli. This phenomenon can be used in the study of the ability of infants to discriminate between two different auditory stimulus selections and thus has some possibly significant relevance to the entire area of receptive language development in infants. Throughout these experiments particular attention has been paid to procedural matters and the individual replication of the experimental effect over subjects has also been of concern. The findings reported in this monograph may have implications for future research with infants in the areas of habituation, inter-modal stimulation effects, receptive language, and individual differences.

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DRAFT

APPENDIX A

Principles and Procedures in the Operation of an Infant Experimental Research Laboratory

Frances Degen Horowitz
The University of Kansas

In the renaissance of experimental infant laboratory research over the last fifteen years there has developed a body of informal knowledge pertaining to the operation of an infant experimental research laboratory. Each investigator, in establishing a new laboratory has discovered for himself or herself the problems that must be solved in such an enterprise. Working first in an already established setting is sometimes deceptive for the individual who then must establish a new setting because the practices and procedures of the old setting are the results of problems being solved and do not necessarily provide the new investigator with a perspective of how to avoid the problems in the first place. The purpose of this appendix, therefore, is to set down some of the practices and procedures that we have found useful along with their rationales and the choices that can be made. Most experimental infant research is a very costly enterprise both in terms of money and time. If the details and ideas provided herein reduce the problems for new investigators or aid already working investigators to improve their laboratories, its aims will have been achieved. This brief discussion is also intended to provide advanced undergraduate and graduate students first entering infant research, with some understanding of the variety of considerations involved in infant laboratory settings. These considerations range from ethical issues to the practices used in an infant laboratoy that are of especial importance because the subjects are human infants. The writer of this article had the opportunity to learn some of the things included here from visits to infant research laboratories around the country and from talking with other investigators. Some of the practices described here were worked out over periods of trial and error. Over the years students have contributed significantly to the practices observed in our laboratory both by their positive suggestions and by their unwitting errors that taught us both what to do and what not to do. We have also learned extensively from the infants themselves by whether they tended to be cooperative or not. Procedures which produced a lot of uncooperative behavior were dropped, those which helped maintain the infant in a cooperative state became part of our standard operation.

Over the years infant researchers tend to hone down to a lexicon of techniques that never really get examined, are not more than casually mentioned in procedural sections, and sometimes not mentioned at all, but which probably play an important role in the level of productivity of any laboratory. The purpose of this discussion is to identify some of these techniques and the issues that generated them.

Ethical Issues

Both the American Psychological Association and the Society for Research in Child Development have developed guidelines concerning the ethics of research with human subjects and in the case of infants have stressed the importance of informed consent from the parent, guardian, or legal caretaker. But, as anyone who has thought about these problems realizes, the matter of

Informed consent is only one aspect of the ethical dimensions of infant research. The human infant is not fragile but he or she is vulnerable to a variety of environmental insults that can effect both permanent and transient impairment of functioning. It is therefore incumbent upon the infant researcher to examine every aspect of the experimental setting and its procedures in such a way as to be able to honestly assure the person who is to give informed consent that there is a high probability that participation in the research involves a risk level for the infant as close to zero as possible.

A risk level of as close to zero as possible is not calculated only in terms of the fact that a checkerboard stimulus can hardly be seen as having any danger in it or that an auditory stimulus is well within safe levels of intensity. Risk level involves such things as the hygienic conditions of the laboratory both in terms of the health of the people handling the infant as well as the possibility of passing on infection from one infant to another through contact of objects. Risk level also involves the construction and use of equipment in such a way that if the equipment malfunctions it cannot involve the infant in any direct physical way. And, risk level involves the inspection of any object with which the infant is to be in contact to make sure it cannot harm the infant by its characteristics and that the infant cannot harm himself or herself by the use of the object. Thus, in addition to explaining the purposes of the research and describing the procedures to be used, the infant researcher must be in the position of certainty that there is nothing in the operation and procedures of the research or the laboratory setting that involves any known risk to the well being of the infant. Some of the practices described below are related to these considerations.

