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The Effect of Continuous White Noise and Mother-Talk Speech on Infant Behavioral State at 3 Months of Age.

Sharon Kader

A Thesis

in

The Department

of

Psychology

Presented in Partial Fulfillment of the Requirements
for the Degree of Master of Arts at
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Abstract

The Effect of Continuous White Noise and Mother-Talk Speech on Infant Behavioral State at 3 Months of Age

Sharon Kader

The purpose of this study was to investigate whether or not Brackbill's "continuous stimulation effect" (C.S.E) was present in 3-month-old infants. Thirty-two fullterm 3-month-old infants (16 males and 16 females) were videotaped while in their cribs under 8 min of no sound and 8 min of continuous white noise in one visit, and 8 min of no sound and 8 min of continuous mother-talk in another visit. Half the subjects heard both sounds at 65 db and half heard both sounds at 75 db. The order of presentation of sound and no sound periods were counterbalanced across subjects, within each intensity. At the end of the second visit, infants were administered Roe's elicited vocalization task (Roe, 1978). Infant state was rated from videotapes using the Thelen Infant Arousal Scale (Thelen et al., 1984). The timing of the duration of infant nondistress vocalizations was recorded from videotapes. The classic C.S.E as found in very young infants (e.g. Brackbill, 1975) was defined as lower arousal under sound than under no sound as well as a lower arousal under 75 db sound than under 65 db sound. The findings for infant state suggested that neither males nor females met the criteria for evidence of the classic C.S.E. Sex differences were found under the impact of white noise although no sex differences were found for mother-talk. Data for mother-talk sessions suggested that mother-talk was not effective in reducing arousal level and thus did not elicit the C.S.E. The white noise analysis for male

infants indicated a significant linear trend reflecting a marked increase in arousal level in the presence of white noise at 65 db, but no change in arousal level in the presence of white noise at 75 db. In the white noise analysis for females, quieting effects at 65 db were indicated by no changes in arousal level during no sound following 8 minutes of white noise, and a large drop in arousal level during white noise following 8 minutes of silence. White noise at 75 db, however, did not have quieting effects. A correlational analysis indicated a significant positive relationship between arousal level during tape-recorded mother-talk and greater duration of nondistress vocalizations to the mother than to the experimenter, and a significant negative relationship between arousal level during mother-talk and the duration of nondistress vocalizations to the experimenter. The difference between males and females in response to white noise was speculated to be a reflection of females being more mature than males in terms of CNS development. The correlational analysis suggested an experiential effect with mother-talk from the infant's mother.

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The Effect of Continuous White Noise and Mother-Talk Speech on Infant Behavioral State at 3 months of Age.

This study was an investigation of the effects of continuous auditory stimulation on the behavioral arousal level of healthy 3-month-old fullterm infants. The effects of continuous stimulation on infant state or arousal level has been the focus of extensive research since the early 1930's. State, referred to as a major variable and mediator of stimulation in infant research (Korner, 1972) has often been used synonymously with arousal level to refer to the organism's overall level of functioning which ranges on a continuum from deep sleep through awake, alert, and active to intense crying (Brackbill, 1971). Behavioral state has also been more narrowly conceptualized as the infant's observed behavior along the sleep-waking continuum whereas arousal level is a more global term referring to or implying both physiological and behavioral indices (Brackbill, 1973). Behavioral state has been measured by a variety of scales (Brackbill & Fitzgerald, 1969; Brazelton, 1973) which also differ according to whether the specific state categories used are believed to reflect qualitatively different underlying patterns of neurophysiological activity (Brackbill & Fitzgerald, 1969) or systematic increases or decreases in arousal level (Thelen, Fisher, & Ridley-Johnson, 1984).

Research studies have focused on the effects of a multitude of sensory stimuli which, when presented continuously to infants function to lower rather than raise arousal level (Birns, Blank, Bridger, & Escalona, 1965). Stimuli that are implemented in the study of the effects of continuous auditory stimulation are typically presented to subjects at moderately intense rather than minimal intensity ranges. The paradoxical effect of a decrease in behavioral arousal level elicited by intense continuous auditory stimulation has been studied extensively by Brackbill (1966, 1970, 1971, 1973, 1975) and documented as the "continuous stimulation effect" (C.S.E) (Brackbill, 1975). This response to unchanging stimulation has been termed pacification or quieting (Brackbill & Fitzgerald, 1969).

Pacification or quieting effects on infant state are of interest given that infants are less aroused in a noisy environment than in an environment that is quiet, less aroused under high illumination than in darkness, less aroused when swaddled than when naked, and less aroused when being jiggled than when lying quietly in their cribs. Although in the present study we are interested only in infant state, the pacification effects refer to a specific pattern of behavioral and physiological responses; for example the infants cry less and sleep more, move about less, and have lower and more stable heart and respiration rates (Brackbill & Fitzgerald, 1969). According to Brackbill (1971) the mediation of the pacification effects originate from a primitive subcortical mechanism. The continuous, ongoing nature of the stimulus presentation appears to be critical for the quieting effects, as stimuli presented intermittently increase rather than decrease behavioral arousal level (Brackbill, 1970). The onset of stimulation, despite its duration elicits the orienting reflex (Lynn, 1966) which is a qualitatively different response from the C.S.E and can be characterized by a transient increase in arousal level (Brackbill, 1971). A general characteristic of the C.S.E is that the magnitude of the C.S.E (or the degree of reduction in behavioral arousal level) is directly proportional to stimulus intensity level (Brackbill, 1975).

Thus, the greatest reduction in arousal level is elicited by the higher of two stimulus intensity levels. This characteristic of the C.S.E has been found in the auditory (Irwin & Weiss, 1934; Brackbill, 1975), visual (Irwin & Weiss, 1934; Brackbill, 1971), proprioceptive-tactile (Brackbill, 1971, 1973), and temperature (Brackbill, 1971) modalities.

Research studies investigating the effects of continuous auditory stimulation on the behavioral arousal level of infants have typically focused on the neonatal period, and have made use of white noise as an auditory stimulus. There exists sparse evidence concerning whether or not the C.S.E in the auditory modality is present past one month of age. Given that the C.S.E has been suggested to reflect a primitive subcortical mechanism (Brackbill, 1971) and that 3 months of age has been described to be the end of a transitional phase in C.N.S development (Graham, Leavitt, & Strock, 1978), one might expect the C.S.E to change at 3 months of age.

Systematic research investigating the effects of continuously presented stimuli on infant behavior was first conducted by Irwin and Weiss (1934) in three different experimental situations, in which infant activity was measured by polygraph recordings. In the visual experiment, 79% of 90 healthy neonates displayed a greater amount of activity under minimal (shaded bulb) than moderate (30 watt white frosted bulb) light conditions. Irwin and Weiss stated these results reflected the quieting effects moderate visual stimulation has on neonates. The second experiment consisted of comparing the effects of two pure tones, 50 decibels (db) and 75 db, presented continuously to newborn infants for 5 minutes while in darkness, to a no-sound control period of equivalent length. The infants showed less activity under both sound conditions than in silence, however 74% of the infants displayed less activity under 75 db than 50 db. According to Irwin and Weiss, these results reflected the quieting effects intense auditory stimulation has on neonates. The third experiment assessed the cumulative effects of two sensory stimuli on the activity level of the newborn. The infants were presented for 5 continuous minutes with 2 pure tones, 75 db and 50 db, and a no-sound period of equivalent length while exposed to moderate light (30 watt white frosted bulb). Activity level was less under 75 db than 50 db and was less under both sound conditions than under silence. According to Irwin and Weiss (1934) these findings reflected that the quieting effects of the sound stimuli were proportional to the intensities of the stimuli used. A comparison of infant activity level across the three experimental conditions indicated that the mean activity rate was lowest under the higher intensity light (moderate light) and sound (75 db) conditions combined.

Brackbill, Adams, Crowell, and Gray (1966) investigated the relationship between stimulus quality and arousal level in neonates. Infants were presented with consecutive presentations of the stimulus conditions paired heartbeats at 72 beats per minute (bpm), metronome beats at 72 bpm, and unfamiliar lullabies each played at 80 db as well as a no-sound control period. Each condition lasted 15 minutes and the experimental sessions lasted one hour. The stimulus conditions were presented to fullterm neonates 48 hours of age, approximately 1 1/2 hours after feeding. The dependent measures were motor activity, amount of crying, heart rate, and regularity of heart rate and respirations. Under the no-sound condition relative to auditory stimulation, there was significantly greater amounts of crying, heart rate was significantly higher and less regular, respiration was more variable and motor activity was greater, although not significantly so. However, no differences were found on any of the measures when the heartbeat condition was compared to the other three experimental conditions. Although these results did not support Salk's (1961, 1962) claim that heartbeat sound is unsurpassed by any other sound in its effectiveness in quieting infants, the findings comparing no sound to any other sound confirmed Irwin and Weiss's (1934) reports of the quieting effects of prolonged auditory stimulation. Brackbill (1966) suggested these findings coincide with Hebb's (1955) notion that human organisms need a continuous supply of sensory stimulation in order to function normally. In addition, Brackbill (1966) suggested that the findings of heightened arousal in the absence of sound reflect the infant's need for stimulation.

