EVIDENCE FOR ASSOCIATIVE VALUE IN 5-MONTH -OLD INFANTS' RECOGNITION MEMORY: OVERRIDING NOVELTY PREFERENCE

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PREFACE

In a recent study, Najm-Briscoe, Thomas and Overton (2000), implemented a classical conditioning procedure were infants' behavioral preference was found to the conditioned familiar stimulus in contrast to the novel stimulus. The purpose of the present paper is to determine whether the findings were a product of stimulus association and not a product of stimulus sensitization. More specifically, to determine whether the value that is associated with mother's face (the unconditioned stimulus, UCS) was indeed conferred onto the auditory tone (the conditioned stimulus, CS) making that tone a secondary reinforcer. It is possible that the infants' behavioral preference could have been influenced by the mere presentation of a visual stimulus and not influenced by the CS-UCS pairings. Infants were randomly assigned to four different within-subject design conditions. In two of the conditions, infants received repeated presentation of a neutral tone in association with a picture of mother's face (conditioned tone with value) and a neutral tone without association. In the remaining two conditions, infants received repeated presentation of a neutral tone in association with a picture of a black square (conditioned tone without value) and a neutral tone without association. Infants' behavioral preference toward the conditioned tone, the neutral tone and a novel tone was recorded and measured. Results indicated a lack of stimulus discrimination across all four groups failing to highlight the nature of the findings generated by Najm-Briscoe et al. (2000).

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CHAPTER 1

INTRODUCTION

From a very young age, infants are capable of encoding, storing as well as retrieving environmental information (Bornstein & lamb, 1992). They are able to recognize as well as discriminate among familiar and novel stimuli (Wetherford & Cohen, 1973; Kaplan & Werner, 1986), and they are capable of short-term memory (i.e., immediate memory) as well as long-term memory (i.e., memory after minutes, hours, or days) (Bahrick, Hernandez-Reif & Pickens, 1997). Such capabilities are all examples of infants' information processing which has been under investigation for decades. Throughout this research, visual fixation has been used as the dependent measure to index infant cognitive ability (e.g., visual recognition memory). The well-documented relations between early visual behavior and later intelligence have made this measure very significant (Rose, Feldman, Wallace, & McCarton, 1989; Morrow, 1993), especially when active exploration of the environment is not yet possible.

Visual recognition memory is defined as the ability to recognize and remember visual stimuli. It has been typically measured in infant research using the paired-comparison paradigm. In this paradigm, the infant is familiarized with a single stimulus, and then is presented with that familiar stimulus and a novel one (a stimulus that has not been presented or observed). The amount of looking time to the familiar is compared to the looking time to the novel stimulus. The infant's differential responding to the novel stimulus denotes stimulus discrimination and implies recognition of the familiar stimulus (Sokolov, 1963).

Overall, much of this research has been concerned with the development of infants' visual responsiveness to novelty, an unlearned visual interest in a stimulus that has not been habituated by experience. Today, novelty preference is employed by investigators of human infancy not only to assess visual and auditory discrimination (Spence, 1996), but to assess memory functions (Morrow, 1993) and processing speed as a predictor of later cognitive functioning (Fagan, 1984).

Novelty Preference Literature

Extensive research has been conducted on information processing in infancy. The following paragraphs provide a brief literature review of relevant findings. This review concentrates on novelty preference, one of the more widely investigated phenomena in the field of infancy (Caron, Caron, Minichiello, Weiss, & Friedman, 1977; Rose, Gottfried, Carminar, & Bridger, 1982; Spence, 1996), and in turn provides the background from which the current research focus was originally formulated.

Thus far, ample research has shown that novelty is extremely powerful in attracting infants' visual attention (Weizmann, Cohen & Pratt, 1971; Colombo & Bundy, 1983; Richards, 1997). For example, Fantz (1964) presented photographs to 6-month-old infants. One of the photographs (varied among the subjects) was presented for 10 successive 1-minute trials. In each trial, this photograph was paired with one of the remaining 10 photographs in random order. During the initial trials, the infants fixated equally to the paired photographs. However, as trials progressed, the infants demonstrated a decrease in looking time to the constant (familiar) photograph and an increase in fixation to the novel. Similarly, Weizmann et al. (1971) familiarized 3-month-old infants to one of two mobiles for a period of four weeks. Mothers were instructed to familiarize the infant with the mobile for 30 minutes a day, during a time when the infant was alert and content. After this familiarization period, infants' visual fixation was measured toward both mobiles (familiar and novel). Results indicated that infants' fixation time was significantly longer for the novel mobile than for the familiar.

A great deal of literature illustrates the robustness of novelty preference in infancy (e.g., Colombo & Bundy, 1983; Hunter & Ames, 1988; Richards, 1997; Weizmann et al., 1971). The general findings stemming from this area, whether dealing with visual or auditory paradigms, show that infants beyond 2 months of age exhibit a reliable preference for the novel stimuli, whereas infants younger than 2 months of age prefer familiar (Fantz, 1964;Weizmann, et al., 1971; Hunter & Ames, 1988). In highlighting the nature of infant information processing, Hunt (1963) initially proposed a two-stage developmental sequence of visual preference. He declared that infants younger than 2 months have the tendency to prefer the familiar stimulus, whereas infants older than 2 months display a preference for the novel stimulus. Hunt (1963) hypothesized that this sequential preference is directly related to the developing ability of object recognition. More specifically, he declared that younger infants are attracted to objects that they can recognize (i.e., familiar objects), whereas such recognition ability is commonplace with older infants and no longer serves as a basis for attraction. Therefore, according to Hunt (1963), 2 months marks the transitional age at which most infants begin to focus their attention to novel stimuli.

A more recent study conducted by Rose, Gottfried, Carminar, and Bridger (1982) demonstrated that the apparent age distinction proposed by Hunt (1963) in relation to stimulus preference is not qualitatively based. In other words, it does not appear to be related to changes in memory processes, but rather it seems to depend on amount of familiarization. In their first experiment, 3½ -, 4½ -, and 6½ -month-old infants were tested for visual recognition memory of shapes using the paired comparison paradigm. Results indicated that the 3½-month-old infants showed a familiarity preference, whereas the 6½-month-old infants showed a novelty preference when each received the same amount of familiarization. In the second experiment, Rose et al. (1982) gave the 3½-month-old infants more familiarization time and the 6½-month-olds less. Here the younger infants showed novelty preference, and the older infants showed familiarity preference. These findings demonstrate that age differences appear to depend on the amount of familiarization required and not on a developmental shift in preference. This is important because understanding the novelty preference phenomenon adds to our understanding of infant information processing and the nature of their memory capacity. Consequently, theories of infant information processing have been refined to include the significance of processing speed in predicting infants' behavioral preferences.

Novelty Preference Versus Conditioned Value

In a recent experiment, Najm-Briscoe, Thomas, and Overton (2000) demonstrated novelty preference using simple auditory stimuli (experiment 1). In this investigation, 5-month-old infants were familiarized with a neutral tone on the first day. On the second day, their behavioral preference between the familiar tone (heard on the first day) and a novel tone (never heard before) was measured. Results indicated a modest but statistically significant novelty preference which corresponds with the established general findings. In contrast, the data from experiment 2 in Najm-Briscoe et al. (2000) provided a different response profile that seemed to contradict the established novelty preference findings.

In this experiment, Najm-Briscoe et al. (2000) investigated the impact of the value of novelty against the associated value of a conditioned stimulus on infants' behavioral preference. A classical conditioning procedure was employed in order to manipulate infants' behavioral preference in relation to the auditory stimuli. A picture of the face of each infant's mother was employed as the unconditioned stimulus (UCS), and a tone was used as the conditioned stimulus (CS). The procedure was as follows: The infants were seated in a car seat about 1 meter away from a computer monitor on which a picture of mother's face could be displayed. A speaker was located on either side of the monitor from which the tones were presented. The infants were randomly assigned to three groups. In the experimental group, a neutral tone was administered from the speakers immediately prior to the onset of mother's face. In the non-contiguous control group, the infants received the same stimuli as in the experimental group but with a random presentation. In the tone-only control group, infants were presented with the tone alone over trials.

Following this familiarization procedure, a posttest was conducted to measure infants' visual preference between the tone presented over trials (now familiar) and a novel tone. Results indicated that in the tone-only control group, infants showed a significant preference for the novel tone, whereas in the non-contiguous control group, novelty preference did not reach significance. However, in the experimental group, the presentation of mother's face during familiarization significantly shifted the infants' attention to the familiar tone. It appears that in the experimental group, the value associated with mother's face was conferred onto the associated tone. The familiar tone with its associated value predominated and attracted preferential looking away from the novel tone, consequently overriding novelty preference. These results demonstrate that behavioral manipulation of infants' visual preference for the familiar and the novel stimuli is possible through stimulus association.

Multifactor Model Versus Conditioned Value

From the infancy research that has been generated thus far, several models have been developed to attempt to highlight the nature of infant's processing ability. Among those models is the multifactor model of Hunter and Ames (1988) which has been utilized as the theoretical framework of most infant recognition memory research (Rose & Orlian, 1991; Wentworth & Haith, 1992; Streri & Molina, 1993; Spence, 1996; Bahrick, Hernandez-Reif, & Pickens, 1997; Courage & Howe, 1998). According to this model, exploratory behavior is first predicted to increase to a new stimulus and then to decrease as the stimulus becomes familiar due to repeated presentations. Therefore, a decrement in response to a stimulus is predicted as a function of repeated exposure. More importantly, the multifactor model highlights the amount of familiarization as the central factor behind infant visual attention. Therefore, inadequate familiarization will lead to a preference for the familiar stimulus due to lack of habituation to that stimulus (reflecting an early phase of processing), whereas adequate familiarization will lead to a preference for a novel stimulus (reflecting a more advanced phase of processing). In summary, this model asserts that the nature of infant information processing in relation to recognition memory consists of a systematic and orderly progression from familiarity preference to novelty preference as a function of familiarization time. This familiarity-to-novelty progression seems to be critical for adaptation purposes where the subject ensures sufficient attention to any given stimulus before releasing his attention to process other stimuli (Roder, Bushnell, & Sasseville, 2000).

Numerous infant studies using various procedures and various stimuli have generated findings that support the theoretical basis of the multifactor model (Fantz, 1964; Caron et al., 1977; Rose et al., 1982; Spence, 1996). It has been repeatedly demonstrated that once a stimulus becomes familiar, it loses its value and the infant ends up fixating a novel stimulus. According to Cohen, Gelber and Lazar (1971), the degree and magnitude of infant fixation to a novel stimulus depends on the degree of stimulus novelty. For example, when a novel stimulus differs only in one dimension (e.g., color) from the familiar stimulus, less recovery is produced to the novel stimulus due to stimulus generalization (Saayman, Ames, and Moffett, 1964). Moreover, several factors, such as the amount of familiarization, stimulus complexity and delay between familiarization and test have been identified to influence the degree and magnitude of infant preference and the results generated from investigations of these factors are congruent with the theoretical framework of the multifactor model (Rose et al., 1982; Bahrick & Pickens, 1995; Caron & Caron, 1968). Contrary to existing findings, the research generated from experiment 2 in Najm-Briscoe et al. (2000) demonstrated that the theoretical basis of the model is perhaps in need of expansion. More specifically, results indicated that infant stimulus preference can also be influenced by the "conditioned value" factor for which the theoretical framework of the multifactor model can not account. It was demonstrated that the impact of the value factor seems to surpass the influence of stimulus experience or amount of familiarization, that is regardless of the familiar nature of the stimulus, the reinforcing value of a stimulus seems to play a significant role in capturing infant visual attention.

It appears that the reinforcing value of a stimulus (achieved through associative processes) seems to have a greater effect on infant information processing than the intrinsic novelty value. Therefore, Najm-Briscoe et al. (2000) demonstrated that the conditioned value factor is one way of eliciting greater visual attention from infants. One thing to note is that this finding is not only important in helping us understand the nature of infant information processing, but according to Olsen (1976, cited in Rose, 1980) early abilities in visual recognition memory may reflect developmentally enduring characteristics of information processing in humans. Thus, finding ways to capture infants' visual attention early on in development may have notable effects on enhancing the significance of stored information later on in life.

Nature and Significance of the study

As described above, while testing 5-month-old infants, Najm-Briscoe et al.

(2000) demonstrated a preference for the conditioned familiar tone as a product of stimulus conditioning. However, it is not clear whether the value of mother's face or a mere presence of a visual stimulus influenced infants' visual fixation toward the familiar tone. The primary purpose of the proposed study is to 1) replicate the results generated by Najm-Briscoe et al. (2000), 2) to determine whether the hedonic value of mother's face and not the presence of any visual event (regardless of its hedonic value) was the influential factor in overriding novelty preference, and 3) to test the influence of the conditioned value factor in the presence of a neutral familiar stimulus as well as a novel stimulus. Consequently, this approach will provide information that will enable us to explain the underlying nature of the findings generated by Najm-Briscoe et al. (2000).