There is a sad but sobering story which is told to all new members of the infant research laboratory at the University of Kansas. In the very beginning of the operation of the laboratory, a three month old infant boy participated in a visual attention study and was to return a week later. The night before he was to come into the laboratory for the second time, he died unexpectedly in a manner that appeared to be a "crib death". Had the death occurred on the night of the day he had been in the laboratory it is not impossible that parents distraught by the tragedy and looking for some explanation might have seized upon his experiences in the laboratory as a possible causative factor. Only the most careful consideration of all aspects of an infant laboratory setting can enable a researcher and his staff to be totally invulnerable to suspicions generated in such a case. Since the etiology of many developmental problems is unknown, the infant researcher must be sure that he or she can give no cause to either rational or irrational searches for responsibility.

Another ethical matter relates to the information given to the mother of an infant after participation in the research. Mothers agree to participate in infant research for a variety of reasons. Some probably take pity on the researcher and know something about research and the problems of getting subjects; some may be glad for the diversion or interested in the problem under study. However, in some significant portion of instances, mothers agree to allow the infant to participate because they themselves are worried that the infant may not be normal. It is important for all personnel working in the laboratory who have contact with the mother to be aware of this possibility and to be careful both not to add to the mother's fears or to assure her in any way beyond the actual level of competence in assessment represented in the procedures of the laboratory. One possible dimension of an infant laboratory operation would be to make available to mothers who allow their infants to participate in research some additional assessments as a service to the mother and infant. Barring that, infant laboratories should be able to refer such mothers to appropriate resources for further examination.

Procedures Used in an Infant Research Laboratory

Personnel

Many states require people working with children to be screened regularly for tuberculosis and if it is not a legal requirement, it is one that should be adopted voluntarily. The acceptance of a student or worker in the infant laboratory should involve some investigation regarding any chronic diseases that in their active recurrence are communicable and such individuals should not be allowed direct contact with the infants or things that come in contact with infants. All personnel in an infant laboratory should be involved in the establishment of procedures regarding their daily health state so that incipient colds and sore throats are legitimate reasons for arranging for replacement on the work schedule. On University campuses where students have access to student health services the students should be instructed when they have need to use such services to ask the doctor if he or she sees any indication that they should not be in contact with infants.

In the daily routine of the laboratory, personnel must be required to wash their hands regularly before handling an infant or handling objects and equipment with which the infant will come in contact. This is a simple matter but one that lapses easily.

It is helpful if the organization of the laboratory provides for one person to be responsible for relating to all of the matters concerned with the health and hygienic states and practices of laboratory personnel. This matter will be discussed below in the section on some of the things we have found useful in organization of an infant research laboratory.

Laboratory Procedures

Recruiting Infants. Infant researchers use a variety of techniques for tracking down subjects: some have connections with local doctors to solicit participation of infants; mailed letters or personal telephone calls are also employed; personal contact when the mother is in the hospital or through organized groups can be utilized. The choice depends partly on the resources and contacts available to the infant researcher as well as the size of the community in which he or she is working. Making appointments for the infant to come to the laboratory usually involves some eventual form of personal contact. Written material and an oral description of the research are usually offered. It is helpful if the researcher can advise the mother ahead of time on what the most desirable state of the infant is for the research: hungry, between feeds, sleepy, alert, etc. Mothers are often willing to call and reschedule their appointment if they know, before starting out for the laboratory, that the infant will not be in an appropriate state for the research.

Depending upon the size of the community in which the work is being done, transportation and parking can be difficult problems. In Lawrence, Kansas it has worked well to offer each mother free taxi transportation to and from the laboratory. Other than the opportunity to choose a small gift from an array of inexpensive items at the end of each session, this is the only other kind of offer we make the mother. Some investigators pay mothers for bringing infants to the laboratory.

In communities where all the births are listed in the local newspaper there is a ready access to the names of possible subjects along with the birth dates for choosing subjects at the right ages. Where no such public listings are available, contacts with physicians and hospitals are the next best resource for potential subjects. Such contacts are sometimes difficult to establish initially. Some investigators have placed advertisements in newspapers and many get good results from this. Once the laboratory is established it begins to get a reputation and if that reputation is a positive one recruiting becomes easier. Laboratories that have the resources to offer adjunct services such as traditional infant assessment can make arrangements with physicians and health services somewhat more reciprocal. It has been our policy at the University of Kansas to evaluate any infant whose behavioral development is of concern to a local physician. This service is performed without charge and results in a written evaluation given to the physician.