Brackbill (1970) demonstrated that auditory stimulation with continuous white noise significantly decreased arousal level whereas white noise presented intermittently increased rather than decreased arousal level. Brackbill investigated the differences in arousal level in neonates while in a quiet awake state under the background conditions of white noise, intermittent white noise with alternate one-half-second periods of sound and silence, and a no-sound control, each played continuously for 8 minutes. Two sets of clicks were superimposed upon the three background conditions to investigate various components of the orienting reflex, such as startles. Findings indicated continuous white noise played at 85 db produced a decrease in respiration, heartrate, and motor activity, and an increase in quiet sleep. Specifically, subjects slept 75% longer under continuous white noise than under intermittent white noise. Intermittent white noise raised level of arousal, minimized total sleep time and increased the amount of time spent awake and crying. Specifically, infants spent 26% of the time crying under this condition whereas under continuous white noise there was not a single recorded instance of crying. Responsiveness to the clicks superimposed onto the background conditions indicated few startles. Thus Brackbill was unable to interpret this last finding in light of the orienting response. The author speculated that the differences in infant responsiveness to continuous and intermittent stimulation may be a function of the differences in the presentation of these two methods of stimulation. Brackbill hypothesized that the on-off nature of the intermittent stimulation elicits a defensive reflex in the infant which does not habituate over time, whereas the effects seen with continuous white noise may be a function of the monotonous nature of this type of stimulation. Brackbill referred to the distinction made by Wolff (1966) that novelty promotes attention, alerting and orienting in the organism while monotony promotes somnolence.

Brackbill (1971) questioned whether the number of sensory modalities stimulated were inversely related to arousal level. One-month-old infants initially in a quiet awake state after being fed were studied on 5 consecutive days. The conditions were no extra stimulation (the control condition) and continuous stimulation of one, two, three, and four sensory modalities. Under the continuous conditions of tape-recorded heartbeat (72 bpm) sound played at 85 db (control condition-ambient noise at 62 db), light at 400 w (control-50 w), neck-to-toe swaddling (control-nonrestrictive blanket of the same weight and material as the swaddling material) and high temperature at 31° C (control-25.5° C); a decrease in arousal level was reflected by an increase in quiet sleep and decreases in crying, heartrate, irregular respiration, and gross motor activity. The author reported that the pacification effects of continuous stimulation were present for all four stimulus modalities. Brackbill also found the quieting effect to be cumulative across sensory modalities. That is, the greater the number of sensory modalities stimulated, the greater the decrease in arousal level.

Results from a study investigating the effects of continuous swaddling and heartbeat sound on the heart rate and respiration rate of an anencephalic infant, who upon autopsy was shown to have only an intact cerebellum and brainstem, closely paralleled those obtained with one-month-old infants (Brackbill, 1971). This led Brackbill to speculate that the effects of continuous stimulation may be mediated by a primitive subcortical mechanism.

Brackbill (1973) investigated whether the effects of continuous stimulation on infant arousal level persist over relatively long time periods and whether any changes occur in arousal level that might reflect compensatory or homeostatic adjustments. Continuous stimulation was presented to neonates for two hours simultaneously in the form of white noise at 85 db (control condition-62 db), light at 21 lamberts (control-2.5 lamberts), neck-to-toe swaddling (control-nonrestictive clothing of the same weight and material as the swaddling material), and temperature at 31° C (control-25.5° C). The experimental conditions were presented after the infants were fed and in a quiet awake state on one of two consecutive days. A control session in which this stimulation was absent took place on the other day and was counterbalanced with experimental trials. The findings indicated continuous stimulation had a quieting effect on the infant's behavior and physiology. Under continuous stimulation in the four sensory modalities, there were decreases in infant crying and heartrate, respirations were more regular, and there were increases in active and quiet sleep. A significant trend of increased heartrate over time under the impact of continuous stimulation was reported, although Brackbill (1973) stated this finding does not adequately support the hypothesis that the effects of continuous stimulation on arousal level show a homeostatic shift over time. Overall, the results indicated that the effects of continuous stimulation occurred rapidly and persisted relatively unchanged over time. These results were consistent with reports from Irwin and Weiss (1934) that the effects of continuous stimulation after an initial period of adjustment remain constant throughout a given stimulation period. On a neurophysiological level, the author (Brackbill, 1973) hypothesized that the nervous innervation resulting from continuous stimulation may modify adrenergic functioning. In terms of neurological function and CNS structure, Brackbill speculated that the effect of continuous stimulation in the cortically-immature organism is to suppress or inhibit reticular-activating-system activity.

In a subsequent study, Brackbill (1975) investigated the relationship between continuous stimulation and stimulus intensity level. Fullterm infants at 44 hours of age just after feeding while in a quiet-awake state were presented with white noise played continuously for 30 minutes at a stimulus intensity level of 60, 70, or 80 db. A control period of 30 minutes (in which ambient noise level was 55 db) was counterbalanced with treatment periods. The findings indicated that as sound intensity increased, percentage of time in quiet sleep rose from 12.9% during the control condition to 67.9% under the 80 db condition. These results indicated that the magnitude of the continuous stimulation effect is directly related to stimulus intensity level. In an attempt to conceptualize the mediation of the C.S.E in infants, Brackbill (1975) hypothesized that continuous stimulation acts as a masking stimulus, thereby elevating the sensory threshold level for the reception of incoming discrete stimuli. Anatomically, Brackbill speculated that the dorsal raphe nuclei of the reticular activating system may play a major role in the mediation of the C.S.E.

Other studies using different types of continuous stimulation have shown similar effects with neonates. Miller and Byrne (1983) presented to sleeping neonates two parameters of a computer-synthesized dipthong (ai), the transition duration (short versus long) and stimulus repetitions (pulsed versus continuous), over a period of 2 minutes each at 78 db. The infants who received the pulsed stimulation moved from light-sleep to drowsy while those receiving the continuous stimulation moved from light sleep to deep sleep. This suggested to the authors that pulsed auditory stimuli were more effective in eliciting infant attention whereas continuous stimulation functioned to lower infant arousal level. Smith and Steinschneider (1975) presented to neonates once roused to a crying state, no sound and taped heartbeat sound at 75 and 105 paired bpm at 75 db. Greater sleeping and less crying was associated with both heart rate conditions as compared to the no sound control. The authors hypothesized that the pacification effects produced in the aroused neonate by intense, continuous auditory stimulation are probably a function of a CNS protective mechanism. This mechanism functions as a stimulus overload control and allows the crying neonate to escape from too much stimulation by shifting behavior to a quieter state, such as sleep.

An issue which remains unresolved in the literature is the question of whether the C.S.E in the auditory modality exists beyond the neonatal period. There is conflicting evidence supporting the notion of the existence of the C.S.E in children. Salk (1961, 1962) presented for one hour each on 4 separate nights a normal heartbeat sound at 72 paired bpm, metronome single beats at 72 bpm, and recorded lullabies, all at 85 db, and a no-sound control period to 1 1/2 to 3-year-old institutionalized children. The children fell asleep to the heartbeat sound in half the time taken to fall asleep under the metronome, lullabye and no-sound conditions, and there was no difference in the time taken to fall asleep between the latter three conditions. These findings suggest the presence of the C.S.E in children. However, a serious methodological problem with Salk's study was that the measurement of the time taken for the children to fall asleep was assessed only at 5-minute intervals by an observer who entered the room for this purpose. Thus the validity of these data is questionable.

Brackbill et al. (1966) in a well-controlled early study also investigated the relationship between stimulus quality and arousal level in children. Auditory stimulus presentations lasting one hour were given to 3-year-olds, 4 times a week over a period of 5 weeks. Testing sessions took place at four nursery schools prior to nap time immediately after lunch. The stimulus conditions were paired heartbeats at 72 bpm, metronome beats at 72 bpm, and unfamiliar lullabies played at 80 db which were compared to a no-sound control condition of equivalent length. Each auditory stimulus condition was presented for one week and a preliminary equalization period consisting of a no sound condition presented for one week preceeded the four weeks of actual experimental work. The dependent measure was the time taken to fall asleep under each condition. Brackbill did not make explicit the children's behavioral state prior to the onset of the stimulus presentations. The children were found to fall asleep significantly faster under the sound conditions, than under the no-sound control. However, the children did not significantly differ in the time taken to fall asleep when the heartbeat condition was compared to all other conditions. These results did not support Salk's (1961, 1962) claim that the normal heartbeat sound is an imprinting stimulus for human beings. However, this study provides evidence that the C.S.E exists in children 3 years of age and that the stimulus of heartbeat sound is one more stimulus capable of eliciting the C.S.E.

In an attempt to extend Brackbill et al.'s (1966) findings with children, Des Bois (1986) in a well-controlled small sample study conducted in one nursery school, presented no sound, counterbalanced with heartbeat sound at 72 bpm, metronome sound at 72 bpm, a lullaby in a foreign language, and white noise to 3-to-4-year-old children for two 10-minute periods at the beginning of naptime. The auditory stimuli were each presented at 70 db and 80 db.. The order of presentation of the stimulus conditions and intensity levels were counterbalanced over a period of 8 weeks following a 2-week adaptation period. The white noise stimulus condition and the two sound intensities were employed to clarify whether the effects seen in preschoolers were the same as those seen with neonates. Because of carry-over effects within sessions, only data for the first 10 minutes were analyzed. No differences were found in behavioral arousal level between the two intensity levels or the four sound types. Continuous auditory stimulation did not reduce arousal level relative to no sound periods, rather subjects were significantly more aroused under sound than no sound. There was a parallel decrease in arousal level over the 10-minute period, however, for both sound and no sound conditions. The author concluded that these findings suggest that the C.S.E is not present in preschoolers, and that the effects seen with older children are not like those seen with neonates. Thus the studies that have investigated the C.S.E in the auditory modality beyond the neonatal period have provided conflicting results. Moreover, there has been no systematic work on the auditory C.S.E in infancy beyond the neonatal period.

The purpose of the present study was to determine if the "continuous stimulation effect" phenomenon is present in the auditory modality in infants at 3 months of age. White noise was selected as the continuous auditory stimulus of major interest to be investigated because this is the stimulus Brackbill used in her research studies (Brackbill, 1966, 1970, 1971, 1973, 1975) and it is most amenable to systematic research. The 3 month period was chosen for study because this age marks the end of what has been described as a transitional phase in CNS development in which cortical-subcortical connections become functional in the human infant (Graham, Leavitt, & Strock, 1978). Because the C.S.E has been suggested to be mediated by a primitive subcortical mechanism (Brackbill, 1971) it might be expected to change after 3 months of age. In addition, there is evidence of a change between 2 and 3 months in the infant's response to continuous white noise (Kopp, 1970; D. Potvin, personal communication, August 1, 1985).