A classical conditioning paradigm was implemented in the present study using a within-subject design in contrast to a between-subject design used by Najm-Briscoe et al. (2000). Forty-eight 5-month-old infants were randomly assigned to 4 different group conditions: two experimental groups consisting of the conditioned-familiar group (E-conditioned-familiar) and the conditioned-novel group (E-conditioned-novel), and two control groups consisting of the conditioned-familiar group (C-conditioned-familiar) and the conditioned-novel group (C-conditioned-novel) (12 infants per condition). For all group conditions, infants first received a familiarization phase followed immediately by a testing phase. Within the familiarization phase (across all 4 groups), the infants received two neutral tones (e.g., 300 Hz and 700 Hz) via headphones. One of these tones (e.g., 300 Hz) was presented over trials in association with a picture that appeared on a computer screen (CS+ or conditioned familiar), while the other tone (i.e., 700 Hz) was presented repeatedly without any association (CS- or neutral familiar). The picture in the experimental conditions consisted of the face of each infant's mother (the primary reinforcer), and the picture in the control conditions consisted of a black geometric square (the neutral visual stimulus).

During the testing phase, there was no direct measurement of the conditioned response (e.g., the emotional reaction to mother's face). Instead, what was of interest was to determine how the conditioned response influenced infants' visual fixation toward the auditory stimuli. Therefore, the infants in the E-conditioned-familiar group and the C-conditioned-familiar group received the presentation of the conditioned familiar tone and the neutral familiar tone, whereas the infants in the E-conditioned-novel group and the C-conditioned-novel group received the presentation of the conditioned familiar tone and a novel tone.

In Najm-Briscoe et al. (2000), a fixed-trial procedure was used where the tone presentation during the testing session was automatically provided regardless of infants' viewing behavior. However, in this study, an infant-control procedure was implemented where the presentation of the tones was dependent on infants' looking behavior toward two identical visual targets. More specifically, when the infant looked at one target, a tone was presented (e.g., 300 Hz), and when the infant looked at the other target, a different tone was presented (e.g., 700 Hz). The visual targets consisted of a toy rabbit wrapped in Christmas lights; one rabbit was located 45 degrees to the left of the infant, and the other rabbit was located 45 degrees to the right of the infant. Tones were not presented when neither target was visually fixated. Total looking time toward each visual target was recorded and measured in order to determine infants' behavioral preference to each tone by means of their visual fixation.

Hypotheses and Predictions

It was hypothesized that as a result of stimulus conditioning, greater visual fixation would be found toward the tone that was associated with mother's face in contrast to the tone that was associated with the geometric square. More specifically, the value of mother's face will in turn endow the associated tone with a reinforcing quality that is lacking in the geometric square, thus promoting longer visual fixation toward that tone. Furthermore, the reinforcing value of the associated tone in the E-conditioned-familiar group and the E-conditioned-novel group will promote longer visual fixation toward that tone in the presence of the novel tone and the neutral familiar tone, respectively. However, with repeated presentation, the conditioned tone in the C-conditioned-familiar group and the C-conditioned-novel group will become familiar without any reinforcing value due to the neutral nature of the geometric square. Consequently, there will be no significant difference in visual fixation between the conditioned tone and the neutral familiar tone in the C-conditioned-familiar group, however the visual fixations for the infants who received the presentation of the conditioned familiar tone and a novel tone in the C-conditioned-novel group will yield novelty preference.

Principal Components of the Study

As mentioned above, the behavioral preference for a novel stimulus has been repeatedly documented in infancy research. The focus of the current study was to override such a preference by means of associative processes thus replicating and highlighting the nature of the results generated by Najm-Briscoe et al. (2000). In the following paragraphs, a detailed description of the components that constituted the framework of the study is provided. This literature review concentrated on 1) the significance of implementing classical conditioning paradigms in infancy research, 2) the significance of the "value" factor in infant recognition memory, 3) the significance of the mother's face as a primary reinforcer, and 4) the advantages of the infant-control procedure over the fixed-trial procedure.

Classical and Instrumental Conditioning

The scientific pursuit of understanding infant behavior and development has been based on a wide range of research approaches. The classical conditioning approach has been very significant in particular mainly because classical conditioning has been documented as a major means by which all types of organisms, including humans, adapt and learn the structures of their environment. Therefore, classical conditioning paradigms are important in nature because they provide the scientific field with the opportunity to investigate infants' earliest associations. Unfortunately, certain biases about the stimulus-response perspectives that defines behavior as a product of learned contingencies are still being held today by those who have not yet recognized the advances generated by this method of investigation. According to Carolyn Rovee-Collier (1986) classical conditioning is one of the most powerful experimental tools that we have thus far and should be implemented in more laboratories. It allows us to seek advanced knowledge not only about infants' sensation and perception, and infants' neurological development and function, but more importantly, it allows us to assess infants' learning ability and early behavioral development. Rovee-

Collier (1986) proposed that the significance in knowing such information is based on the nature of our basic cognitive abilities which remain invariant throughout development. What changes developmentally are the contents of what is learned and how learning is expressed. In other words, the underlying mechanism in which information is acquired does not change ontogenetically and classical conditioning procedures are used to reveal the nature of such learning mechanisms.

Existing research indicates that classical conditioning is readily achievable in infancy (Brackbill & Koltsova, 1967). The type of conditioning, whether appetitive or aversive, depends on the nature of the unconditioned stimulus (or UCS). In appetitive conditioning, the UCS is positive and valuable to the subject, whereas in aversive conditioning, the UCS is negative to the subject. According to Brackbill and Koltsova (1967), aversive UCSs tend to increase the probability of pseudoconditioning in infancy and are not very effective in generating conditioned responses. More specifically, aversive stimuli tend to elicit a general defense reaction or an arousal level that in turn hinders the infant's ability to discriminate. The appetitive conditioning procedure is more effective in promoting stimulus discrimination. Therefore, when dealing with infancy research, the UCS seems to be an important component of classical conditioning.

In a pioneering study, Papousek (1961, as cited in Rovee-Collier, 1986) investigated the impact of appetitive conditioning on the behavior of newborn infants. Initially, the newborns received a squirt of milk following a reflexive rooting response (i.e., turning the head to the left or to the right side). When Papousek conditioned the rooting response to a buzzer or a tone, the newborns became efficient in making the appropriate ipsilateral response to the auditory cue. As a result of stimulus conditioning, the infants were able to act on the predictive information that was supplied by these auditory stimuli that normally do not predict feeding. Therefore, Papousek demonstrated how organisms, in particular newborn infants, come to learn the predictive relations between environmental events which in turn shape their behavior.

The significance of appetitive conditioning in shaping infants' behavioral preference was further demonstrated by Lu (1967). In this study, Fantz's (1964) perceptual measure was applied as an assessment of classical conditioning utilizing a red light as the conditioned stimulus and food as the unconditioned stimulus. Initially, Fantz (1963) reported that the color red was not highly preferred by 2-month-old infants as measured by infants' visual fixation to different plain-colored surfaces. Lu (1967) further investigated whether the infants' initial preference for the red color can be made more significant by means of appetitive conditioning. During the conditioning trials, the infant was fed by the mother who was wearing a red blouse, and who was instructed that during every feeding period to use a red light bulb on the lamp that was placed beside the baby. Thus, with each onset of the red light which stayed on for 15 s, food was introduced and then the light was off for 10 seconds as soon as the food was completely consumed. There were 50 pairings in each session for eight sessions. Results indicated that during the posttest, infants visually fixated the color red second in comparison to fourth in the pretest. This suggests that the conditioning paradigm used in this study was successful in endowing the color red a positive value that in turn influenced the infant's preference.

In another study, Silverstein (1972) used a conditioning paradigm with a tone as the discriminative stimulus and food as the primary reinforcer. In this study, 10-month-old infants were taught to spatially discriminate between geometric figures. In the conditioning phase, upon touching the appropriate target, infants received a presentation of a tone (T+) for 3 sec followed by Froot Loops cereal as reinforcement. The pairing of T+ and the cereal was presented on a fixed interval 23-sec reinforcement schedule during which the infants received the presentation of another tone (T-) with no reinforcement. The T- tone was randomly presented once for 3 sec during each 20 sec intertrial interval. In the testing phase, touching one of the two new targets produced the T+ for 3 sec and touching the other target produced the T- for 3 sec. Results indicated that infants responded significantly more to the T+ than the T-, thus demonstrating a secondary reinforcement effect. A secondary reinforcer is " a stimulus that enhances the level of a preceding response (beyond that of an appropriate control stimulus) because of its prior contingent presentation with a primary reinforcer" (Silverstein, 1974, p. 323).

For the current experiment, an analogous procedure to the one used by Silverstein, 1972) was employed. During the conditioning phase, infants who were assigned to the experimental conditions received a tone (T+) that was presented in association with a picture of mother's face (primary reinforcer), and another tone (T-) that was presented without any association. The idea was to endow the T+ with similar influential properties as those associated with the mother's face, thus making the tone a secondary reinforcer. Consequently, infants' stimulus preference for that tone should be enhanced. In contrast, infants who were assigned to the control conditions received a picture of a geometric square, a neutral stimulus that theoretically should not endow any influential properties onto the associated tone. Therefore with repeated presentation, the tone should become familiar without any conditioned reinforcement and consequently should not influence infants' auditory preference.

The "Value" Factor

In the majority of the existing studies that assess information processing ability in infancy, a stimulus is usually presented for a number of trials and then a new stimulus is introduced. Typically, the infant's response to the repeatedly exposed stimulus declines or habituates over trials. However the response magnitude returns to its original level at the onset of a new stimulus presentation. Habituation to the repeated stimulus represents a loss of significance and interest toward that specific stimulus, in other words, the stimulus is interpreted as neutral and familiar. According to Sokolov's neurocognitive model of the orienting response (1963), when an organism detects a new stimulus in the environment, the organism begins to form a representation of that stimulus. As orientation continues, certain characteristics of the stimulus are extracted and stored. With continued presentation of that stimulus, this schema will eventually reflect an accurate and complete representation of that stimulus. Not until that representation is completely formed does a stimulus become familiar, thus losing its significance to maintain attention.

According to Malcuit, Bastien, and Pomerleau (1996), most researchers have implicitly relied on the theoretical foundation of Sokolov's model (which shares the theoretical framework of the multifactor model) to predict outcomes of infant behavioral preferences. However, most have disregarded other factors that may sustain infants' attention toward a stimulus despite repeated presentations. For example, only a few researchers have considered the "value" factor in their investigations of infant visual attention. The value factor refers to 1) the affective properties of the stimulus, 2) the reinforcing properties of the stimulus, 3) the meaningfulness of the stimulus and 4) individual's preference for a stimulus. Stimulus complexity and age of the subjects have been documented as factors influencing attention toward a stimulus (i.e., a younger subject takes longer to process a complex stimulus thus giving more attention to that stimulus (Caron & Caron, 1968)). However the functional value of a stimulus has been generally overlooked in such investigations despite Sokolov's effort in highlighting the influence of the "signal stimulus" on the orienting response (i.e., stimulus significance will promote orientation longer than a neutral stimulus).

When investigating infant behavioral preference, there are two types of processes that need to be taken into consideration when assessing infant attention, 1) the attention-getting process that occurs when the subject's attention is triggered and 2) the attention-holding process that occurs when the subject's attention is maintained (Cohen, 1972). The attention-holding process is the process that is directly influenced by the nature and the quality of the stimulus. Any type of stimulus can trigger a subject's attention. However a stimulus that maintains attention is considered to be significant or more interesting to look at than any other event in the immediate setting. In relation to the impact of the value factor, maintained attention to a functional but familiar stimulus may not automatically reflect an incomplete schema construction or insufficient familiarization of that stimulus as implied by Sokolov's model and multifactor model. Rather, maintained attention may reflect sustained interest due to the value of that stimulus despite its familiar nature. Therefore, Malcuit et al. (1996) asserted that the quality, or what we would call value, of a stimulus needs to be taken into consideration when assessing infant information processing.