Receiving infants in the laboratory. Once an appointment has been made for an infant several matters must be handled. The first is arranging for arrival of the infant. If a taxi is to be sent, the taxi must be ordered. (Previous to this, arrangements for billed payments to the taxi company must have been established.) If the mother is to provide her own transport, convenient parking must be available for her. On University campuses or in crowded urban areas this can be an amazingly frustrating and time consuming problem.

The second concern is the actual reception in the laboratory. Infants are attractive to many people and it is not unusual to find that by the time an infant and its mother have made their way from the front door of a building to the actual lab room, several people have oohed and aahed over the infant, sometimes handling the infant and playing with the infant. The same thing can be repeated in the laboratory itself. If this process has been extensive the chances of getting the infant to cooperate in a task that does not involve social stimulation are reduced. Turning the infant from a highly responsive and stimulating social environment to looking at checkerboards or other slides or hearing controlled auditory stimuli will often result in the onset of crying and fussiness. Therefore, it has been our practice to instruct secretaries, custodial personnel, and students that infants coming to the laboratory should not be stopped enroute and played with. Furthermore, the infant and mother are greeted by only one or two people in the lab itself and social interaction with the infant is kept in a low key. There are research problems which do not involve minimal social stimulation and such precautions are then probably less important. But, studies involving visual and auditory responsiveness can be seriously disturbed by uncooperative infants if prior to the start of the experimental situation the infant is subjected to a high level of social interaction.

The third concern is readiness. If the infant arrives in the laboratory and the experimental procedures and personnel are not immediately ready to start, the waiting period can result in an alert cooperative infant becoming a sleeping, crying, or uncooperative infant. This is especially true if the infant is set into the experimental crib or seat and nothing happens. The infant who arrives in the laboratory ready to participate in an experiment should not be kept waiting.

During the laboratory session. Once in position for the experimental procedures to begin, the research laboratory needs to have worked out in advance alternative actions if the state of the infant changes during the session. For some studies a state change to fussy, crying, or sleeping might end the session. In other studies a "break" is called. Conventions governing who calls the break, when it is called, and under what conditions resumption of the session should occur should all be worked out in advance. It has been convenient in our laboratory to have observers note the occurrence of crying, fussing, drowsy, and sleep behavior. If any one or a combination of these occurs for a duration of 15 consecutive seconds the equipment operator, seeing the record of the key depression recording such behavior, calls a break. Alternatively, one of the observers or another person in the room could make the break call. If the baby has fallen asleep, some investigators allow the infant a short nap and if the infant awakens they will continue or restart the session. For others the nature of the problem under investigation is such that the session is discontinued and perhaps rescheduled. Short of sleep or very drowsy behavior the break can be used to calm the infant and once calmed attempt to continue or restart the session. All breaks should be recorded as to time of occurrence and duration and the conventions adopted with regard to them reported. During any break which is to be followed by an attempt to continue with the infant in that session, it is important to observe the same conventions with regard to social stimulation during the break as observed prior to the session. This is especially true if the experimental session involves a minimum or no level of social interaction.

Parents are reassured if the personnel in the laboratory seem to know what they are doing and function smoothly and efficiently. If the infant has been brought to the laboratory as a pilot subject where procedures are being tried out and where the session is likely to be interrupted with personnel discussing matters, it is helpful to inform the parent ahead of time that this is what is going to go on. It has been our experience that parents are more likely to return for other sessions if they feel confident that the personnel in the laboratory know what they are doing.

It has always been our policy for the parent to know that he or she has the right to stop an experimental session at any time. In fact, no parent has ever attempted to stop a session or requested that a session be discontinued.

At the end of the session. As noted above some investigators pay parents for participation in the laboratory. Others offer them a small gift for the infant or themselves. In some studies where we have asked the parent to return for seven and eight seeks in succession, we have sometimes given them a small gift certificate that can be redeemed at the local department store. If the parent is being asked to bring the infant back again, the appointment for the next visit is usually made at the end of the first session. Arranging for the taxi to arrive to return the infant home can be done before hand if it is certain how long the session will last. In most cases this is difficult to predict so that the taxi is called when the session ends.