Kopp (1970) conducted a developmental study of soothing stimuli. One- to- 3-month-old infants who began crying spontaneously were presented with auditory, visual, and tactual-kinesthetic stimulation for one minute in the form of white noise and the voice of the infant's own mother at 85 db, the upper torso of a mannequin and an aluminum cylinder, and rocking and patting of the infant's back. The results for continuous auditory stimulation indicated a developmental change in the soothing effect of continuous white noise between the ages of 1, 2, and 3 months. White noise presented at 85 db was most effective as a soothing stimulus at both 1 and 2 months of age. However, at 3 months of age there was an appreciable difference in the total number of soothing responses to white noise. At 2 months of age, white noise was effective 70% of the time, whereas at 3 months it was effective only 30% of the time. D. Potvin (personal communication, August 1, 1985) also found a marked decrease in the effectiveness of continuous white noise at 80 db in reducing the arousal level of crying infants between 2 and 3 months of age.

Kopp (1970) reported that the developmental pattern of soothing responses to mother-talk was the inverse of that seen with white noise. Recorded mother-talk (from the infant's own mother) was least effective at 1 and 2 months of age, and most effective as a soothing stimulus at 3 months of age. At 1 month, the number of soothing responses was significantly greater for white noise than for mother-talk, whereas at 3 months the frequency of soothing responses was greater for mother-talk than for white noise; although this difference was not significant. Kopp speculated that the differences in the effectiveness of the white noise and mother-talk stimuli at 3 months of age may be a function of the infant being generally more sensitive to soothing of a social rather than a nonsocial nature. Mother-talk, which according to the author can be defined as a social stimulus, may hold a special meaning for the infant which in turn may be a function of the development of sensory-motor schemas. This view is consistent with Graham, Leavitt, and Strock's (1978) suggestion that 2 and 3 months is a transitional age in CNS development in which cortical-subcortical connections may become functional in the developing human infant. Kopp (1970) hypothesized that the cessation of crying in the 1- and 2-month-old infants under continuous white noise was attributable to a localized reflex which is slow to habituate and may be a component of the orienting response. She also hypothesized that the increased crying responses to white noise at 3 months of age may be a defensive reaction resulting in high levels of arousal. The responses to white noise at 1 and 2 months seen by Kopp may simply be a reflection of the existence of the C.S.E; if so the change in crying infants' responses to white noise at 3 months reported by Kopp (1970) and D. Potvin (personal communication, August 1, 1985), may reflect some change in the C.S.E by this age.

A second form of continuous auditory stimulation in the form of tape-recorded mother-talk (from women unfamiliar to the infants) was included in the present study as a contrast stimulus in order to clarify the nature of the C.S.E in 3-month-old infants. Although tape-recorded mother-talk has not been investigated within the context of C.S.E research in very young infants, this form of stimulation would appear to fall into a class of stimuli including heartbeat sound, metronome beats, and lullabies, that seem to be considered continuous (Brackbill & Fitzgerald, 1969). Given that there is evidence that the C.S.E may be elicited in neonates by different types of relatively intense continuous auditory stimuli, the C.S.E appears to be an all pervasive effect. Therefore, if the C.S.E is present in the auditory modality, infants may respond to continuous speech in the same way in which they respond to continuous white noise at the same intensity level. In very young infants, the C.S.E involves a reduction in arousal level and is also known to be related to intensity level in that the magnitude of the reduction in arousal level is directly proportional to stimulus intensity level. Because a reduction in arousal level with the introduction of sound, for example from a state of awake and active to a state of awake and quiet, can be attributable to other factors such as attention to the stimulus, both sound stimuli were presented at two intensity levels to determine whether arousal level was affected in a manner consistent with the C.S.E: specifically that a lower arousal level was associated with the higher intensity level. The specific intensities used (65 db and 75 db) were well within the hearing limits and the more intense level was somewhat less loud than that which has been used in other research because of ethical concerns and concern over distorting tape-recorded mother-talk speech.

If the C.S.E does not extend to tape-recorded mother-talk in 3-month-old infants, available research suggests that this form of stimulation at normal speaking levels may be interesting and compelling to infants, however mother-talk at higher intensity levels might be aversive. Mother-talk speech or motherese refers to the ways in which adult speech is modified when addressed to infants. This modified speech includes special prosodic characteristics, such as sing-song rhythm and a high pitch (Werker, 1986). Perceptual preferences for motherese over adult-directed speech has been suggested to help the infant attend to and therefore, ultimately acquire language (Fernald, 1984). The exaggerated prosody of motherese may function to elicit attention, and convey affect in the prelinguistic infant. Fernald (1985) reported that 4-month-old infants showed a preference for motherese over adult-directed speech when both speech samples were spoken by women unfamiliar to the infants. Werker (1986) found that infants at each of three different ages (newborn, 4- 5 1/2 months, and 7 1/2- 9 months) showed a perceptual preference for motherese over adult-directed speech whether spoken by a female or a male. These studies investigating the effects of motherese suggest that this is an interesting and compelling stimulus for infants.

Roe's Differential Vocal Responsiveness (D.V.R) measure (Roe, 1978; Drivas, Roe, & Roe, 1983; Roe, Drivas, Karagellis, & Roe, 1985) was used in this study to provide a standard index of the infant's language experience and differential responses to language as an interesting and familiar stimulus. The D.V.R score is defined as the amount of time the infant spends emitting nondistress vocalizations in response to vocal stimulation by a stranger (the experimenter) subtracted from the amount of time the infant spends emitting nondistress vocalizations in response to vocal stimulation by the mother-caretaker (Roe, Drivas, Karagellis, & Roe, 1985). Greater vocal responsiveness to mother than to stranger (and thus higher D.V.R scores) has been associated with linguistic-cognitive and academic competencies up to the age of 12 years (Roe, McClure, & Roe, 1982), and home-reared male infants have been reported to show significantly higher D.V.R scores than home-reared females (Roe, Drivas, Karagellis, & Roe, 1985).

Because of the conflicting evidence in the literature about the existence of the C.S.E beyond the neonatal period, no specific hypotheses were formulated about the effects of continuous white noise and continuous mother-talk on 3-month-old infants. It was decided that evidence of the classic C.S.E as found in very young infants (e.g. Brackbill, 1975) would be a lower arousal level under sound than under no sound as well as a lower arousal level under 75 db sound than under 65 db sound.

Method

Subjects

The final sample consisted of 32 clinically normal fullterm 3-month-old infants (16 males, 16 females). To control for both biological maturity and social experience, infants were tested within the 2-week period falling between 12 and 14 weeks of both their actual date of birth and their expected date of birth: mean chronological and post-conceptional ages of the subjects at test sessions 1 and 2 may be found in Appendix A. Criteria for inclusion in the study consisted of: gestational age (GA) of 39 to 41 weeks; no congenital anomalies, hearing loss, complications or illnesses during or after birth; a birthweight of at least 2600 gms; and Apgar scores of at least 7 at 1 min and 5 min after birth. Three infants were delivered by repeat Caesarian section. Mothers of infants were solicited from the local English newspaper, the Gazette, by telephone when the infant reached the chronological age of 11 weeks. Infants were screened to ensure that the only language that they heard at home was English. Mothers of infants who met the selection criteria were screened for maternal complications such as toxemia and diabetes. Eighty-one percent of the 80 mothers who were approached agreed to participate in the study. Informed consent was obtained (see Appendix B). Six subjects were replaced due to experimental error (4 females, 2 males). Four infants (1 female, 3 males) were replaced for crying during the state measure over a period of 2 consecutive minutes, throughout the change of conditions. Two subjects (1 female, 1 male) were replaced for being out of town during the appropriate period for the testing of infant vocalizations. Three subjects (1 female, 2 males) included in the analyses for state, were excluded from the analyses for infant vocalizations due to crying exceeding 20 seconds during the 9 min procedure. Two infants (both female) were replaced due to the use of atypical seats during the testing of infant vocalizations. Namely, one seat was almost completely horizontal and one seat functioned as a swing and was not entirely motionless during the testing procedure.

Auditory Stimuli and Equipment

Two 16-min tapes consisting of 8 min of white noise and 8 min of no sound were used. The white noise was produced by a white noise generator and had a rise and decay in peak of 10 msec. The continuous white noise was re-recorded onto TDK High Position audiocassettes SA-60. Presentation order of continuous white noise versus no sound on the audiocassettes was counterbalanced between tapes. Two samples of continuous mother-talk were used to make four 16-min tapes, each consisting of 8 min of continuous speech and 8 min of no sound. Order of mother-talk and silent periods was counterbalanced across tapes. Each mother-talk sample was obtained by audiorecording a mother as she spoke naturally and spontaneously to her own 3-month-old infant for 20 min in her home. Two samples of mother-talk were included to cancel out any biases brought about by using only one speech sample.

The speech samples were initially recorded on a Uher Report Monitor 4400, with a Uher Microphone M534 with Scotch Audio-Recording reel-to-reel tapes 3M, 206 1/4 x 600, and re-recorded onto TDK High Position audiocassettes SA-60 after editing in which extraneous noises such as breathing and crying from the baby and sounds from the environment were eliminated. Pauses of 1-2 seconds, obtained by audio-recording 3-min ambient noise segments in the exact location of the maternal speech recordings, were used to fill in the spaces between edited portions of the speech samples. This restored the tapes to their natural and spontaneous sound.

Videotaping was implemented through the use of a Sony Betamax videocassette recorder SLO 340 and a Sony camera HVC 2200 with a Velbon tripod V6B32. A Simpson sound level meter 886 was used to measure ambient noise. The videotapes were viewed on a Sony Trinitron color monitor CVM 1900.