The impact of stimulus quality, in this case stimulus preference, on infants' rate of habituation and rehabituation was initially investigated by Shoemaker and Fagen (1984). Four-month-old infants were randomly assigned to four different groups, two experimental groups and two control groups. The two experimental groups further consisted of the preferred group and the non-preferred group that were defined by the order of the stimulus presentation. More specifically, the stimuli consisted of a red bullseye (the preferred stimulus), blue horizontal stripes (the non-preferred stimulus) and a checkerboard. In the preferred group, infants initially received two trials of the checkerboard stimulus and then were familiarized with the bullseye (the preferred stimulus) stimulus until they reached the habituation criterion. Next, they were presented with the blue horizontal stripes (the non-preferred stimulus) until they reached the habituation criterion, followed by two trials of the checkerboard stimulus. The procedure for the non-preferred group was similar except that the infants in this group were familiarized with the blue horizontal stripes first until habituation took place followed by the presentation of the bullseye stimulus. The two trials of the checkerboard presentation were included at the beginning and at the end of each session in order to control for any startle effect and fatigue. In one of the control groups, infants initially received 2 trials of the checkerboard stimulus and then were familiarized with the bullseye stimulus until the habituation criterion was met. Next, they were presented with the same bullseye stimulus over trials, followed by the two trials of the checkerboard presentation. In the other control group, the same procedure was applied as in the first control group, however infants were familiarized and habituated to the blue horizontal stripe stimulus, and then were presented with that same stimulus over trials. The two control groups were included in order to insure that the habituation procedure was effective in reducing infants' visual fixation to a repeated stimulus. More specifically, by presenting the same stimulus over trials after the habituation criterion was met, infants visual fixation to that stimulus should remain low and should not recover over trials. For clarification, the experimental design for the preferred, the non-preferred and the two control groups is presented in Table 1.

Results indicated that in relation to the preferred and non-preferred experimental groups, infants who were familiarized with the preferred stimulus spent more time fixating the stimulus and required more trials to habituate to that stimulus, compared to the infants who were familiarized with the non-preferred stimulus. Furthermore, subjects in the preferred group demonstrated a minimal recovery of looking time when exposed to the novel but non-preferred stimulus, and in turn took less time to habituate to that stimulus. In contrast, subjects who initially were habituated to the non-preferred stimulus took less time to habituate to that stimulus and when exposed to the novel but preferred stimulus, they took longer to habituate to that stimulus. These results demonstrate the importance of equating stimulus preference especially when comparisons across stimuli are made in order to assess infant recognition memory. But more importantly, these

Table 1

Experimental Design

Group	Warm-up (2 trials)	Habituation	Recovery and Rehabituation	Warm-up (2 trials)
Control 1	Checkerboard	Bullseye	Bullseye	Checkerboard
Control 2	Checkerboard	Stripes	Stripes	Checkerboard
Preferred	Checkerboard	Bullseye	Stripes	Checkerboard
Non-preferred	Checkerboard	Stripes	Bullseye	Checkerboard

findings demonstrate that when a stimulus is of a certain value to an infant, in this case a preferred stimulus, it will promote and sustain attention longer than a neutral stimulus despite the amount of familiarization.

As mentioned earlier, the value factor refers to various stimulus properties. The impact of such properties on infants' orienting responses was investigated by manipulating the value of the stimulus into two different functions, eliciting and signaling (Malcuit et al., 1996). The focus of the study was " to isolate the several functional values an attention-getting stimulus may possess or acquire and to determine the differential effect of these functional values on the stimulus effectiveness to elicit orienting responses in infants" (Malcuit et al., 1996, p. 273). The authors posited that a neutral stimulus will trigger an infant's attention (visual exploration), however such attention might be triggered in a different way, or for a longer period of time if that stimulus had some relative value that is significant to the infant. In the "eliciting" condition, a checkerboard pattern was presented for two seconds at a time with an inter-stimulus interval of 10 seconds. In the "eliciting-signaling" condition, a checkerboard pattern was presented for two seconds and at the same time, a cartoon film was projected 45 degrees from the location of the checkerboard pattern.

Results indicated that there was a significant decrease of head-turning toward the checkerboard in the eliciting condition, however there was no such response habituation in the eliciting-signaling condition. Instead, a continued orientation was found toward the checkerboard pattern that signaled the onset of the cartoon film. This continued orientation was interpreted to mean that the infants learned the association between the presentation of that stimulus (the checkerboard) and an attractive visual event (the cartoon film). Therefore, the checkerboard in the eliciting-signaling condition gained a value which made it more meaningful to the infant, maintaining infant visual attention despite its familiar nature.

In another study, the "affective value" of a stimulus was investigated using 7-month-old infants (Nachman, Stern & Best, 1986). The infants sat on their mothers' lap facing a small theater designed with left and right windows; hand puppets (a rabbit and a frog) were presented in those windows. The pretest consisted of two 15-second trials. For example, on the first trial, the rabbit puppet appeared in the left window and on the second trial, the rabbit puppet appeared in the right window. Results indicated that during the pretest, infants looked equally at both puppets. Shortly after the pretest, one of two familiarization procedures was used for each infant. In the first procedure (experimental group), a rousing method, which consisted of disappearance and reappearance of one of the puppets behind the screen, was implemented to elicit a smile. In the second procedure (control group), a neutral method was implemented where one puppet would sway horizontally across the window span and was always in sight. Both the rabbit and the frog puppets were randomly assigned to these two familiarization conditions.

After the familiarization period, a posttest was conducted where the infants were shown the two puppets in the theater exactly as in the pretest. Results indicated that infants who were assigned to the control group and responded neutrally to the familiarization puppet (again take the rabbit as an example) focused their attention more on the less familiar puppet (in this example the frog more than the rabbit). Infants who were assigned to the experimental group and who responded with positive affect towards the familiarization puppet (e.g., the rabbit) focused their attention more on that puppet (the rabbit). These findings demonstrate that the rabbit that generated the positive affect became a much more interesting stimulus to the infants than the frog that did not provide any direct reinforcement. Consequently, the affective value of a stimulus seems to be a critical factor in capturing infants' attention.

The above mentioned studies demonstrated that infant recognition memory is influenced not only by the familiar and novel nature of a stimulus, but more importantly by stimulus significance. The whole concept of the value factor focuses on increasing the significance of a stimulus despite its familiar nature. As mentioned earlier, the infant's response to the repeatedly exposed stimulus declines or habituates over trials reflecting a loss of interest toward that specific stimulus. The value factor maintains that interest by providing the subject with direct reinforcement. For the present study, mother's face was used as the unconditioned stimulus in a classical conditioning paradigm. The purpose was to manipulate infant information processing by associating a neutral tone with the value of mother's face thus making that tone more significant despite its repeated presentation. This associated value was then used to elicit infants' attention despite the presence of novelty.

Reinforcing Properties of Faces

There is a great deal of merit behind using mother's face as an unconditioned stimulus in the present study. For example, Bowlby (1960) declared that the initial attachment by the infant to his mother is a result of species-specific behavior patterns. These instinctual-response systems guide the infant to bond with other humans, and later to a particular mother-figure (Bowlby, 1960, as cited in Goslin, 1969). Such significant, individualized attachment occurs between 3 and 6 months of age as a result of repeated interactions.

In addition to its attachment value, the human face contains intriguing and appealing characteristics that are extremely influential in capturing infants' attention. Some theorists advocate that infants may enter the world with a predisposition to respond to faces (Miller, 1984, as cited in Kaplan, Fox and Huckeby, 1992) by simply focusing on the distinctive physical characteristics. Others believe that it is not so much the intrinsic physical features of the face that capture the infant's attention. Rather, such arousing properties are a product of repeated pairings of the face with primary reinforcers (Gewirtz, 1969, as cited in Kaplan et al., 1992). Regardless of the source of the "value" of faces, by 5 months, infants are thought to be able to recognize faces and in turn their behavior is influenced by established associated experiences.

There is an ample amount of research that illustrates that faces in general are arousing stimuli that in turn attract infants' visual attention (Oster, 1981, as cited in Kaplan et al., 1992; Maurer, 1985). Kaplan, et al. (1992) investigated the reinforcing properties of faces by pairing a female face (of various expressions; smiling, surprised, and neutral) with a tone and subsequently tested that tone's ability to increase visual fixation on a checkerboard pattern. Results indicated that the tone that was associated with the smiling and surprised expressions (but not the neutral expression) influenced visual fixation significantly more to the checkerboard than when the checkerboard was presented alone. Therefore, Kaplan demonstrated associative learning in infants and how such learned association influenced visual attention.

Infant-Control Procedure

In most of the existing studies, the fixed-length-trial procedure has been used to investigate infants' information processing (Kaplan et al., 1992; Cohen et al., 1971). In this procedure, the length of the familiarization as well as testing trials is fixed, that is the stimulus is exposed for fixed durations regardless of the infant's viewing behavior. In 1972, Horowitz, Paden, Bhana and Self noticed that there was a disadvantage using the fixed-length-trial procedure because at the end of the trial, some infants were still fixating the stimulus. They concluded that the fixed-length-trial procedure is not sensitive enough to assess the absolute nature of infant recognition memory. Due to individual differences, a two-minute trial may be long enough for one infant to meet the habituation criterion, however such a fixed period of time may not be enough for another. Consequently, the infant may undergo the familiarization session without being properly habituated to the familiar stimulus. As a solution, they proposed a new procedure to measure infant visual fixation, they called it the infant-control procedure. In the infant-control procedure, the infant's behavior controls the initiation of the trial as well as the trial length. More specifically, a trial starts with the infant looking at the stimulus and ends when the infant looks away from the stimulus. Therefore, the infant determines when and for how long to view the stimulus which makes this procedure a more sensitive method of investigation.

In order to assess the effectiveness of the fixed-trial procedure against the effectiveness of the infant-control procedure, Millar and Weir (1995) conducted an experimental comparison. Six- to 13-month-old infants were randomly assigned to two different groups, the infant-control group and the fixed-trial group. In the fixed-trial group, subjects received seven trials (20 s each trial,10 s intertrial intervals) of two visual stimuli consisting of pictures of females' smiling faces projected on a screen. On the first six trials, one stimulus was presented repeatedly (habituation phase) followed by the new stimulus on the seventh trial. Once the infant fixated the screen, the seven trials were presented automatically and infant's visual fixation and duration toward the stimuli was measured. In the infant-control group, the familiarization procedure was initiated with the infant's first fixation of the stimulus, the stimulus remained on as long as the infant was looking at it, and off when the infant looked away. There was no set number of trials this familiarization session, however once the established response decrement criterion was met, the novel stimulus was then presented. The aim of this study was to contrast response decrement and recovery across the two procedures. To make such comparison possible, the data of the fixed-trial group was rescored according to the infant-control set of criteria.

Results indicated that the two procedures yielded significantly different response profiles. More specifically, the subjects in the infant-control procedure looked longer and looked more at the stimulus during the habituating phase in comparison to the infants in the fixed-trial group whose visual fixations were curtailed by the automatic stimulus presentation. More importantly, the response to the novel stimulus was much greater for the subjects in the infant-control group suggesting that a more consolidated representation of the familiarized stimulus was possible using the infant-control procedure.

In measuring infants' auditory selectivity to novel and familiar stimuli, Colombo and Bundy, (1983) implemented a variation of the infant-control procedure. In this study, 4-month-old infants underwent a familiarization and a testing phase. During the familiarization phase, the infants sat in a cart wearing earphones and facing two identical visual targets. The visual target consisted of 16 red lights mounted in a plywood window about 40 cm apart. As soon as the earphones were in place, half of the infants were familiarized with an auditory stimulus over 6 trials, whereas the other half received a presentation of an auditory stimulus over 20 trials (the visual targets were not on during the familiarization phase).

At the end of the familiarization phase, the testing phase began where the infants were presented with the auditory stimulus that they heard over trials along with a novel one. In this phase, the visual targets were lit and the presentation of the auditory stimuli was contingent upon the infant fixating to either target. The familiar stimulus was presented upon infants' fixation to one target, and the novel stimulus was presented upon infants' fixation to the other target. Therefore, the presentation of the auditory stimuli were under the control of the subject. Any difference in fixation time to the visual targets was assumed to signify stimulus discrimination between the auditory stimuli as well as a stimulus preference for one over the other. However, the testing trials were of limited duration and consisted of two 2-minute trials, thus there was no pre-established criterion to meet that would indicate the end of a trial.

Results indicate that infants across both the 6- and 20-presentation familiarization conditions revealed novelty preference, however there were no differences between the two conditions. The Colombo and Bundy (1983) study is significant to the present investigation not only because it highlights novelty as an important determinant of auditory attention, but also because it has demonstrated the effectiveness of the infant-control procedure in measuring infant behavioral preference which is identical to the procedure used in the present study (i.e., two 2-minute test trials).

CHAPTER II

Method

Participants. The original sample consisted of 53 infants who were recruited from birth announcements published in the local newspaper. Only healthy infants 150$\pm$14 days of age with no known history of auditory system or neurological problems were accepted to participate. Data from five of the subjects were discarded due to excessive fussiness yielding a final sample of 48 infants (12 infants in every group). A large majority of the infants were from middle-class, Euro-American families. Infants were given toys as a compensation for their participation.