Many parents want to discuss the behavior that occurred during the session or they want to know more about the research. Thus a member of the staff of the laboratoy needs to be ready to answer questions, keeping in mind that any kind of general evaluation of the infant's developmental status is usually unwarranted if it is based on the observations of behavior during an experimental laboratory session. It has been our policy that only one person is designated to speak to the mother as a spokesman for the laboratory. Additionally, all personnel in the laboratory are instructed not to discuss the infant's behavior among themselves in front of the parent or with the parent if they have not been designated. The rules of confidentiality must be strictly observed and early coding of data without identifying names is done as quickly as possible.

Training Laboratory Personnel

Personnel in an infant research laboratory must receive training on a variety of dimensions. The health and hygienic precautions noted above must be communicated and kept at a high standard at all times. The individuals working in the laboratory need to be aware that the laboratory depends upon the good will and cooperation of parents. Thus the public relations aspect of the laboratory is important and the role of each person in this needs to be identified. Finally, personnel require training in the recording procedures being used and in operation of equipment being used.

It may be helpful for investigators to calculate the cost in dollars of each laboratory session. This can be done roughly and easily by taking the total annual budget of the laboratory and dividing the number of laboratory sessions scheduled and run in a year. By our calculations each laboratory session with an infant costs approximately $150.00. The figure will vary depending upon the number of personnel needed to run sessions and to maintain the overall operation of the laboratory. However, in informal discussion with other investigators, $150.00 per session is not unusual. Thus, if a staff member of the laboratory causes the data for the session to be lost by operating the equipment incorrectly or presenting stimuli differently than planned that individual's error costs $150.00. All personnel in the laboratory who can cause data to be lost need to know what their errors cost and training procedures to minimize such errors are necessary.

Minimizing Errors in the Laboratory

In a laboratory where only one study is being run at a time it is probably easier to control errors since equipment settings and research set-ups do not undergo constant change. Also, the fewer the personnel the easier it is to control errors. In our laboratory anywhere from three to six different studies may be running simultaneously and the opportunity for experimenter error is high. Reduction of this error rate can be effected by the following behaviors:

1. Staff scheduled for an experimental session need to be on hand fc at least a half-hour before the session is scheduled to start.
2. During this half hour all equipment is checked to see if it is in operating order.
3. Procedures particular to each study are posted and become a check list for readying the setting and equipment.
4. At the end of a session, equipment is closed down and, if necessary, cleaned but the settings are left in place. It is the responsibility of the staff scheduled for the next session to make whatever changes are necessary when they arrive. This eliminates false expectations that a previous group or individual has set the equipment up and requires the staff for each session to be responsible for the total operation of that session.
5. If a staff member is ill or cannot make a session for which he or she is scheduled, it is that individual's responsibility to find a replacement among the other staff members. All

staff members should be trained on all procedures being used in the laboratory and for all roles in the laboratory with regard to recording data and operating equipment.

Staffing Patterns in the Laboratory

Most infant research laboratories (in University settings) include one or more senior investigators, graduate students, undergraduate students, and sometimes non-student personnel. It is possible to run a good laboratory without any paid personnel if the individuals are committed to the research program. Most laboratories involve paid personnel of some kind. The more complex the studies in the laboratory, the more studies being run, and the more subjects being run, the necessity increases for there being at least one full-time paid person to have the overall responsibility for the general operation of the laboratory. Obviously there are many choices to be made in staffing but an infant research laboratory, like any scientific research laboratory, usually requires a minimal level of support personnel who bear the basic responsibility for seeing that high standards are maintained in all areas. The institutions in which research laboratories are located have a stake in the laboratory's reputation to the same extent that the senior investigator does and the institution should be expected to invest a level of support in the operation of the laboratory as a training, educational and research site. It is the responsibility of the senior investigator to continuously communicate such a perspective to the administrators of the institution in which he or she is located.