Measures

Thelen Infant Arousal Scale. A slightly modified version of the Thelen Infant Arousal Scale (Thelen, Fisher, & Ridley-Johnson, 1984) was used to rate infant behavioral state or arousal level. The Thelen scale consists of the following 6 states numbered in order of increasing behavioral arousal: 1 (asleep), 2 (drowsy), 3 (alert, quiet), 4 (alert, gross motor movements of head, arms, and torso), 5 (fussing), and 6 (crying hard). For the present study, state 4 was slightly modified to include gross-motor movements of the head and/or torso, arms and/or legs. The scale yields arousal scores that are conventionally subjected to parametric analysis (Thelen et al., 1984). Thelen et al. (1984) used this scale to relate arousal level in infants 2, 4, and 6 weeks of age to the behavioral consequences of somatic growth and an interobserver reliability of .97 has been obtained (Thelen et al., 1982). D. Potvin (personal communication, August 1, 1985) found that this scale is appropriate at 3 months of age.

Roe's Differential Vocal Responsiveness (D.V.R) Measure. Roe's Differential Vocal Responsiveness measure (Roe, 1978; Drivas, Roe, & Roe, 1983; Roe, Drivas, Karagellis, & Roe, 1985) was used as a way of providing a standard index of the infant's language experience and differential responses to language as an interesting and familiar stimulus. A differential vocal responsiveness (D.V.R) score was obtained by subtracting the amount of time the infant spent emitting nondistress vocalizations in response to vocal stimulation by the experimenter-stranger from the amount of time the infant spent emitting nondistress vocalizations in response to stimulation by the mother-caretaker. Roe's D.V.R measure has been used as an index of the infant's vocal interaction with mother-caretaker versus stranger and has related significantly and consistently with children's later verbal-cognitive and academic functioning up to the age of 12 years (Roe, 1978; Roe, McClure, & Roe, 1982).

Procedure

Each infant was visited 2 or 3 times, on separate days at the same time during the day, within a 1-week period. Visits were scheduled so that the first took place at an age no younger than 12 weeks whether calculated from the actual or expected date of birth and the last took place at an age no older than 14 weeks. All sessions were videotaped. Testing began 30 minutes after the infant's last feeding. Mobiles, toys, and blankets were removed from the crib and the infant was placed in the supine position, uncovered in the crib. Prior to the start of the experiment, ambient noise readings were taken at the infant's head. These readings in all but one case were under 40 db, thus an analysis of variance indicated no significant differences between the infants. A digital clock was placed on the crib railing facing the camera in order to facilitate the timing of the experimental sessions. Once the test session began, both the mother and the experimenter remained outside of the infant's field of vision, and maintained silence. Experimental sessions began when the infant maintained a quiet-awake state for 30 seconds.

The sound conditions were played at two intensity levels. One half of the infants sampled were tested at 65 db and the other half at 75 db. During each experimental session, the infant lay supine in the crib and was exposed to 8 min of sound and 8 min of silence. On one visit, the infant was presented with continuous white noise and on the other visit the infant received continuous mother-talk. Each infant received the same order of the sound and no sound conditions. Order of presentation of sound and no sound periods and mother-talk and white noise conditions were counterbalanced across subjects within each intensity group. If the infant cried for 1 min during the first condition, the audiocassette was advanced to the second and final condition. If the infant continued to cry for another minute, the experimental session was terminated.

At the end of the second visit, an additional 9 min of videotaping took place. The infant was videotaped while seated in its infant seat for three 3-min periods: first with no adults in sight and no vocal stimulation, and then with the experimenter and mother in turn talking to the infant and encouraging the infant to vocalize. Order of experimenter's and mother's turn was counterbalanced across subjects within each intensity. Each mother was instructed to make frequent pauses while vocalizing to her infant in order to give the infant the opportunity to respond vocally. Mothers were asked not to touch their infants while they spoke, in order to avoid tactile-stimulation as a reinforcer for the infant's vocalizations. The experimenter followed the same instructions given to the mothers and spoke to the infants with much expression. In order to keep the experimenter's vocalizations to the infants consistent, the experimenter used the same sentences when speaking to each infant. Mothers did not follow a script. A list of the sentences spoken by the experimenter as well as the instructions given to each mother for the D.V.R measure can be found in Appendix C. On the second visit following the state measure, if the infant did not maintain an awake and quiet or an awake and active state while seated in its infant seat for the first minute of baseline for the vocalization measure, the session was terminated and administered on a third visit.

The rating of behavioral state was carried out by a naive rater uninformed about the purpose and method of the study. The trained rater coded behavioral state from the videotapes at 5 second intervals, using the Thelen Infant Arousal Scale (Thelen, Fisher, & Ridley-Johnson, 1984). For reliability purposes, the rater and the experimenter trained separately on pilot subjects, who were of equivalent age and health status to the experimental subjects, and rated the pilot and experimental tapes in accordance with the definitions for state which can be found in Appendix D. Percentage agreement between the rater and the experimenter for both the pilot and the experimental subjects were calculated. The total number of observations for each state during each condition that were less than 10 were not included in the calculations of agreement, in order to reduce the occurance of percentage agreements that were at the very low and high ends of the scale. Percentage agreement on 9 pilot subjects was calculated for each state under the white noise, mother-talk, and no noise control conditions. These reliabilities can be found in Appendix E, Table 1. Half way through rating the experimental subjects, an additional reliability check was implemented to insure that a high degree of reliability was being maintained. Percentage agreement on 7 randomly chosen pilot subjects was calculated for each state under the white noise, mother-talk, and no noise control conditions. These reliabilities can be found in Appendix E, Table 2. When the rating of the 32 experimental subjects was completed, percentage agreement on 12 randomly chosen subjects was calculated for each state under the no sound (white noise control), white noise, no sound (mother-talk control), and mother-talk conditions at both 65 and 75 db. These reliabilities can be found in Appendix E, Tables 3 and 4. The overall Pearson Product Moment Correlations for the white noise no sound control, white noise, mother-talk no sound control, and mother-talk conditions, were respectively at 65 db, .91, .96, .92, .96; and at 75 db, .90, .87, .90, .91.

The timing of the infants' nondistress vocalizations was carried out by 3 raters; two raters considered experts on infant vocalizations (the experimenter and her research assistant) and one rater uninvolved with the coding of infant behavioral state, and uninformed about the purpose and method of the study. Pearson Product Moment Correlations were calculated between the raters. The two experts on infant vocalizations, for reliability purposes, trained from 16 pilot subjects who were of equivalent age and health status to the experimental subjects and achieved on 17 video-segments (5 subjects plus 2 video-segments) an inter-rater reliability of .99. Time scores from these ratings were used as the goal for training the naive rater on (a) the timing of nondistress vocalizations and crying sounds and (b) recognizing fussing vocalizations. Definitions of nondistress vocalizations, fussing vocalizations, and crying sounds can be found in Appendix D. The timing of crying sounds was implemented as a reliability check to insure that the experimental subjects did not exceed crying for more than 20 seconds during the 9 min procedure. Percentage agreement between the experimenter and naive rater on the number of infants who cried less than 20 seconds was 100. The naive rater trained on the same 16 pilot subject tapes as did the experts and achieved on 17 video-segments an intra-rater reliability of .99. The naive rater achieved an inter-rater reliability of .98 with the experimenter and an inter-rater reliability of .96 with the research assistant. The timing of infant vocalizations on 29 experimental subjects was implemented on separate occasions by the naive rater and the experimenter for reliability purposes. An intra-rater reliability of .99 was achieved by the naive rater on 30 video-segments (10 randomly chosen subjects). The experimenter and naive rater achieved on the 30 video-segments an inter-rater reliability of .96.

Results

Mean arousal scores which were tabulated from the original data for each minute of each experimental session can be found in Appendix F. All analyses of the arousal scores were performed on reciprocal transformation scores because the original distributions were skewed and did not meet the homogeneity of variance assumption as tested by Hartley's F max statistic and Bartlett-Box and Cochran's statistic (Kirk, 1982). The reciprocal transformations normalized the distributions and reduced heterogeneity of variance.

It was of interest to establish whether the "continuous stimulation effect" (C.S.E) existed in 3-month-old infants. It was decided that evidence of the classic C.S.E as found in very young infants (e.g. Brackbill, 1975) would be a lower arousal level under sound than under no sound as well as a lower arousal level under 75 db sound than under 65 db sound.

In order to investigate whether the classic C.S.E was evident in the sample studied, an analysis of variance was first performed with intensity level and order of condition (sound/no sound versus no sound/sound) as between-subjects factors, and sound type (white noise vs. mother-talk), on/off (presence or absence of sound), and minutes (1 to 8) as within-subjects factors. The analysis indicated no significant main effects for intensity level, order of sound presentation, sound type, presence or absence of sound, or minute trials. There was, however, a significant sound type x on/off x order interaction, _F_(1,28)=4.50, _p_<.05, shown in Figure 1, as well as a significant sound type x on/off x intensity level x order interaction, _F_(1,28)=7.53, _p_<.01, shown in Figure 2. There was also a significant sound type x