Materials. All infants sat in their mothers' laps facing a wooden panel. The panel (4 feet X 6 feet) was designed with a left, a right and a center window located at the same height as the infant's eye level and about 2 feet away. Rabbit dolls wrapped in Christmas lights were placed behind the window's sliding doors 45 degrees to the left and right of the infant's eyes, and the screen of a 17 inch computer monitor was fully displayed in the center window. Four inches above the computer monitor, a camera lens was displayed through a circular opening in the panel. Between the camera and the computer monitor, a 25-watt light bulb was attached to the front of the panel fully visible to the infant (see Figure 1).

The testing room, in which the panel was displayed, was adjacent to the control room from where the experiment was run. In the control room, the

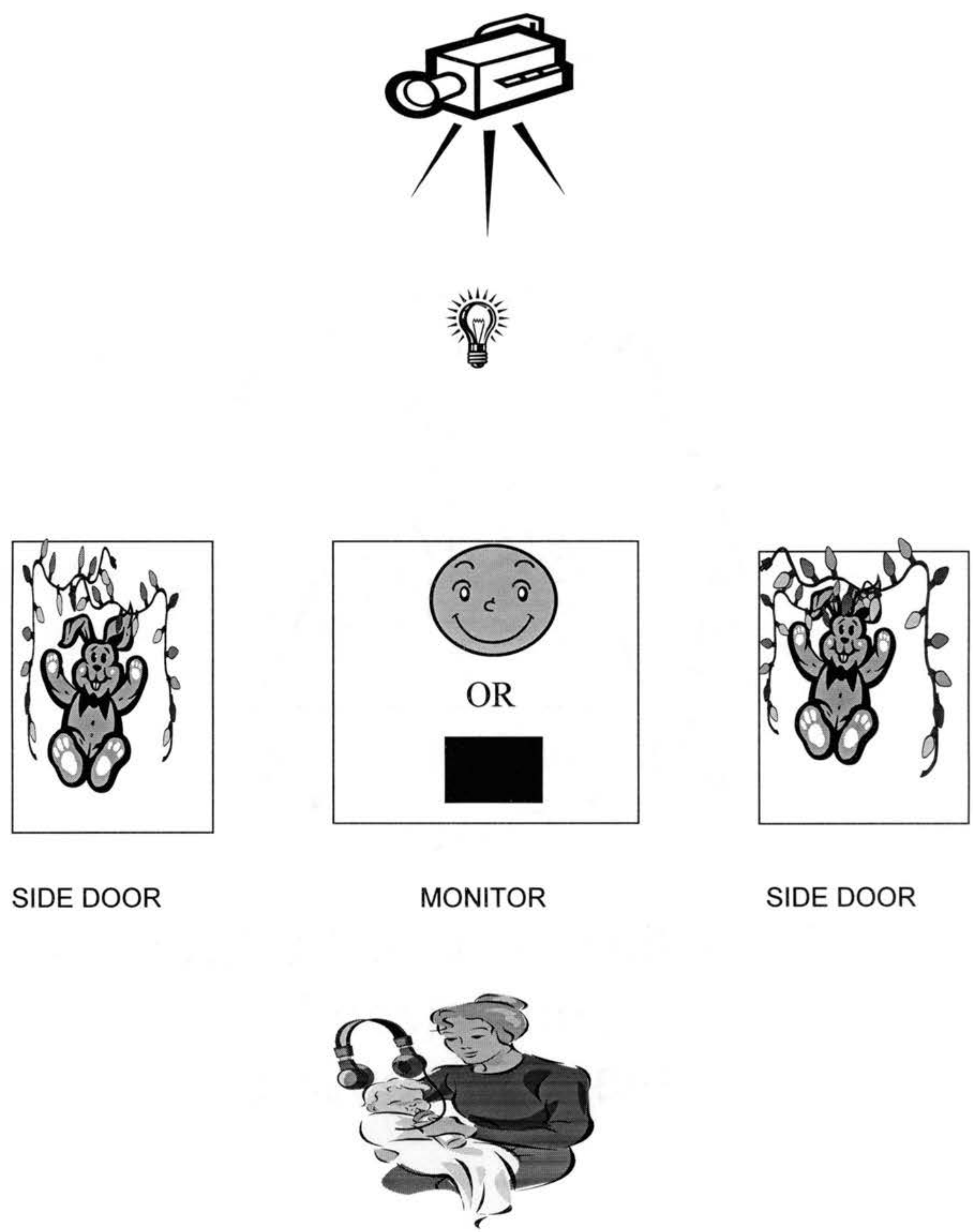

Figure 1. A diagram of the apparatus that was used across all groups during the familiarization session as well as during the test trials.

work station included two computers (a main computer and a slave computer) along with two monitors, a VCR and a small television where the infant's looking behavior was monitored and recorded.

Stimuli. Auditory and visual stimuli were used in this study. The auditory stimuli consisted of three different pure tones, 300 Hz, 700 Hz, and 1100 Hz. The tones (100 ms duration, 70 dB sound pressure level [spl]) were generated by a personal computer and were presented to the infant via Realistic headphones that were fitted with an elastic strap. The visual stimuli (1500 ms duration) which consisted of the smiling face of each infant's mother and of a black geometric square were displayed on a computer monitor. The face was displayed from the neck up about 8 inches in height, and the sides of the black square consisted of 7.25 inches. Both visual stimuli were presented on a white background. A digital camera was used to photograph each mother's smiling face.

Design. A within-subject design was implemented in this study. Forty-eight infants were subjected to a classical conditioning procedure and were randomly assigned to four groups, two experimental and two controls (each group consisted of 12 infants). Infants across all four groups received a familiarization session followed immediately by a testing session. Within the familiarization session, the infants received the presentation of two tones of different frequencies that varied across subjects. One of the two tones (e.g., 300 Hz) was presented immediately prior to the onset of a visual stimulus to attempt to establish stimulus association between a neutral tone and a visual stimulus. The other tone (e.g., 700 Hz) was presented over trials without any subsequent visual stimulus. In the experimental conditions, the visual stimulus consisted of the picture of mother's smiling face, whereas in the control conditions, the visual stimulus consisted of the picture of a black square. The interstimulus interval (ISI) (tone onset to picture onset) was 100ms across all conditions with 0 s between offset of the CS (tone) and onset of the UCS (picture). The intertrial interval (ITI, tone onset to tone onset) varied across trials for all subjects however it consisted of a minimum of 3 s. The tone was administered only upon infants' fixation toward the monitor following the minimum 3 s ITI. Every subject received a total of 50 trials, 25 trials of tone-picture combination (e.g., 300 Hz followed by a picture) and 25 trials of tone alone (e.g., 700 Hz).

During the testing session, infants across all groups received two tones. The first consisted of the tone that was associated with the visual stimulus (either mother's face or the black square, i.e., the conditioned familiar) whereas the second either consisted of the tone that was presented over trials without association (i.e., the neutral familiar tone) or a novel tone. Therefore, in relation to the two experimental groups, one group received the presentation of the conditioned familiar tone that was associated with mother's face and the neutral familiar tone (E-conditioned-familiar), whereas the other experimental group received the presentation of the conditioned familiar tone and a novel tone (E-conditioned-novel). The same method was applied to the two control groups only using the conditioned tone that was associated with the black square. Therefore, one control group consisted of the conditioned-familiar group (C-conditioned-familiar) and the other control group consisted of the conditioned-novel group (C-conditioned-novel).

Procedure. Upon arrival, informed consent was obtained and the mother and the baby were brought to a room where the digital camera was set up to photograph the mother's face for experimental conditions. In order to maintain the same procedure in all groups, all mothers and infants retired to the camera room for 5 minutes before the initiation of the experiment. After the picture session, the mother and the infant were taken to the testing room where the infant was placed on mother's lap 2 feet away from and facing a wooden panel. At this time, the headphones were placed on the infant's head, the computer monitor that was located in the center window of the panel was made visible to the infant (by removing the cover) and the toy rabbits were hidden behind the sliding doors. Subsequently, the lights in the room were dimmed, the door to the testing room was closed to minimize distractions and the experimenter proceeded to the control room to run the experiment.

In the control room, the visual stimuli (a picture of mother's face or a picture of a black square) were downloaded on the slave computer and displayed on the linked monitor. The monitor that was located in the testing room was also linked to the slave computer thus displaying the same image as the one in the control room. Thus, the visual presentations that the infant received were also viewed by the experimenter in the control room. The tone presentations were emitted from the main computer where the number and the nature of the trial were displayed on the linked monitor. More specifically, if the trial number was highlighted in red, then the trial involved stimulus conditioning and the infant received the presentation of a tone followed by the presentation of a visual stimulus (either mother's face or the black square). If the trial number was not highlighted in red, then the infant received the presentation of the tone alone.

To initiate the familiarization session, the experimenter flashed the light bulb that was attached to the panel in order to fixate the infant's attention toward the center. As soon as the infant's attention was captured, the blinking stopped and a light bulb that was placed behind the infant was flashed to indicate the beginning of the session. Subsequently, the experimenter proceeded with the presentation of the trials administering both a tone and a picture during a conditioning trial, and a tone alone during a neutral trial. All infants were subjected to stimulus conditioning, however the nature of the conditioning (whether the visual stimulus consisted of mother's face or the black square) depended on the group (experimental or control) that the infants were assigned to. A total of 50 trials were presented for every subject, 25 trials involved stimulus conditioning and 25 trials involved the presentation of the tone alone.

After the administration of the last familiarization trial, the light bulb that was located behind the infant was flashed to indicate the end of the session. Subsequently, the experimenter proceeded into the testing room to prepare for the testing session by covering up the computer monitor and by opening the side doors making the toy rabbits visible to the infant. The testing session consisted of two 2-minute trials where the infants received the presentation of the same two tones for both trials. Across all infants, one of the two tones consisted of the conditioned tone and the other varied across conditions (sometimes novel and sometimes neutral familiar). More specifically, two groups (E-conditioned-novel group and the C-conditioned-novel group) received the presentation of the conditioned tone and a novel tone, whereas the remaining two groups (E-conditioned-familiar group and the C-conditioned-familiar group) received the presentation of the conditioned tone and the neutral familiar tone. Stimulus preference for either tone was measured indirectly by infants' amount of looking time toward each toy rabbit.

To capture the infant's attention and initiate the first 2-minute test trial, the light bulb on the panel was flashed for the infant to visually fixate ahead. As soon as the infant fixated the bulb, the blinking stopped and two guidance trials were administered. More specifically, the Xmas lights on the left rabbit were lit to attract the infant's attention toward that rabbit. Once the infant fixated the rabbit, two trials of a tone (e.g., the conditioned familiar, 300 Hz) were presented associating that rabbit with the tone. At the end of the two guidance trials, the Xmas lights on the left rabbit were turned off and the Xmas lights on the right rabbit were lit. As soon as the infant fixated the rabbit, two trials of a different tone (e.g., a novel tone, 700 Hz) were presented associating that rabbit with the tone. At the end of the two trials, the Xmas lights on the right rabbit were turned off and infant's attention was once again focused straight ahead by flashing the light bulb located on the panel. Once the infant fixated the bulb, the blinking stopped, the bulb that was located behind the infant was flashed to indicate the beginning of the first test trial (2-minute duration) and the Xmas lights on both the left rabbit and the right rabbit were lit.

An infant-control procedure was implemented where the presentation of either tone (the 300 Hz or the 700 Hz) was dependent on infants' looking behavior toward the two rabbits. More specifically, when the infant looked at the left rabbit, the tone that was given during the guidance trial (in this case 300 Hz) was repeatedly administered at a rate of 2 tones per second as long as the infant was looking at the rabbit. When the infant looked away from the left rabbit, the presentation of the tone was stopped. However, if the infant fixated the left rabbit again, the tone presentation was resumed. Once the infant fixated the right rabbit, the tone that was given during the guidance trial (in this case 700 Hz) was repeatedly administered at a rate of 2 tones per second for as long as the infant was looking at the rabbit. Again, once the infant looked away from the right rabbit, the presentation of the tone was stopped and resumed again upon the infant's fixation toward that rabbit. The tone presentation was not provided when neither target was visually fixated. The testing trials were timed by a stopwatch and at the end of the 2-minute time duration, the light bulb that was located behind the infant was flashed indicating the end of a trial and the lights to both rabbits were turned off.

To initiate the second 2-minute trial, the light bulb on the panel was flashed periodically in order to get the infant to focus ahead. Subsequently, the same infant control procedure was implemented during the second trial as was used in the first trial except that the guidance trials were reversed and the tones were counterbalanced. More specifically, the Xmas lights on the right rabbit were lit first and when the infant fixated the rabbit, two trials of the conditioned tone (300 Hz) were presented associating that tone with the rabbit. Subsequently, the Xmas lights on the left rabbit were lit and once the infant fixated the rabbit, two trials of the novel tone (700 Hz) were presented associating that tone with the left rabbit. Across both 2-minute test trials, infants' visual fixation toward the left rabbit and the right rabbit were recorded and later measured by a team of blind scorers.