Because the scheduling of subjects must usually be done to the convenience of parents, individuals working in the infant laboratory need large blocks of free time for assignment to the laboratory. Since training is extensive we usually require that undergraduates who work in the laboratory must be able to be scheduled in the laboratory for at least three full half-days each week. Graduate students whose primary research interests are in the laboratory are generally expected to be scheduled for at least 15 to 20 hours but in practice often spend much more time in the laboratory. The ideal arrangement is to, in addition, have one full-time paid non-student to coordinate the activities of the laboratory.

The Utility of a Research Log

We have found that the maintenance of a daily research log is very useful. At the end of every laboratory session, one pre-designated staff member records in the log the details of that session. The subject, the study and the conditions, the staff working in that session, the number and reasons for any breaks, and any unusual occurrences are noted. Because we have had a problem in controlling temperature and humidity in our laboratory the data of these two measurements are also recorded. If a session is not completed the reasons are noted. On more than one occasion the log has served to retrieve information which has aided us in revising and changing procedures and in keeping an overall picture on problems in the laboratory.

A Special Word About Newborns

The discussion thus far has assumed that the infant research laboratory is recruiting infants from their homes. However, since a significant portion of infant research is with newborns some special observations are in order. All of the procedures with regard to health, hygiene, risk levels, and equipment apply equally to a newborn research laboratory as to any other infant research laboratory. The special issues concern the functioning of the newborn organism, relating to mothers who have just given birth, and working in a hospital setting.

The newborn infant is making many adjustments to extra-uterine life. These adjustments sometimes involve unstable functioning or functioning that changes radically and suddenly. For this reason anyone working with newborn infants should have immediate access to personnel trained in aspiration and resuscitation methods and should know what events define an emergency. Unless the researcher is, himself or herself, trained in emergency procedures, such procedures should only be performed by qualified hospital personnel. Even if the researcher has such training, permission to use that training should be cleared in advance as standard procedure when making arrangements to do the research. The authorization to act in an emergency has many legal implications for both the researcher and the institution involved.

Getting informed consent can involve some unusual problems. A mother who gives her consent while she is in a drowsy or semi-drugged state may not remember what she has done. If the research is to involve the newly born infant in the first few hours after birth, consent should probably be obtained before the birth whenever possible. Sensitivity to the concerns of the new parent is important. Some parents suspect that their infant is in some way abnormal and that the request for participation of the infant in the research is being made because of an abnormal condition. Special care needs to be taken to obviate such fears.

Infant research with newborns usually requires careful development of relationships with physicians, nurses, and hospital administrators. In overcrowded and understaffed settings a researcher can be annoyingly intrusive and disruptive. A sudden spate of premature and sick infants can seriously strain the resources and tempers of previously cooperative personnel. It is helpful for the infant researcher in the newborn nursery to know what is going on and what the problems are that the nursery staff must handle. Unsympathetic or hostile nursery staff can make infant research even more difficult than it often is.

Administrators of hospitals work under many many pressures. Permission to work in a hospital setting requires that the hospital personnel be fully informed about the purposes and procedures of the research. They must have assurance that the standards and principles are impeccable in both risk level and other ethical issues.

All of the above observations are reasons why the senior investigator must be especially careful in choosing associates to work with newborn research programs. The newborn research laboratory is not a setting for anyone who is not very serious and responsible. It is also not a setting for relatively inexperienced individuals in infant research. For this reason the involvement of undergraduate students needs to be carefully screened and the senior investigator needs to be intimately aware of events that occur in the hospital setting.

Some Concluding Comments

The purpose of this discussion has been to aid already established investigators in training new personnel and to help newly starting investigators avoid having to use time in learning things about operating a laboratory that others have already learned. Issues in infant research that are substantive have been omitted though there are many points at which substantive matters interact with procedural decisions. There are days when infant research can be as discouraging as it is exciting. Sometimes the data "pay-offs" that are so reinforcing to researchers come at infrequent intervals. It is hoped that needless interferences in the collection of good data due to inappropriate laboratory practices can be reduced by a discussion such as this.

There are some areas of research where if all activity stopped tomorrow it would not make a very great deal of difference for the scientific world. Partly because of the cost and effort involved in infant research there has been a strong tendency to attack significant problems. Thus, any encouragement and help that can be given to the infant researcher to increase or insure a good level of productivity from the laboratory is likely to be worthwhile. It is hoped that this discussion has made some contribution toward that goal.

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