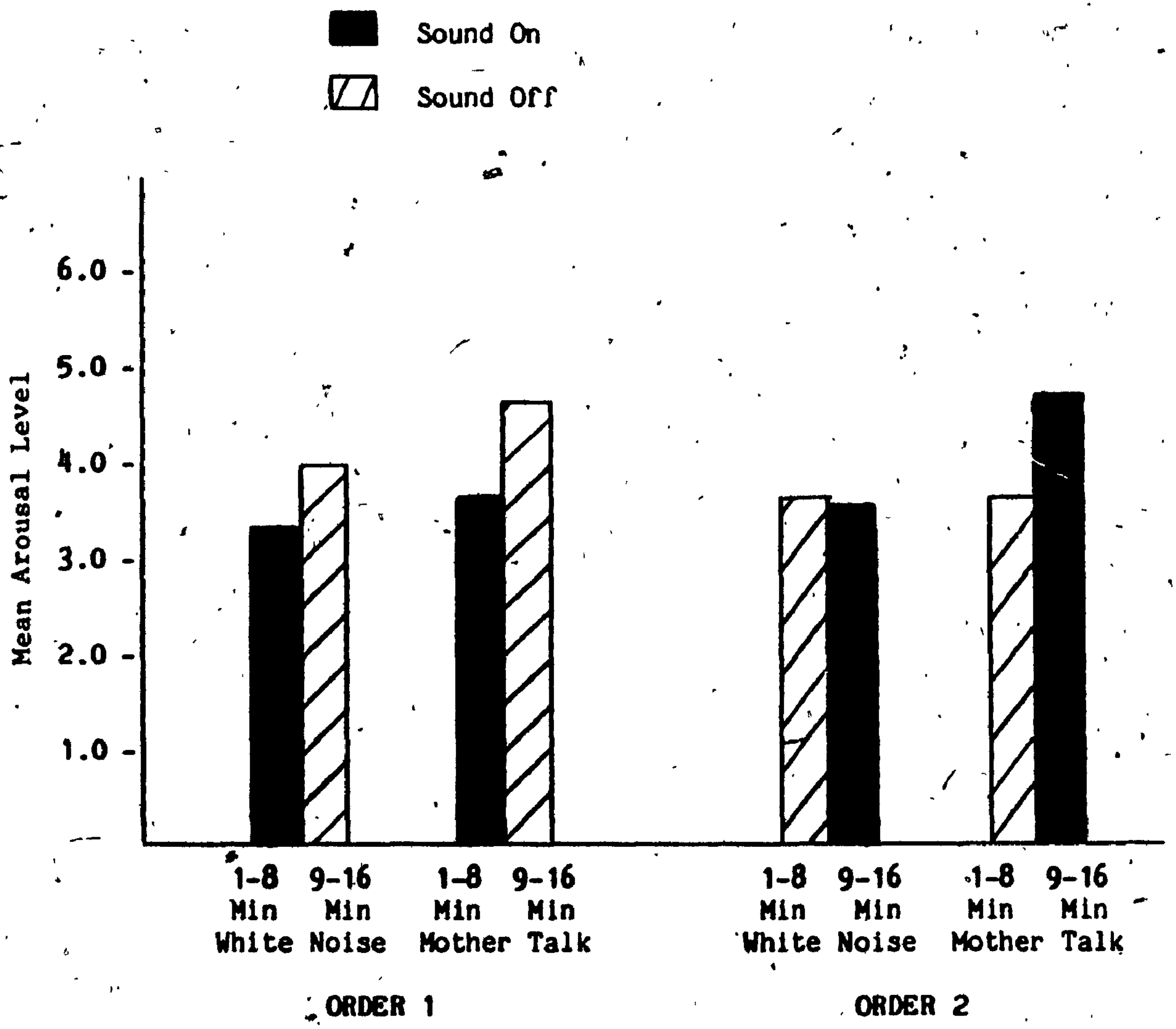


Figure 1. Sound type x on/off x order interaction in arousal scores for all subjects.

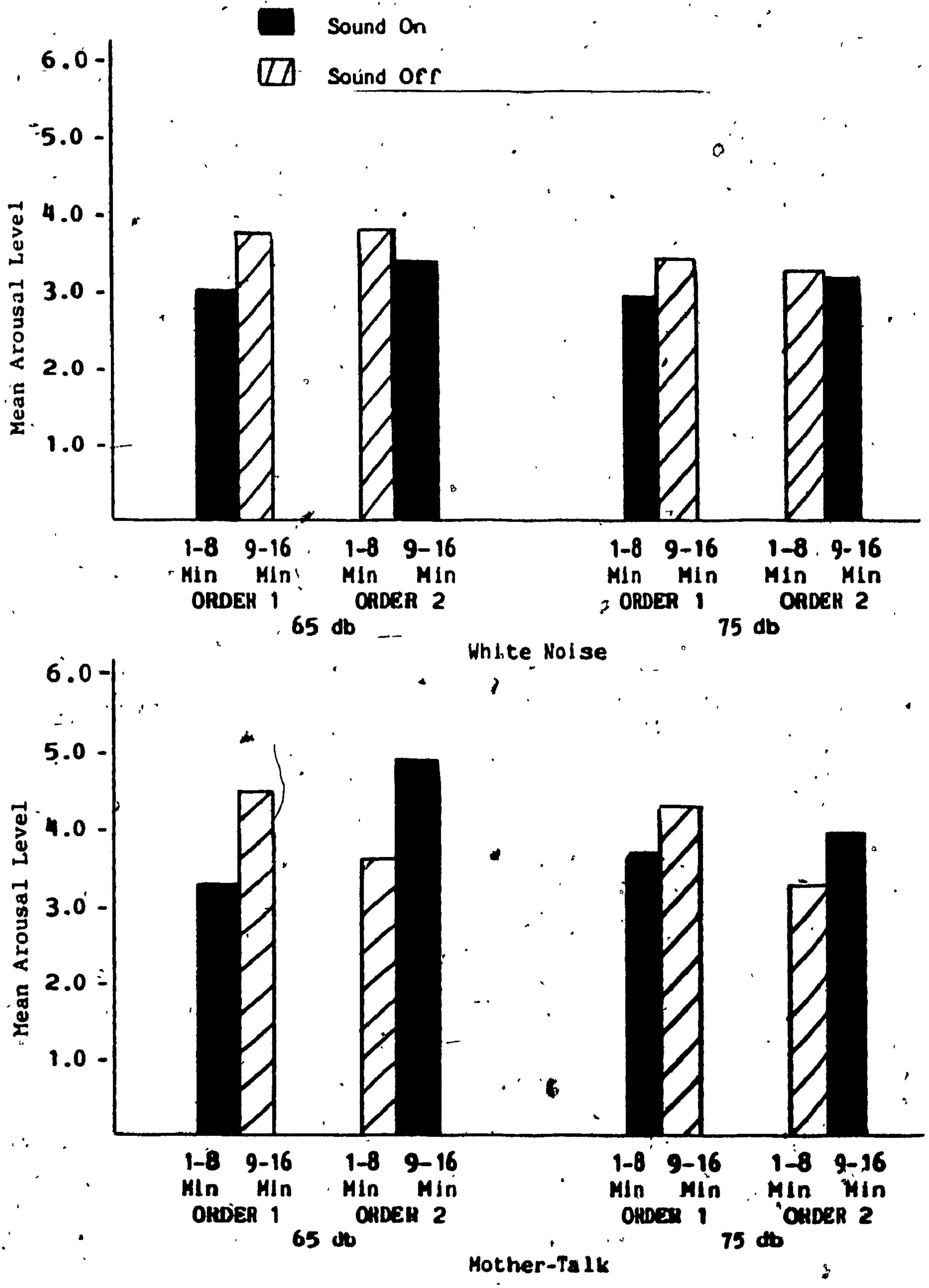


Figure 2. Sound type x on/off x intensity level x order interaction in arousal scores for all subjects.

minutes x intensity level interaction, $F(7,196)=2.55$, $p<.02$, shown in Figure 3, with significant linear x quadratic trend components, $F(1,28)=5.17$, $p<.05$. The analysis of variance source table may be found in Appendix G, Table 1.

To clarify the nature of the interactions found in the first analysis, it was decided to analyze arousal scores for the mother-talk and white noise experimental sessions separately. These analyses included sex, intensity level, and order of sound presentation as between-subjects factors, and presence or absence of sound, and minutes as within-subjects factors. The analysis of variance source tables may be found in Appendix G.

The analysis of the arousal scores for the mother-talk sessions showed no significant main effects for sex, intensity level, order of sound presentation, presence or absence of sound, and minute trials. There was, however, a significant on/off x order interaction, $F(1,24)=8.19$, $p<.01$, which is shown in Figure 4. Although post hoc tests (Duncan's New Multiple Range Test) at the .05 alpha level indicated no significant differences between means, this interaction essentially reflected the fact that arousal level was lower in the first 8 minutes of the session than in the second 8 minutes whether sound was on or off. Thus mean arousal level with mother-talk on was 3.5 in minutes 1-8 (Order 1) and 4.5 in minutes 9-16 (Order 2), while mean arousal level with sound off was 4.4 for minutes 9-16 (Order 1) but 3.6 for minutes 1-8 (Order 2).