Data Scoring. The scoring team consisted of two assistants viewing the tapes of the recorded sessions and timing infants' visual fixation (in sec) towards the left and the right rabbits (using a stopwatch). For example, one member of the team focused on the left half of the television screen thus timing the infant's looking time towards the right rabbit (on both trials), and the other member focused on the right half of the television screen thus measuring the infant's looking time towards the left rabbit (on both trials). Even though the experiment was videotaped, the tones that were administered during the familiarization and testing trials were not recorded. In order to direct the scorers of when to start and when to stop measuring infant's looking time towards the speakers, a light bulb was placed behind the infant; when the bulb was lit, that indicated the onset of a trial session and when the bulb was off, that indicated the end of the session.

The team collected four data points per infant: how much the infant looked toward the tone that was associated with the left rabbit and how much the infant looked toward the tone that was associated with the right rabbit during the first and second trials. These measures were then converted from left and right fixations to fixations toward the conditioned familiar tone (i.e., the reinforced tone), the neutral familiar tone or the novel tone depending on the assigned group. For example, if infants in one group received the conditioned tone plus a neutral familiar tone during the testing session, then two of the four data points would consist of infants' visual fixations toward the conditioned familiar tone and the remaining two data points would consist of infants' visual fixations toward the neutral familiar tone in each of the two trials. However, if the infants in a group received the presentation of a conditioned familiar tone and a novel tone, then two of the four data points would consist of infants' visual fixations toward the conditioned familiar tone and the remaining two data points would consist of infants' visual fixations toward the novel tone.

In some of the data analyses, the proportion or percent of looking time and not the amount of visual fixation was used as the dependent measure. Therefore, the visual fixation that was measured in seconds toward each tone, for example the reinforced tone, was then converted to a reinforced quotient. The reinforced quotient (RQ) is the percent of total looking time spent fixating the reinforced tone and is calculated as:

[time fixating the reinforced tone] / [time fixating the reinforced tone
+ time fixating the non-reinforced tone]

Due to the nature of the procedure, a second team of assistants was not needed to establish scoring reliability. At the end of the test trials, the computer automatically printed out a data sheet for every subject indicating how many tones were given to the left rabbit and how many tones were given right rabbit on the first and the second test trials. Since the stimulus presentation was based on two tones per second, the number of tones was divided by half yielding the amount of looking time toward each rabbit across both trials. This calculated measure was then compared to the data reported by the assistants to test for reliability. The interrater reliability for the four data cells (2 trials) X 2(sides) averaged $\underline{r}$= +.998 and ranged from +.97 to +.99. The scores that were reported by the assistants were used in the data analyses and the calculated scores generated by the computer were used as reliability checks.

Results

It was hypothesized that a greater visual fixation will be found toward the tone that was associated with mother's face in contrast to the tone that was associated with the geometric square. More specifically, the value of mother's face should endow the associated tone with a reinforcing quality that is lacking in the geometric square, thus promoting longer visual fixation toward that tone. Since a directional a priori hypothesis had been generated, the influence of such a value was assessed by planned-comparisons for the E-conditioned-familiar group versus the C-conditioned-familiar group, $t(22) = .047$, $p = .481$ (see Figure 2 and Table 2), and for the E-conditioned-novel group versus the C-conditioned-novel group, $t(22) = -1.569$, $p = .065$ (see Figure 3 and Table 3) using total looking time for the reinforced tone. Although the results were not significant for either comparison, the data did reveal that the infants looked longer toward the reinforced tone in both the C-conditioned-familiar group and the C-conditioned-novel group (i.e., the tone associated with the picture of the black square) thus reflecting an opposing response profile than the one originally predicted.

Another paired comparison was carried out on the E-conditioned-novel group versus the C-conditioned-novel group using total looking time for the non-reinforced stimulus (in this case, the novel tone). This analysis was conducted in order to determine whether there was a significant difference in the way infants responded to the novel tone in the presence of the tone that was associated with mother's face (E-conditioned-novel group) versus the tone that was associated with the black square. Although the results indicated non-significance between the two groups, $t(22) = -.616$, $p = .272$, the difference that did exist revealed more

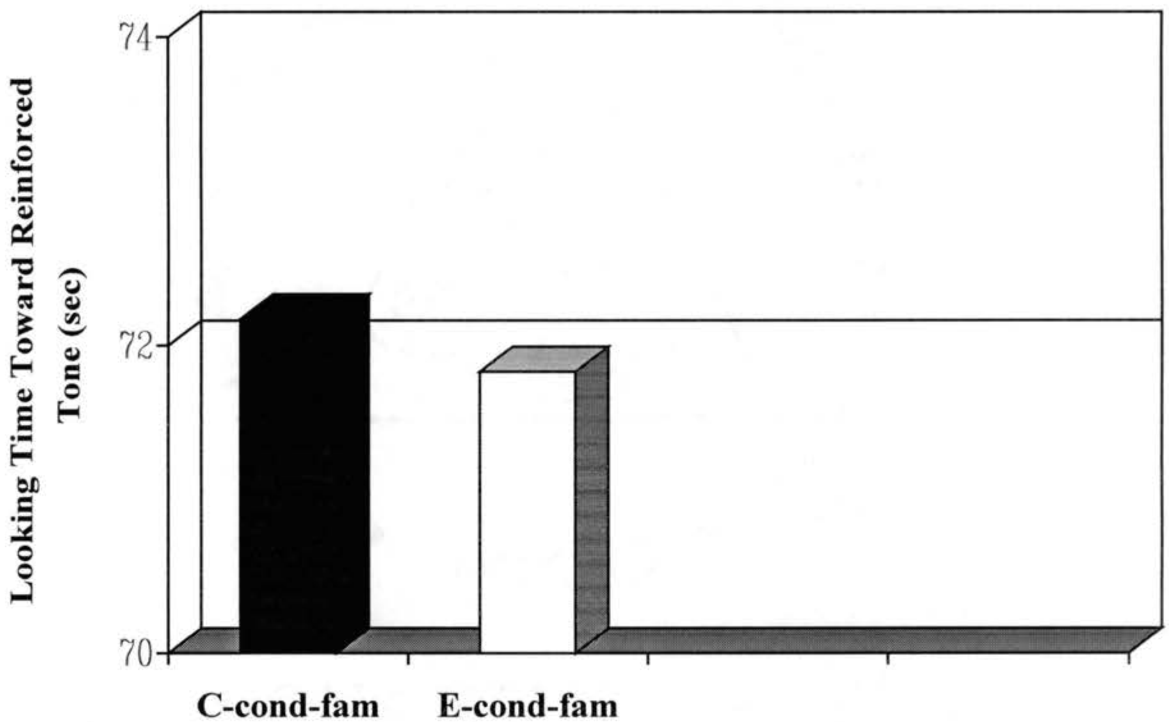

Figure 2. Total looking time toward the conditioned familiar tone (reinforced tone) for the C-conditioned-familiar group versus the E-conditioned-familiar group.

Table 2
One-Tailed t-test

Looking time-reinforced tone

E-conditioned-familiar group
versus
C-conditioned-familiar group

Variable	Number of Cases	Mean	SD	SE of Mean
E-conditioned-familiar	12	72.17	20.58	5.94
C-conditioned-familiar	12	71.83	13.19	3.81

t-value	df	1-Tail Sig.
.047	22	.963/2 = .481

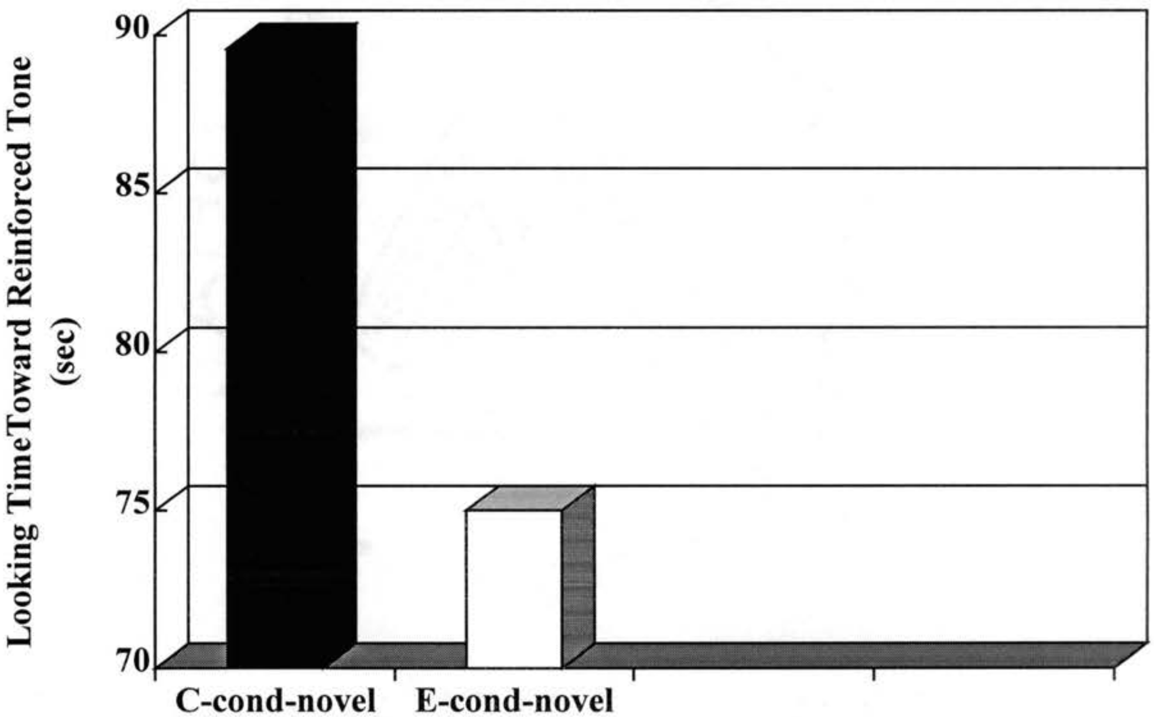

Figure 3. Total looking time toward the conditioned familiar tone (reinforced) for the C-conditioned-novel group versus the E-conditioned-novel group.

Table 3
One-Tailed t-test

Looking time- reinforced tone

E-conditioned-novel group
versus
C-conditioned-novel group

Variable	Number of Cases	Mean	SD	SE of Mean
E-conditioned-novel	12	75.00	21.98	6.34
C-conditioned-novel	12	89.58	23.51	6.79

t-value	df	1-Tail Sig.
-1.569	22	.131/2 = .065

looking time toward the novel tone in the E-conditioned-novel group versus the C-conditioned-novel group (see Figure 4 and Table 4), again reflecting an opposing response profile than the one originally predicted.

With four group conditions (a=4), the degrees of freedom associated with the treatment source of variance (df_A = a-1) is (4-1)= 3. Since the number of the planned comparisons (i.e., 3 comparisons) did not exceed the df_A =3, the significance level of .05 was maintained for all 3 comparisons. Therefore a Bonferroni correction was not necessary (Keppel, 1991).

It was further hypothesized that the reinforcing value of the associated tone in the experimental groups should promote longer visual fixation toward that tone in the presence of the novel and the neutral familiar tones. However with repeated presentation, the conditioned tone in the control groups will become familiar without any reinforcing value due to the neutral nature of the associated geometric square. Consequently, there will be no difference in visual fixation between the conditioned tone and the neutral familiar tone. However the infants who received the presentation of the conditioned familiar tone and a novel tone should yield a novelty preference. Due to the dependent nature of the tones that were given in the test trials (i.e., if the infant is fixating one tone, he will not be able to fixate the other), the proportion of looking time for the reinforced tone (reinforced quotient (RQ)) across all groups was calculated and examined against 50% (chance) in order to assess the above stated predictions. The highest percent of looking time toward the reinforced tone was 53% (SEM= .02) for infants in the C-conditioned-novel group, followed by 49% (SEM)=.02 for the infants in the E-conditioned-familiar group, 47% (SEM= .04) for infants in the

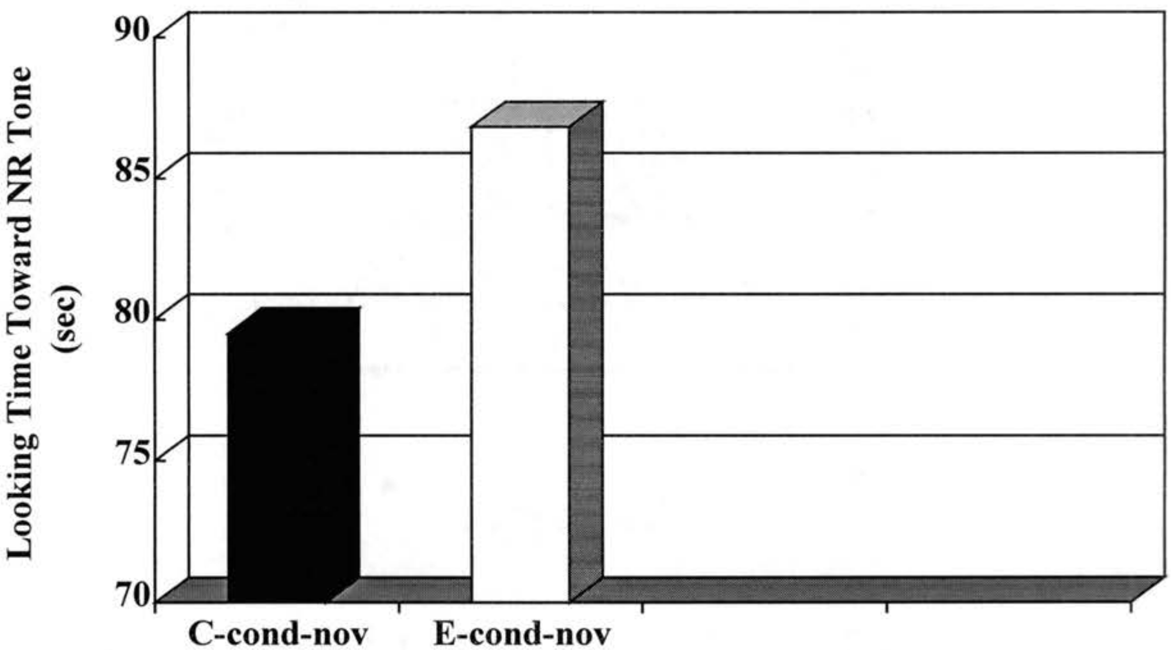

Figure 4. Total looking time toward the non-reinforced novel tone for the C-conditioned-novel group versus the E-conditioned-novel group.

Table 4
One-Tailed t-test

Looking time- non-reinforced tone

E-conditioned-novel group
Versus
C-conditioned-novel group

Variable	Number of Cases	Mean	SD	SE of Mean
E-conditioned-novel	12	86.83	32.83	9.48
C-conditioned-novel	12	79.50	24.93	7.20

t-value	df	1-Tail Sig.
-.616	22	.544/2 = .272

E-conditioned-familiar, and 47% (SEM=.04) for the E-conditioned-novel group (see figure 5). A 1-tailed t-test carried out on the RQ and calculated against 50% revealed a lack of significant difference for the RQ across all groups, $t(11) = 1.224$, $p = .123$ for C-conditioned-novel group (see Table 5), $t(11) = -.231$, $p = .410$ for the infants in the E-conditioned-familiar group (see Table 6), $t(11) = -.764$, $p = .230$ for the C-conditioned-familiar group (see Table 7), and $t(11) = -.677$, $p = .256$ for the infants in the E-conditioned-novel group (see Table 8).

In order to assess the impact of the reinforcing stimulus (i.e., the visual stimulus) on infants' behavioral preference, the group factor was divided into two levels (instead of four levels) consisting of experimental versus control. More specifically, the infants in the experimental groups received the presentation of mother's face, while the infants in the control groups received the presentation of the black square. Furthermore, there were two levels of tone condition consisting of the 1) conditioned familiar and neutral familiar (F+/F) tone combination and the 2) conditioned familiar and the novel (F+/N) tone combination. More specifically, the infants either received the F+/F test trial condition or the F+/N test trial condition. Therefore, a 2(group) X 2(condition) X 2(trial) repeated measure analysis of variance (ANOVA) was carried out on the total looking time for the reinforced tone. Results indicated a significant main effect for trial, $F(1,44) = 7.368$, $p = .009$ (see Figure 6 and Table 9). This effect showed that the infants tended to look in the direction of the reinforced tone progressively less from Trial 1 to Trial 2. Although this analysis did not indicate a group main effect, $F(1, 44) = 1.365$, $p = .208$, the difference that did exist reflected more looking time toward the tones that were associated with the black square, a

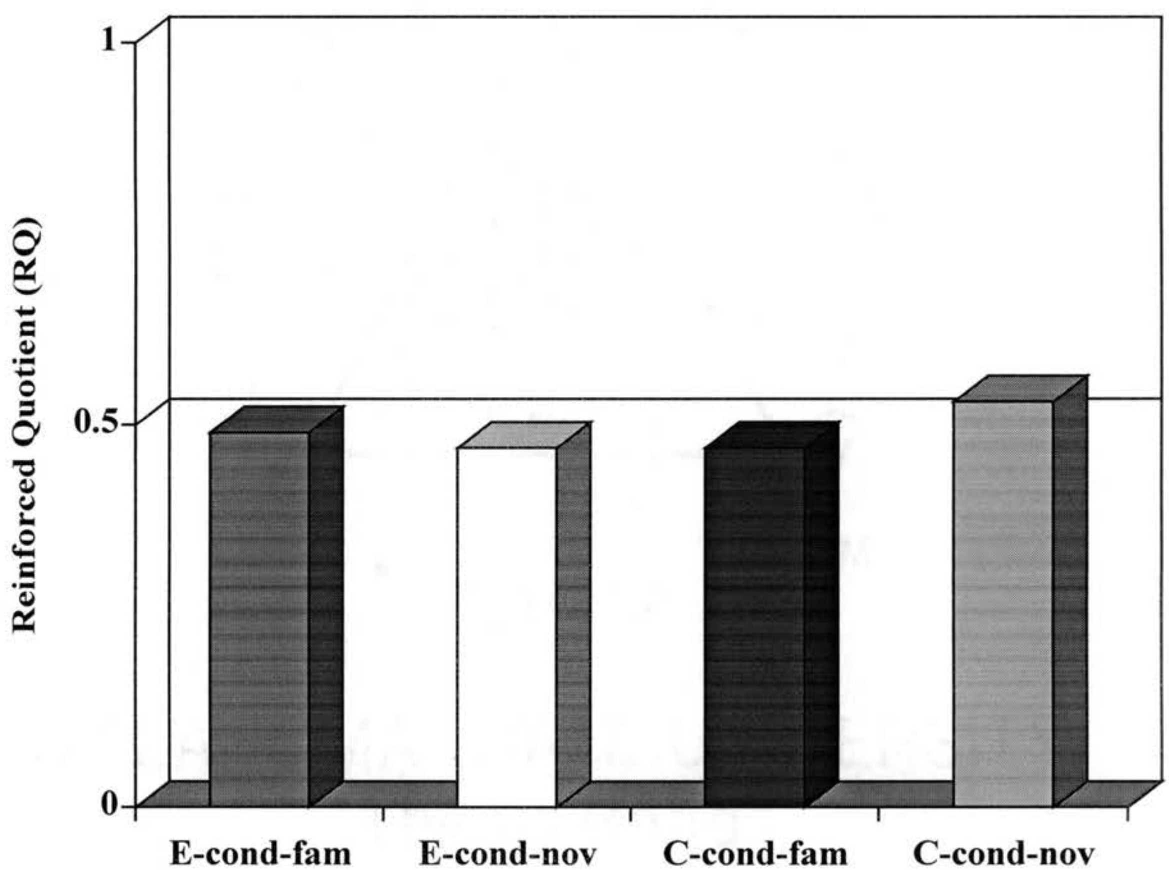

Figure 5. Reinforced quotient (RQ) for all four groups. The horizontal line at .50 represents the border between reinforced versus non-reinforced preference .

Table 5
One-Tailed t-test
Percent: conditioned tone against 50%

C-conditioned-novel group

Variable	Number of Cases	Mean	SD	SE of Mean
Tone +Square	12	.5322	.09	.02

t-value	df	1-Tail Sig.
-1.224	11	.246/2 = .123

Table 6
One-Tailed t-test
Percent: conditioned tone against 50%

E-conditioned-familiar group

Variable	Number of Cases	Mean	SD	SE of Mean
Tone + Face	12	.4935	.09	.02

t-value	df	1-Tail Sig.
-.231	11	.821/2 = .410

Table 7
One-Tailed t-test
Percent: conditioned tone against 50%

C-conditioned-familiar group

Variable	Number of Cases	Mean	SD	SE of Mean
Tone + Square	12	.4676	.15	.04

t-value	df	1-Tail Sig.
-.764	11	.461/2 = .230

Table 8
One-Tailed t-test
Percent: conditioned tone against 50%

E-conditioned-novel group

Variable	Number of Cases	Mean	SD	SE of Mean
Tone + Face	12	.4727	.14	.04

t-value	df	1-Tail Sig.
-.677	11	.512/2 = .256

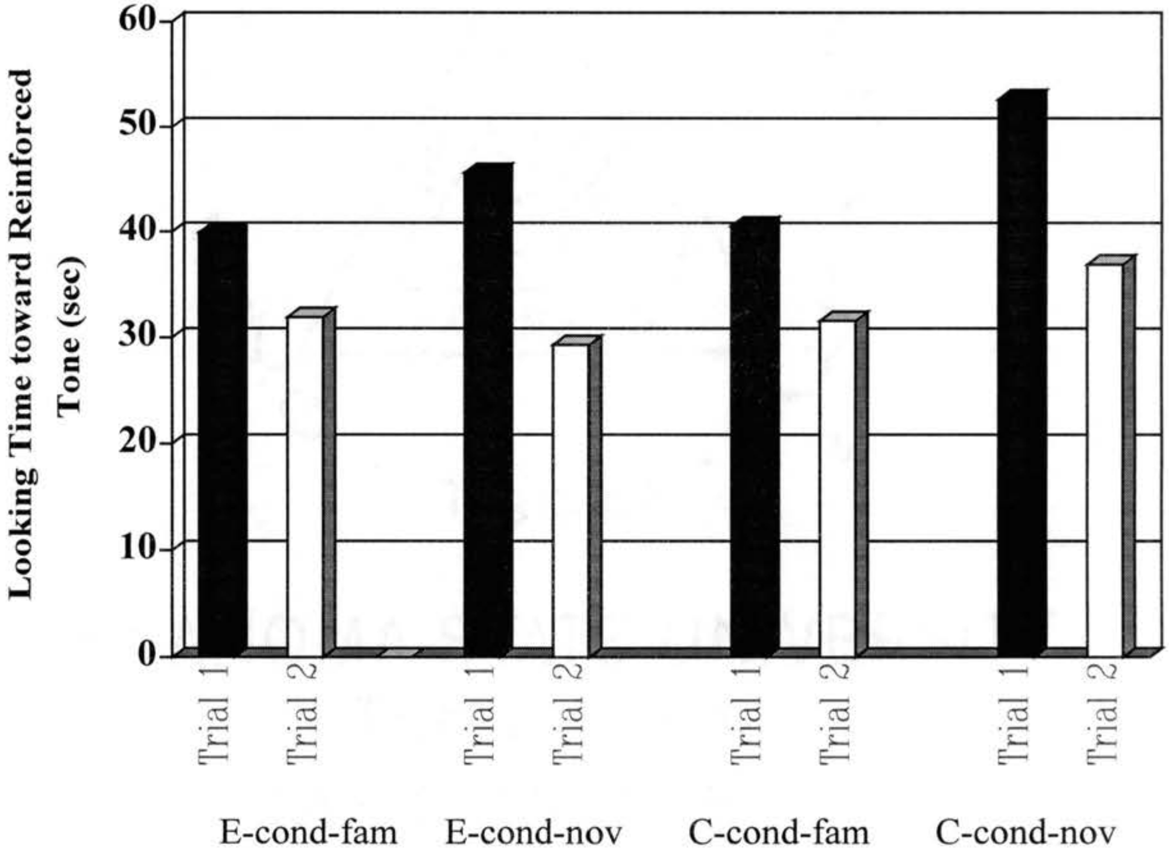

Figure 6. Total looking time toward reinforced tone as a function of group and trial.

Table 9
Repeated Measure ANOVA

Group X Condition X Trial
(Looking time- reinforced tone)

Source	df	SS	MS	F	p
Between Subjects					
Within+Residual	44	8984.125	204.185		
Group	1	333.760	333.760	1.635	.208
Condition	1	635.510	635.510	3.112	.085
Group X Condition	1	304.594	304.594	1.492	.228
Within Subjects					
Within+Residual	44	21580.458	490.465		
Trial	1	3613.760	3613.760	**7.368**	**.009**
Trial X Group	1	.260	.260	.001	.982
Trial X Condition	1	341.260	341.260	.696	.409
Trial X Group X condition	1	3.760	3.760	.008	.931

mean of 161.74 versus the tones that were associated with mother's face, a mean of 146.84 (see Figure 7). This analysis further indicated that the condition factor approached significance, F(1,44)= 1.492, p=.085, reflecting that the infants looked more at the reinforced stimulus during the F+/N test trial conditions, a mean of 164.59 versus the F+/F conditions, a mean of 144 (see Figure 8)

A 2(group) X 2(condition) X 2(trial) repeated measure ANOVA was also carried out on the total looking time for the non-reinforced tone. Results indicated a significant main effect for trial, F(1,44) = 6.939, p= .012 (see Figure 9 and Table 10). This effect showed that the infants tended to look in the direction of the non-reinforced tone progressively less from Trial 1 to Trial 2. There were no other main effects or interactions.