The analysis of the arousal scores for the white noise sessions yielded no significant main effects for intensity level, order of sound presentation, presence or absence of sound, and minute trials. There

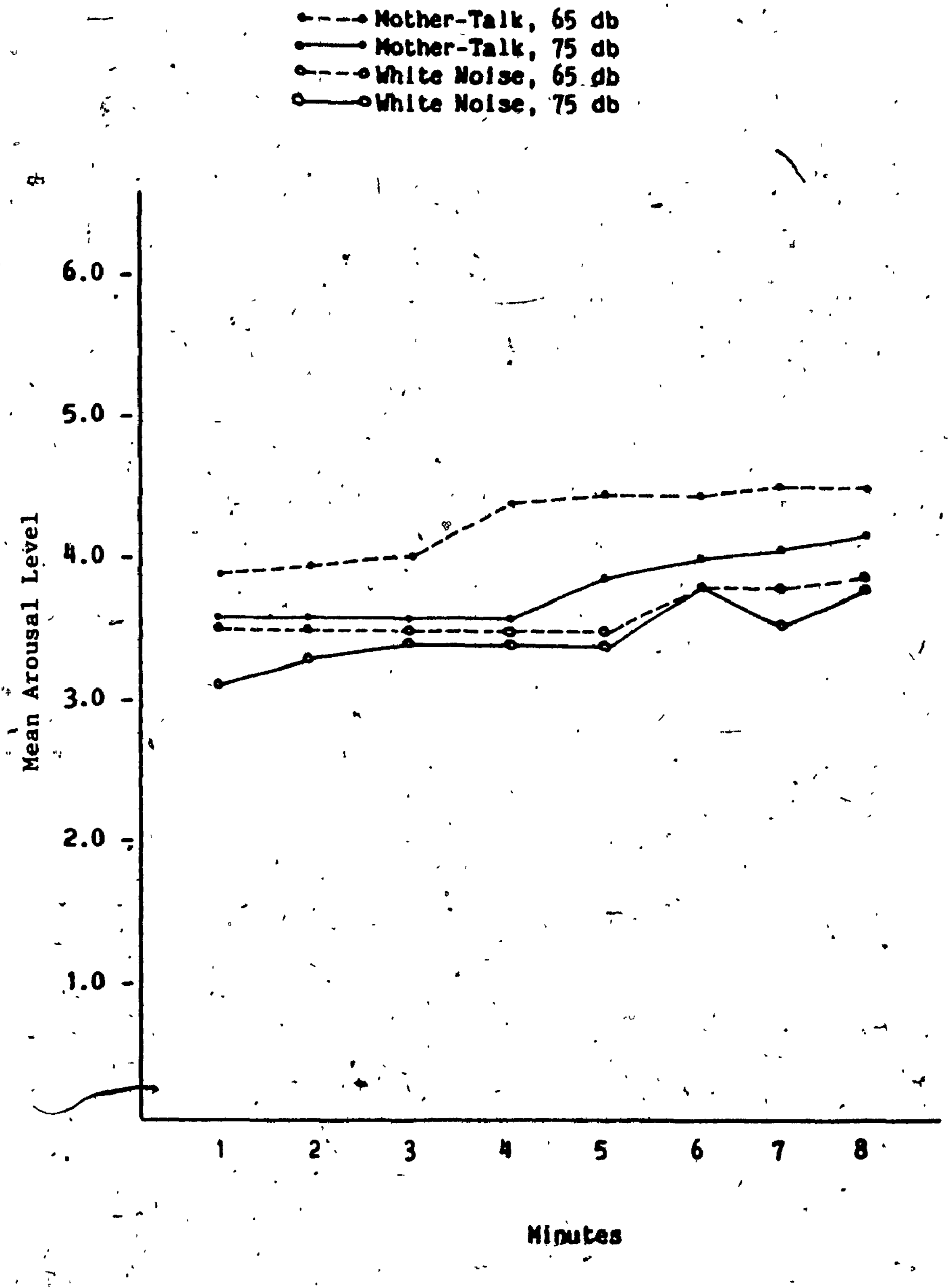
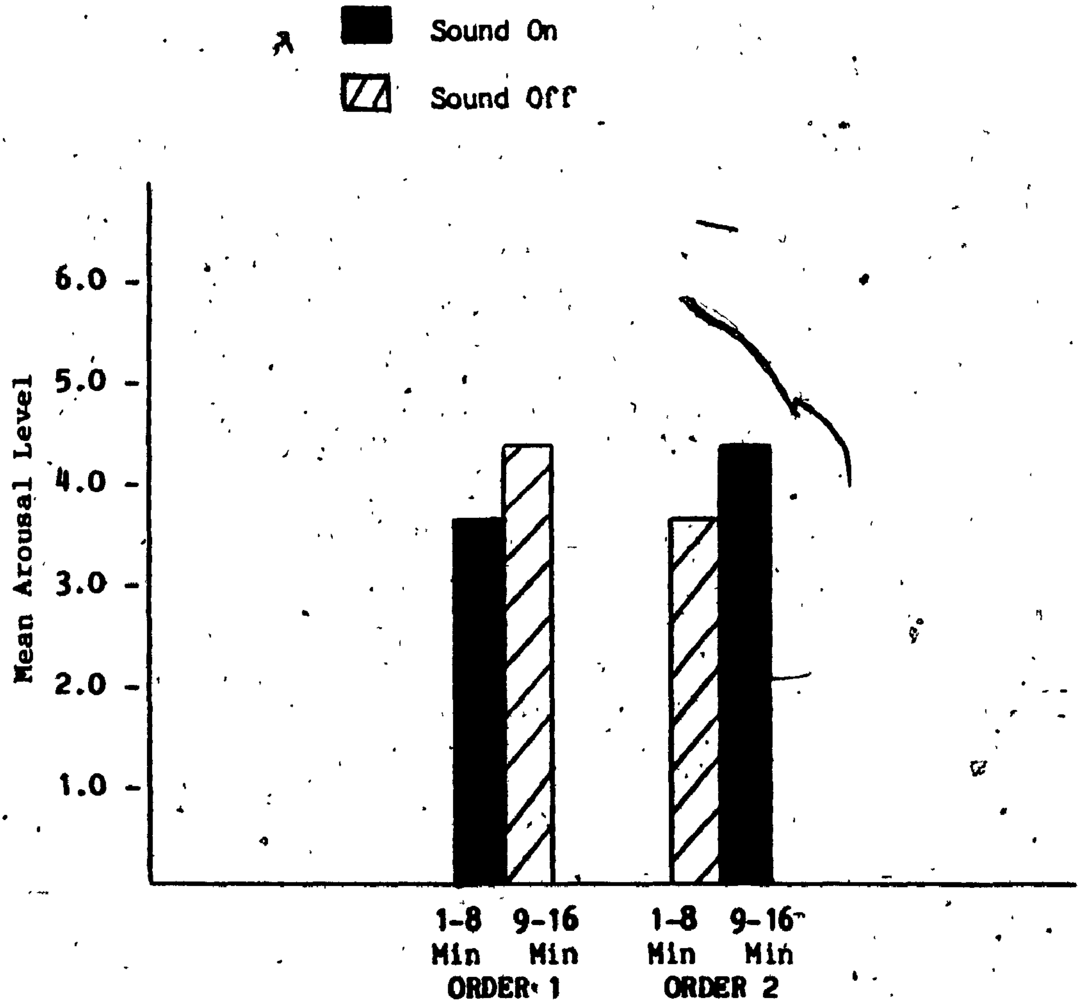


Figure 3. Significant linear x quadratic trend interaction in arousal scores for all subjects for the sound type x minutes x intensity level interaction.



<u>Figure 4</u>. On/off x order interaction in arousal scores for the Mother-talk sessions.

was, however, a significant main effect for sex, F(1,24)=6.48, p<.02, which reflected the fact that mean arousal level was lower for females (M=3.2) than for males (M=3.9). In addition, all factors interacted with sex. (See Appendix G, Table 3). Consequently, data for males and females were analyzed separately. The source tables for these analyses can be found in Appendix G.

The analysis of variance of the arousal scores of the male infants (n=16) in the white noise sessions revealed no significant main effects for order of sound presentation and presence or absence of sound. The analysis showed a main effect of intensity level, F(1,12)=4.47, p=.056, and a main effect of minute trials, F(7,84)=6.10, p<.0001, which is shown in Figure 5. Both effects were qualified by an on/off x minutes x intensity level interaction, F(7,84)=5.52, p<.0001, which is shown in Figure 6. The main effect of intensity level reflected the fact that arousal level for males was lower in the 75 db white noise session (M=3.5) than in the 65 db white noise session (M=4.3). Orthogonal trend tests indicated a significant linear trend, F(1,12)=13.74, p<.01, in the main effect of minutes and as well significant linear x linear trend components, F(1,12)=11.84, p<.01, in the interaction of presence or absence of sound with minutes and intensity level. Thus while the main effect of minutes reflected a tendency for arousal level to increase over the 8 minutes of each experimental condition, the triple interaction was attributable chiefly to the fact that there was no change in arousal scores after minute 2 in the presence of white noise at 75 db (and thus no trend), whereas there was a marked and consistent increase in arousal level in the presence of white noise at 65 db. These findings met one criterion for Brackbill's C.S.E phenomenon.

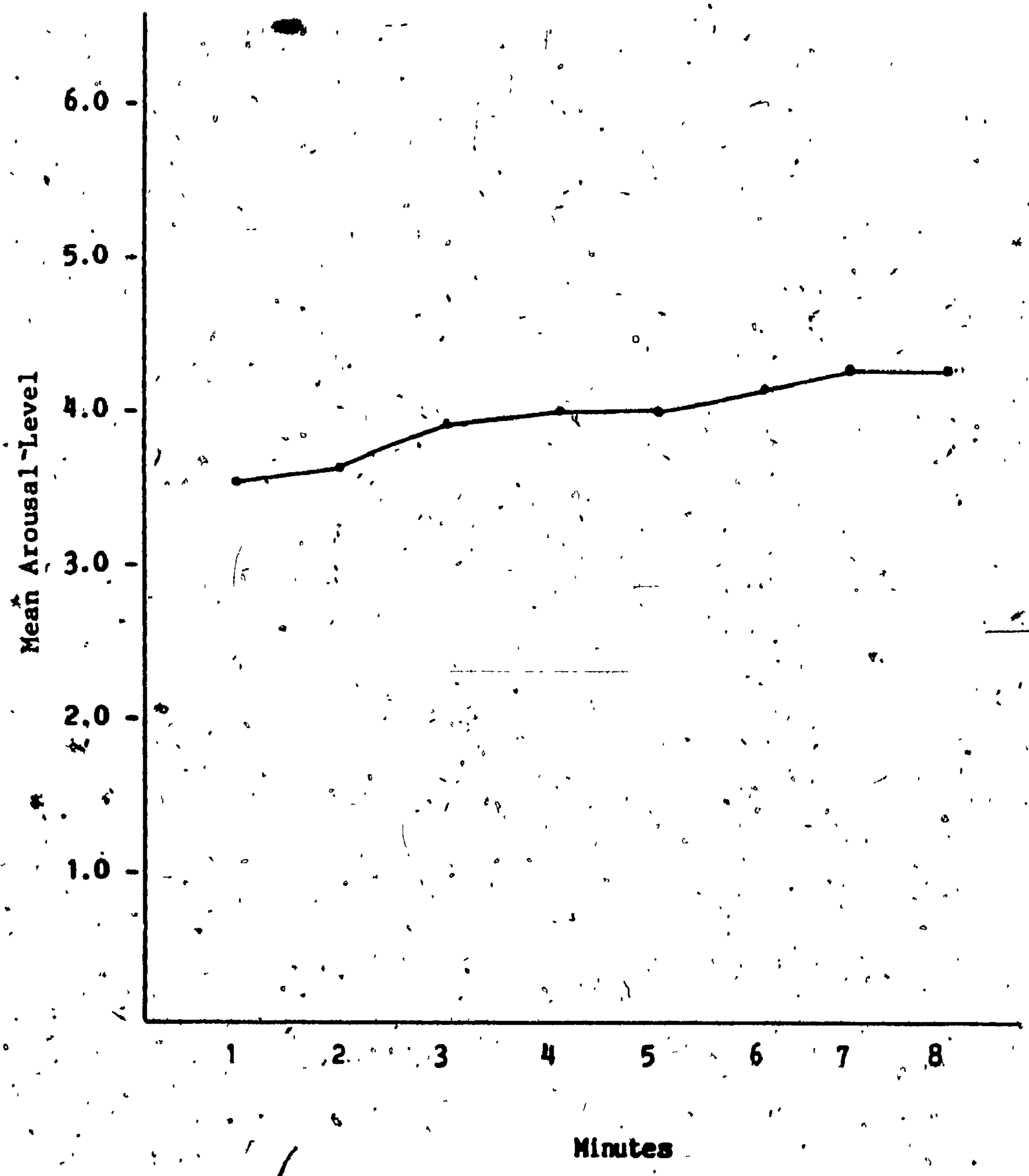


Figure 5. Significant linear trend in arousal scores of male infants for the white noise sessions.

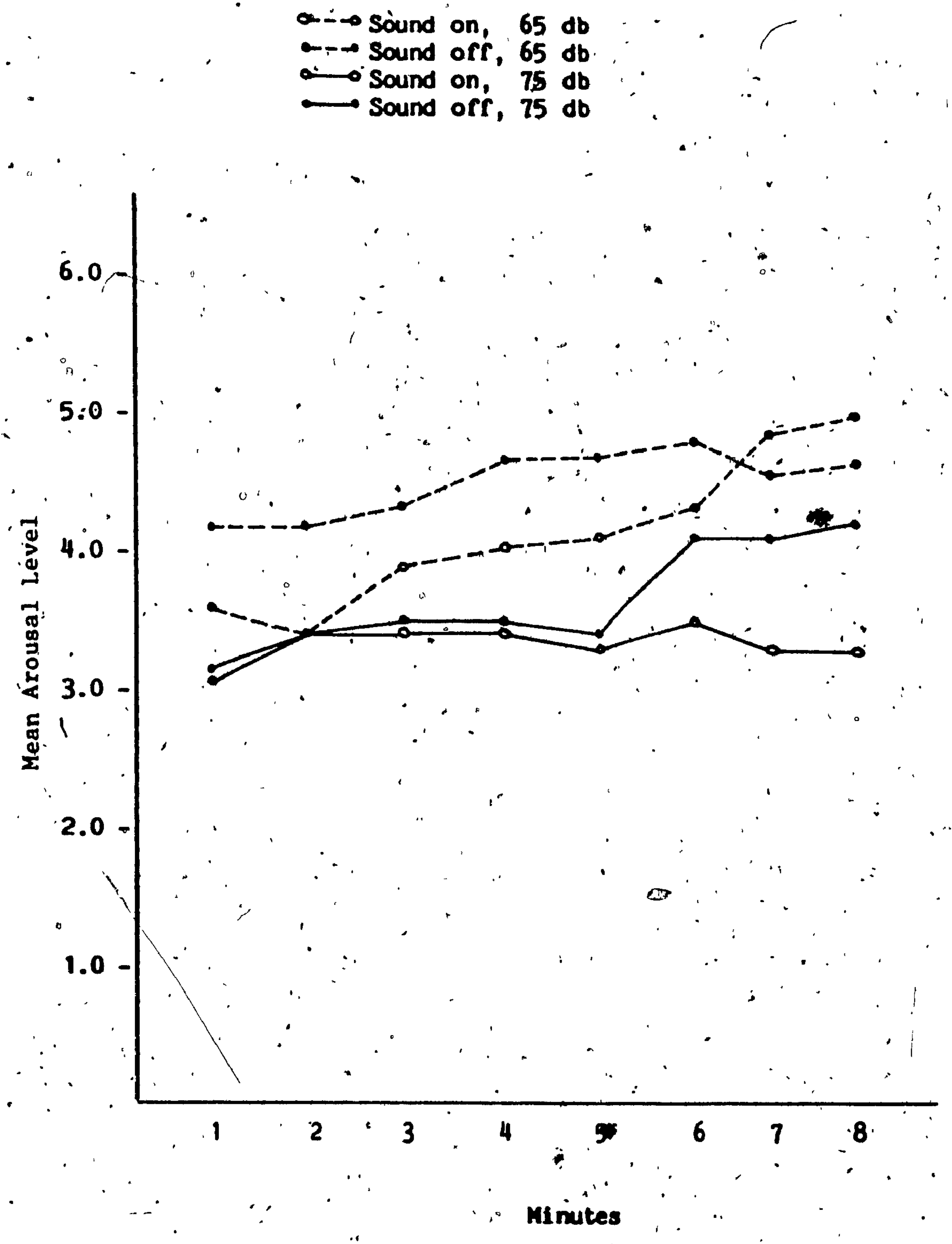


Figure 6. Significant linear x linear on/off x minutes x intensity level trend interaction in arousal scores of male infants for the white noise sessions.

The analysis of variance of the arousal scores of the female infants (n=16) in the white noise sessions yielded no main effects for intensity level, order of sound presentation, and presence or absence of sound. It was found, however, that there was a significant on/off x intensity level x order interaction, F(1,12)=7.71, $p<.02$, which is shown in Figure 7. This triple interaction reflected a definite quieting effect of 65 db white noise which did not occur under 75 db white noise. The 65 db quieting effects were indicated by no changes in arousal level when the sound was turned off following 8 min of white noise in order 1, and a large drop in arousal level with the introduction of white noise after 8 minutes of silence in order 2. The mean arousal scores showed that arousal level during the presentation of white noise at 65 db approached a state of drowsy, particularly for order 2. In contrast, arousal level tended to increase both following the presentation of white noise at 75 db in the first 8 minutes of the session, and when white noise at 75 db was introduced in the second 8 minutes of the session following 8 minutes of silence. The analysis also yielded a main effect of minute trials, F(7,84)=2.33, $p<.05$, and a significant minutes x intensity level interaction, F(7,84)=3.08, $p<.01$, which is shown in Figure 8. Orthogonal trend tests indicated no meaningful significant trend components. The minutes x intensity level interaction reflected the fact that differences in arousal level emerged between the two sound intensity conditions over the last 4 minutes of the experimental periods such that arousal level was higher in the 75 db sessions than in the 65 db sessions. (Mean score minute 8 75 db session= 3.6; mean score minute 8 65 db session= 2.9). This was a further reflection of the quieting effect of 65 db white noise seen in the triple interaction and it

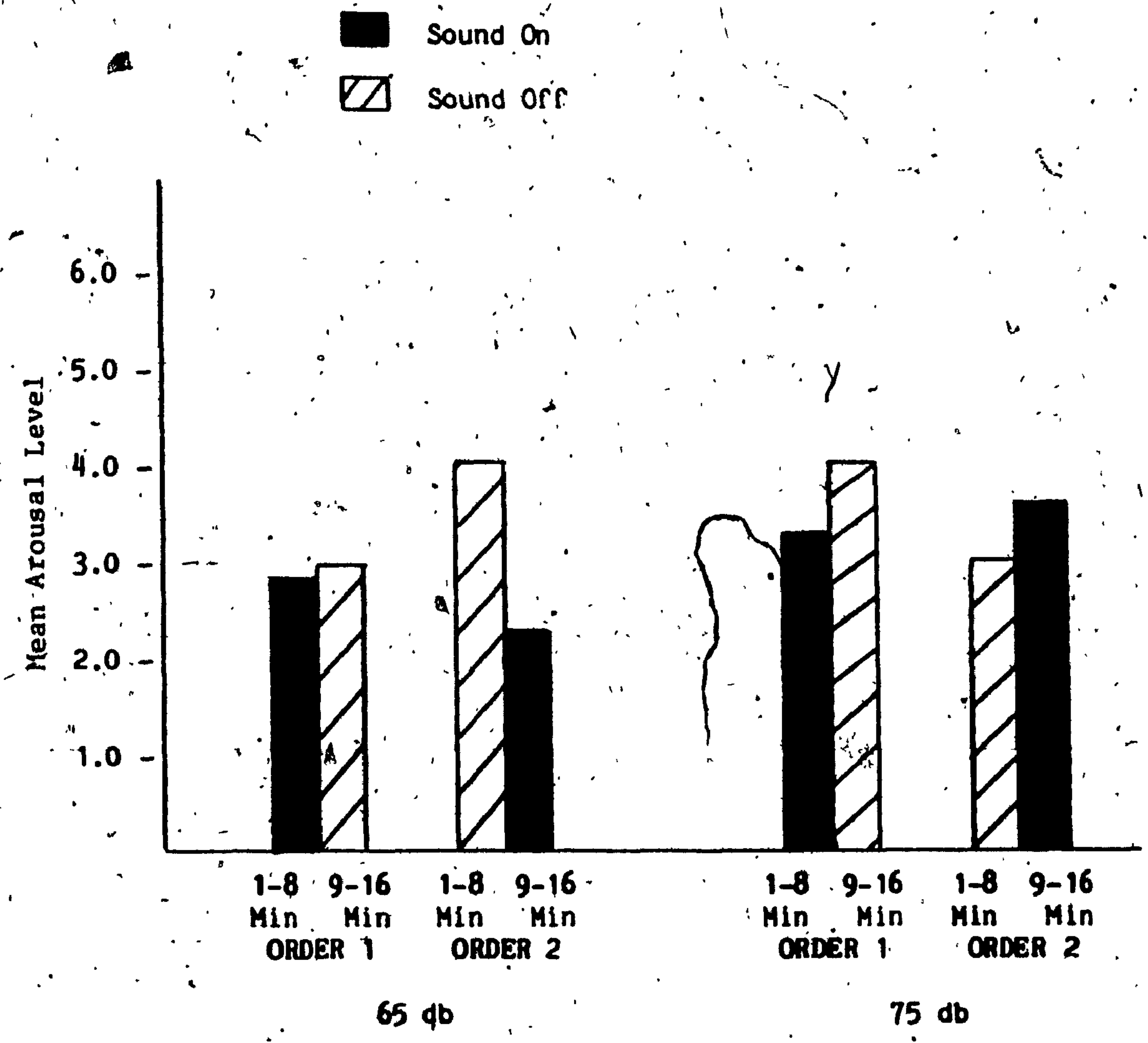


Figure 7. On/off x intensity level x order interaction in arousal scores for female infants in the white noise sessions.