A 2(group) X 2(condition) X 2(trial) repeated measure ANOVA was carried out on the percentage of looking time toward the reinforced stimulus. Results indicated a lack of significant main effect for group, F(1,44) = .062, p = .805, for condition, F(1,44) = 2.73, p= .604, or for trial, F(1,44) = .011, p= .916 (see Figure 10 and Table 11).

From a scientific point of view, the current findings suggest that the implemented experimental manipulations were not effective in establishing stimulus conditioning. Nevertheless, it is important to note that all of the assumptions for conducting an analysis of variance (ANOVA) were met. For example, the distributions were fairly normal considering the limited number of subjects, the subjects were randomly assigned to all four groups thus ensuring independence, and the variance across all four groups was determined to be similar in nature by the F-max test, F(1,46) = 3.379, p = .072 for the reinforced

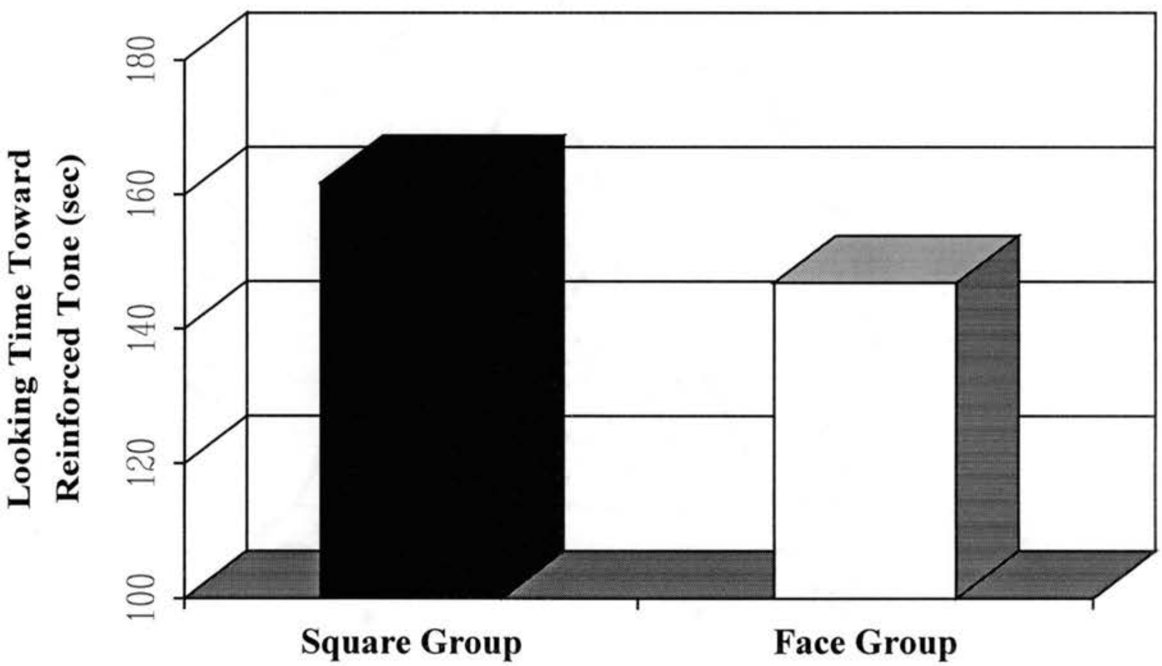

Figure 7. Total looking time toward the tones that were associated with the black square (i.e., in the C-conditioned-familiar group and the C-conditioned-novel group) versus the tones that were associated with mother's face (i.e., in the E-conditioned-familiar group and the E-conditioned-novel group).

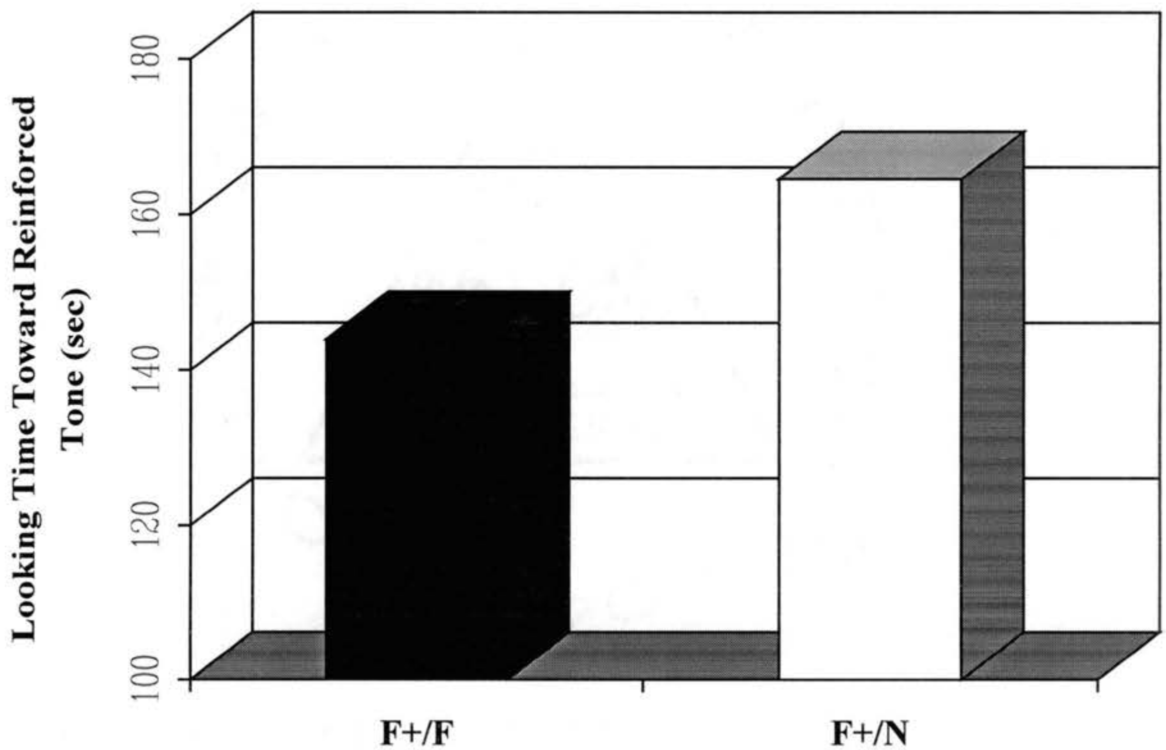

Figure 8. Total looking time toward the reinforced tones in the F+/F condition versus the F+/N condition.

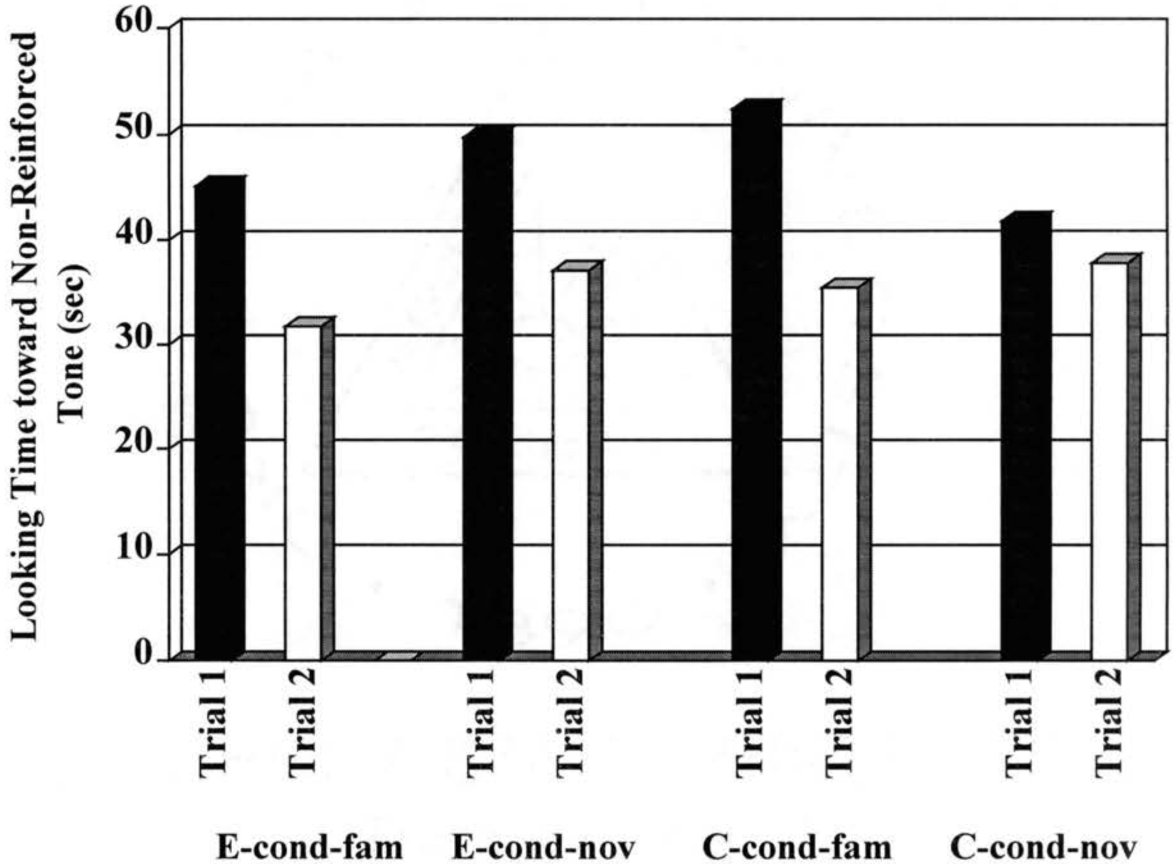

Figure 9. Total looking time toward non-reinforced tone as a function of group and trial.

Table 10
Repeated Measure ANOVA

Group X Condition X Trial
(Looking time- non-reinforced tone)

Source	df	SS	MS	F	p
Between Subjects					
Within+Residual	44	22024.198	500.550		
Group	1	19.711	19.711	.039	.844
Condition	1	3.961	3.961	.008	.930
Group X Condition	1	501.878	501.878	1.003	.322
Within Subjects					
Within+Residual	44	21048.615	478.378		
Trial	1	3319.378	3319.378	**6.939**	**.012**
Trial X Group	1	38.12	38.12	.080	.779
Trial X Condition	1	281.878	281.878	.589	.447
Trial X Group X condition	1	226.628	226.628	.474	.495

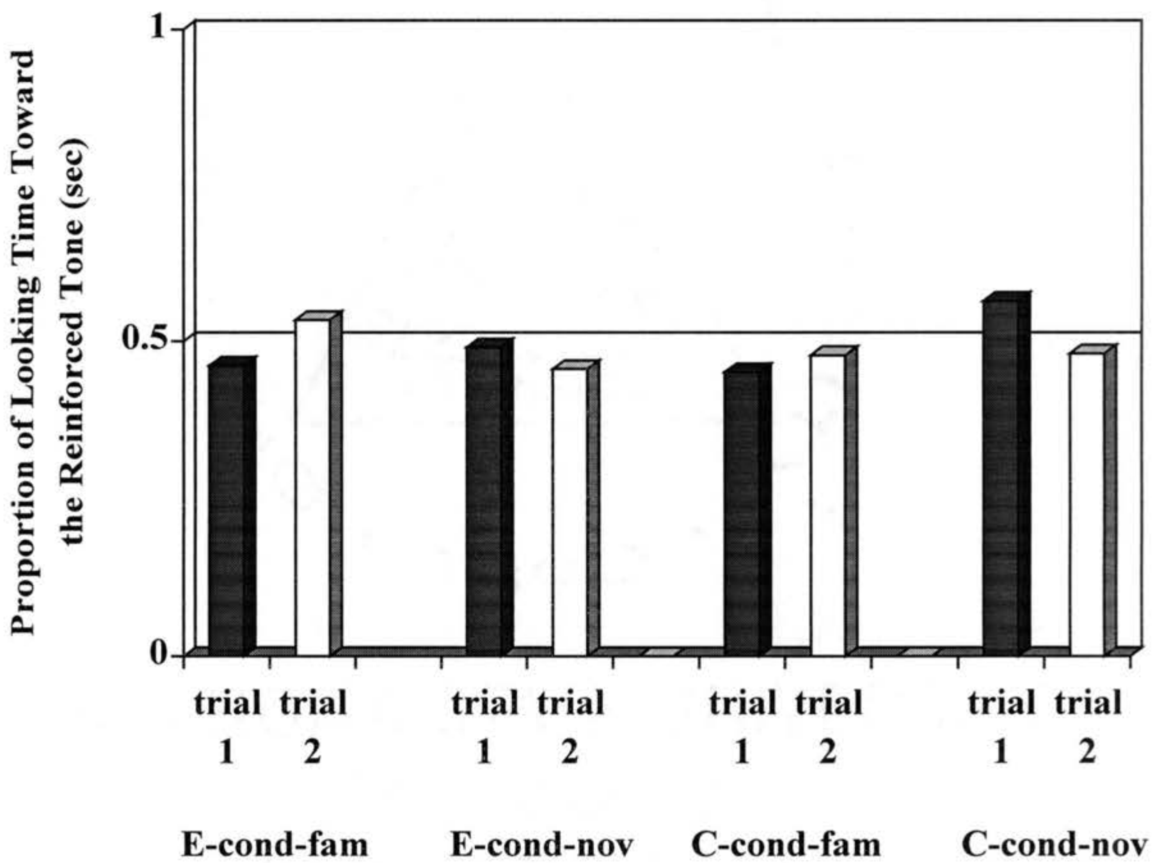

Figure 10. Proportion of looking time toward the reinforced tone across groups, trials and conditions.

Table 11
Repeated Measure ANOVA

Group X Condition X Trial
(Proportion of Looking time- reinforced tone)

Source	df	SS	MS	F	p
Between Subjects					
Within+Residual	44	1.119	.02542		
Group	1	.001570	.001570	.062	.805
Condition	1	.006930	.006930	.273	.604
Group X Condition	1	.04165	.04165	1.638	.207
Within Subjects					
Within+Residual	44	2.398	.05449		
Trial	1	.0006157	.0006157	.011	.916
Trial X Group	1	.01363	.01363	.250	.619
Trial X Condition	1	.07184	.07184	1.318	.257
Trial X Group X condition	1	.000019	.00001985	.000	.985

stimulus across groups, and the F-max test, $\underline{F}$ (1,46)= .033, $\underline{p}$ = .857 for the non-reinforced stimulus. So, it appears that the distribution of the spread of the scores was consistent from group to group. Furthermore, omega squared was calculated to give us an indication of the effect size across groups. The value for the omega squared yielded ω^2=.019 in comparison to Cohen's (1977) cut-off for a medium effect size of ω^2 = .06 to .14, and a large effect size of ω^2 = .15 or greater. Due to the limited number of subjects used in this study, power was indicated at .152. Therefore, it appears that the effect of the existing experimental manipulations was not strong enough to be detected, especially with such a small number of subjects.

CHAPTER III

GENERAL DISCUSSION

The primary purpose of the proposed study was to replicate the results generated by Najm-Briscoe et al. (2000) and to determine whether the hedonic value of mother's face and not the presence of any visual event (regardless of its hedonic value) was the influential factor in overriding novelty preference. Consequently, this approach was aimed to provide critical information that would in turn explain the underlying nature of the findings generated by Najm-Briscoe et al. (2000). As was mentioned in the introduction, many factors (such as amount of familiarization) can influence infants' information processing. The attempt of the current investigation was to determine whether the conditioned value of a stimulus is indeed another factor that needs to be incorporated into the theoretical framework of infancy research, especially novelty preference.

It was initially hypothesized that stimulus conditioning would take place across all four groups, however the nature of the conditioning would be different in the groups that received a picture of mother's face versus the groups that received a picture of the black square in association with a neutral tone. Consequently, infants' behavioral preference during the testing session would be greater in the presence of the tone that was associated with mother's face due to its conditioned value than in the presence of the tone that was associated with the insignificant black square. Even though the current study applied the same principal of investigation (i.e., conditioned value) and similar auditory and visual stimuli as those used in Najm-Briscoe et al. (2000), the results do not appear to substantiate the findings reported by Najm-Briscoe et al. (2000) nor do they provide any insight about the nature of the visual stimulus (i.e., mother's face versus the black square). Using a within-subject design (in contrast to the between-subject design used by Najm-Briscoe et al. (2000)), no difference was found between the amount of looking time toward the tone presented in association with mother's face versus the tone that was presented in association with the black square. This finding seems to indicate that the nature of the visual stimulus (whether valuable or neutral) did not play a significant part in influencing infant's behavioral preference. However, before accepting this conclusion, it is essential to determine whether or not stimulus conditioning took place between the visual stimulus and the associated tone.

One way to determine whether stimulus conditioning did take place is to assess the pattern of the current findings against a pattern that would be generated in theory. For example, if conditioning did take place and the nature of the visual stimulus is not the significant factor in manipulating infants' attention, then the infants across all four groups should have looked significantly longer toward the conditioned tone (i.e., the tone that was presented in association with the visual stimulus, either mother's face or the black square) in comparison to the neutral familiar tone that was presented without association or the novel tone. However, if stimulus conditioning did not take place, then a different response profile should have been generated. More specifically, in relation to the E-conditioned-familiar group and the C-conditioned-familiar group, infants in each group should have looked equally toward the reinforced tone and the non-reinforced tone mainly because the infants would have received the same amount of stimulus familiarization for both tones without any added value. However, in the E-conditioned-novel group and the C-conditioned-novel group, infants' visual fixation in each group should have been significantly longer toward the novel tone versus the reinforced tone because of the preference for novelty seen in infancy (Caron et al., 1977; Rose, Gottfried et al., 1982; Najm-Briscoe et al., 2000).

The analyses that were conducted on the proportion of looking time for each group generated findings that do not correspond with any of the above predicted response profiles. More specifically, results indicated that there was an equal proportion of looking time toward the reinforced and the non-reinforced tones across all groups. This pattern of findings evidently does not provide any support for the conditioned value hypothesis, nor does it support the predicted outcomes of stimulus conditioning irrespective of the value factor. Furthermore, it does not seem to fully correspond with the response pattern that would be predicted in the absence of stimulus conditioning, that is no novelty preference was found. Therefore, the most plausible explanation of what led to the generated results is stimulus generalization or lack of stimulus discrimination.

During the familiarization session, all subjects were subjected to a within-subject design where each infant received the presentation of two different tones, one tone was reinforced with the presentation of a visual stimulus and the other tone was presented without any reinforcement. It is possible that the infant's cognitive ability may have been taxed while trying to process two auditory tones plus a visual stimulus. The evidence that support the stimulus generalization explanation comes from the fact that novelty preference was not established in the E-conditioned-novel group nor was it established in the C-conditioned-novel group. Considering the potency of novelty preference in the field of infancy, the infants should have focused their attention significantly longer to the novel stimulus across both groups if stimulus discrimination did take place irrespective of stimulus conditioning.

It is important to note that the infants in Najm-Briscoe et al. (2000) were successful in distinguishing between frequencies that were similar to those used in this study. Therefore, the nature of the tones (i.e., whether it is 300 Hz or 700 Hz) may not be the issue that is contributing to lack of stimulus discrimination, rather it may be the nature of the stimulus presentation instead. More specifically, in Najm-Briscoe et al. (2000), a between-subject design was implemented where infants received the presentation of one neutral tone during the familiarization session instead of two neutral tones as was conducted in the current investigation. Consequently, when tested, the infants were able to distinguish the familiarized tone from the novel tone across both the experimental group as well as the control group. In contrast, the current findings reflect that the infants may have had some difficulty discriminating among the tones throughout the within-subject procedure, especially when some infants received three different tones throughout the experiment (i.e., the two tones that they heard during the familiarization session and a novel tone during the testing session).

According to the Dual-Process Theory (Kaplan, Werner & Rudy,1990), differences in fixations between complex and simple patterns are usually observed during between-group comparisons. However this theory asserts that the impact of stimulus complexity will be reduced or even eliminated in a within-subject design where the subject is presented with both stimuli. For example, Bashinski, Werner and Rudy (1985) repeatedly exposed the same group of 4-month-old infants to a simple 4 X 4 and a complex 12 X 12 pattern. Results indicated that there was no differences in fixation of the 4 X 4 and the 12 X 12 pattern in the within-subject group. However, infants' visual fixation for the 4 X 4 pattern in the within-subject design was then compared to the visual fixation generated by infants that were only familiarized with the 4 X 4 pattern. Results indicated that the visual responding to the 4 X 4 pattern in the within-subject condition was greater than responding among subjects tested only with the 4 X 4 pattern. This study suggests that it is not as easy to establish stimulus differentiation in a within-subject design as it is in a between-subject design due to the effect of stimulus sensitization. More specifically, the sensitization that is generated by one stimulus can energize the responding to any stimulus that follows. Therefore, in relation to the current results, the contiguous presentation of the neutral tone along with the visual stimulus could have generated stimulus sensitization that in turn impacted the tones that followed and consequently prevented stimulus discrimination from taking place.

One other factor that may have contributed to a lack of stimulus discrimination in the current results is the infant-control procedure that was implemented during the testing session. In Najm-Briscoe et al. (2000), the tones were presented via two speakers; the familiar tone was presented once per second from one speaker, and the novel tone was presented at the same rate but offset by 0.5 seconds from another speaker. Therefore, during the testing session, the tone presentation was automatic in nature and the infants heard both tones. However, in the current investigation, the presentation of the tones was under the control of the infant where the infant could only hear one tone at a time. Perhaps hearing one tone at a time made it difficult for the infants to distinguish between the different frequencies especially when they did not have any other tone to compare it to.

In assessing the different factors that may have contributed to lack of stimulus conditioning, one needs to also examine the nature of the task that the infants were subjected to. Perhaps the infants in the current study found the task to be aversive while viewing the UCS as negative. According to Brackbill and Koltsova (1967), aversive UCSs are not very effective in generating conditioned responses which could account for the current findings. However, even though the current results reflect lack of stimulus conditioning, a higher rate of subject attrition (more than 5 subjects) should have resulted if the paradigm was truly aversive in nature. Furthermore, since one of the UCSs (i.e., mother's face) that was used in the current study was also used in Najm-Briscoe et al. (2000), a similar response profile to the one reflected in the current findings should have been reported if the unconditioned stimulus was negative in nature. On the contrary, a response profile reflecting stimulus discrimination was reported instead.

Suggestions for Future Research

The results generated by Najm-Briscoe et al. (2000) suggested that the theoretical basis of the multifactor model is in need of expansion. More specifically, the conditioned value factor should be incorporated into the theoretical framework of the model when predicting infant behavior preference. Because the current results do not confirm nor refute this finding, further research is needed in order to delineate the underlying factors that contributed to the preference of a familiar stimulus in the presence of a novel stimulus. The difference in the within-subject procedure that was used in this study versus the between-subject procedure used in Najm-Briscoe et al. (2000) may have made the comparison among the findings difficult. But most importantly, it appears that the within-subject design may not have been sensitive enough to allow the infants to establish stimulus discrimination, let alone stimulus association.

It is important to note that classical conditioning is regulated by many variables regardless of the subjects' population or the nature of the learned response. Therefore, the lack of stimulus discrimination that was demonstrated in the present study may have been a product of the characteristics of the training variables (e.g., the intensity of the CS) and not a product of an absence of an experimental effect. Even though some of the training variables used in this study were successful in promoting a conditioned response in Najm-Briscoe et al. (2000), different stimulus parameters may be required to promote stimulus conditioning in a within-subject design. Thus to successfully highlight the nature of the findings reported by Najm-Briscoe et al. (2000), future research may increase the CS duration from 100 ms to 200 ms and increase the duration of the UCS from 1500 ms to 2000 ms in order to enhance stimulus familiarization. Furthermore, the ITI may be increased to 6 s to minimize stimulus sensitization between trials, and most importantly, the CS+ and the CS- should perhaps differ in more than just stimulus frequency in order to enhance discrimination. Overall, subjects in a within-subject design should be given adequate opportunity to process the given stimuli due to the more complex nature of the stimulus presentation. After all, not only do they need to establish stimulus association between the CS+ and the UCS, but also stimulus discrimination between the CS+ and CS-.

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Oklahoma State University
Institutional Review Board

Protocol 5/16/01

Date : Tuesday, April 24, 2001 IRB Application No: AS00128

Proposal Title: EVIDENCE FOR ASSOCIATIVE " VALUE IN 5-MONTH-OLD INFANTS" RECOGNITION MEMORY: OVERPOWERING NOVELTY PREFERENCE

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Reviewed and
Processed as: Expedited (Spec Pop)

Approval Status Recommended by Reviewer(s) : Approved **Modification**

Please note that the protocol expires on the following date which is one year from the date of the approval of the original protocol:

Protocol 5/16/01

Signature : Carol Olson

Carol Olson, Director of University Research Compliance

Tuesday, April 24, 2001
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

VITA

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