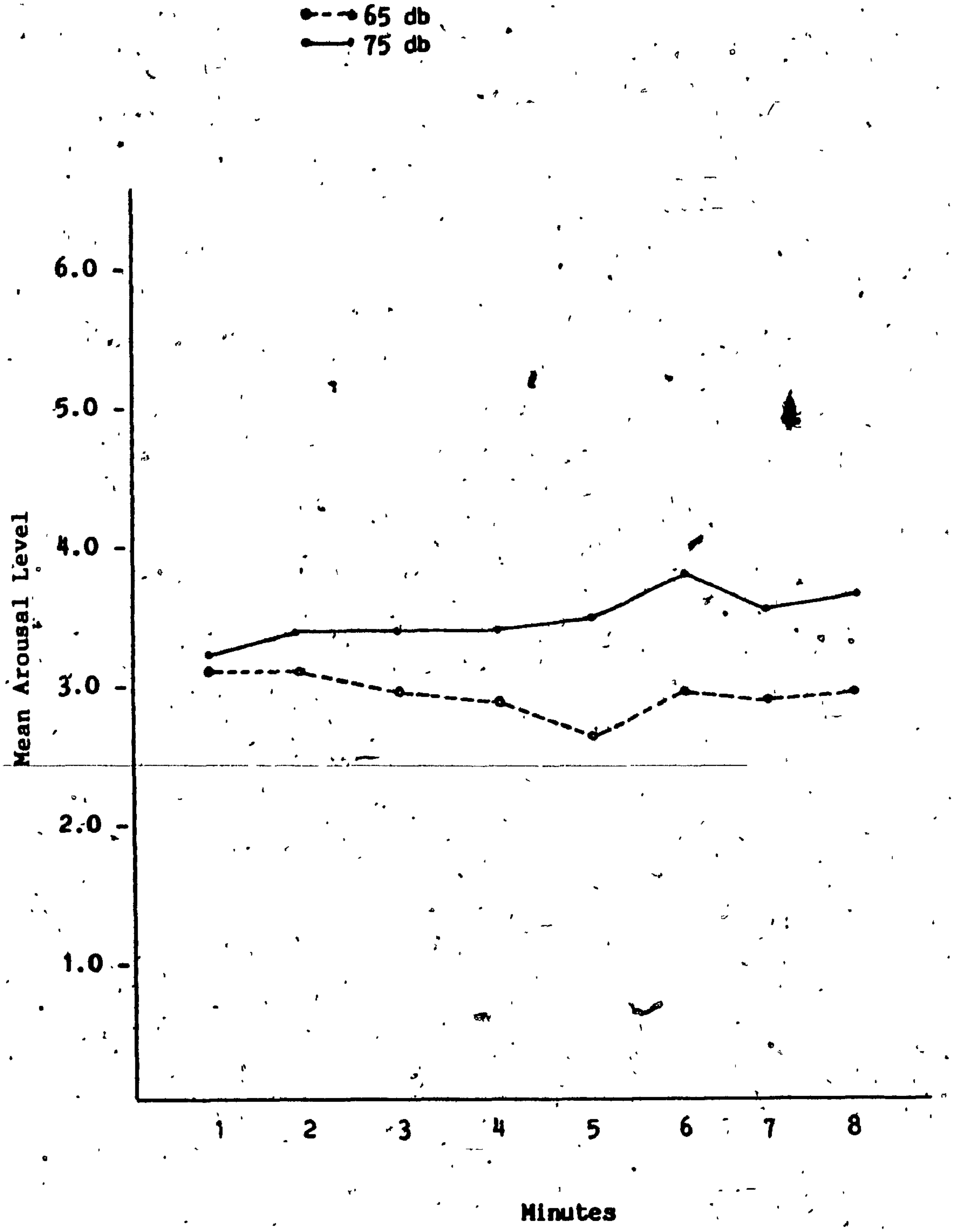


Figure 8. Minutes x intensity level interaction in arousal scores for female infants in the white noise sessions.

suggested as well an arousing effect of white noise at 75 db. The finding of a decrease in arousal level during the presentation of 65 db sound following the 8 minute silent period is consistent with descriptions of Brackbill's C.S.E phenomenon, but the finding of a greater reduction in arousal level with a lower intensity of sound did not meet one criterion for the C.S.E, and was also contrary to the finding obtained with white noise in male infants.

Roe's Infant Vocalization Task

Roe's task was administered to 14/16 infants who received mother-talk in Order 1 and to 15/16 infants who received mother-talk in Order 2; for 8/14 infants in Order 1 and 9/15 infants in Order 2 administration of the task required a third visit. Mean time scores for infant nondistress vocalizations during baseline, and vocal stimulation by mother and by experimenter, and the mean D.V.R scores for both mother first and experimenter first speaker conditions can be found in Appendix H, Table 1. The raw D.V.R scores for males and females can be found in Appendix H, Table 2. All analyses of variance were performed on reciprocal transformation scores because the original distributions were positively skewed. The mean durations of baseline vocalizations for males and females were respectively, 16.1 s and 12.0 s. An analysis of variance performed on the baseline scores to test for differences between the sexes in spontaneous vocalizations showed no significant sex differences. The mean durations of nondistress vocalizations for the baseline, mother as speaker, and experimenter as speaker periods were respectively, 14.0 s, 15.1 s, and 16.3 s. An analysis of variance performed with sex and order of speakers as between-subjects factors, and periods (baseline, mother as speaker, and experimenter as speaker) as a within-subjects factor, yielded no significant effects. Thus Roe's finding of greater vocal responsiveness to mother than to stranger (Roe, Drivas, Karagellis, & Roe, 1985) was not replicated. To assess whether this finding was due to the D.V.R measure always following the state measure, 17 infants who were administered the D.V.R on a separate visit were examined. A one-way analysis of variance performed with periods as the within-subjects factor on the time scores of 10 males and 7 females also indicated no significant effects. The analysis of variance source tables can be found in Appendix I.

Spearman Coefficients of Rank Correlation were computed on the original scores to explore the relationship between the effects of tape-recorded mother-talk on infant state during each minute of the appropriate experimental conditions and three measures derived from Roe's task: the duration of nondistress vocalizations to the mother, the duration of nondistress vocalizations to the experimenter, and the D.V.R score. Since there were no sex effects in the analysis of the mother-talk conditions and no sex effect for measures related to infant vocal responsiveness, the correlational analysis did not require separate analysis for males and females. On the other hand, the analysis of variance on the mother-talk conditions indicated diffefences in arousal level depending on whether mother-talk was presented in the first 8 minutes (Order 1) or the last 8 minutes (Order 2) of the experimental session. Therefore the correlational analysis was performed on the arousal scores for the two orders of mother-talk separately. The tables of intercorrelations can be found in Appendix J.

A significant positive relationship was found for both orders of mother-talk between the duration of nondistress vocalizations emitted to the mother and to the experimenter. (Order 1 rho= .55, p<.05; Order 2 rho= .56, p<.05). Although there were no significant correlations found between the D.V.R score and the duration of nondistress vocalizations to the mother, there was a significant negative relationship between the D.V.R score and the duration of nondistress vocalizations to the experimenter in Order 1 (rho= -.64, p<.05). In addition, a significant positive relationship was found between arousal level under tape-recorded mother-talk and the D.V.R, for Order 1 (min 1, 5, 6, and 7 respectively, rho= .64, .62, .59, and .57, p<.05) and for Order 2 (min 6 and 7 respectively, rho= .61, .50, p<.05). For Order 1, these correlations reflected the fact that infants who were more active or fussed under tape-recorded mother-talk were those who responded more to the mother than to the experimenter on Roe´s task and those who were quiet or drowsy under tape-recorded mother-talk responded more to the experimenter than to their mother. For Order 2, these correlations reflected the fact that infants who cried hard under tape-recorded mother-talk were more responsive to their mother on Roe´s task, whereas infants who did not fuss or cry under tape-recorded mother-talk tended to respond more to the experimenter than to their mother. It was also found that for both orders, there was a significant negative relationship between arousal level under tape-recorded mother-talk and the duration of nondistress vocalizations to the experimenter on Roe´s task. (Order 1 min 1, 6, and 7 respectively, rho= -.51, -.50, -.54, p<.05; Order 2 min 1-7 respectively, rho= -.50, -.56, -.56, -.53, -.49, -.45, -.45, p<.05). Consistent with the above, these correlations reflected that infants who vocalized more to the experimenter tended to tolerate the tape-recorded mother-talk condition better.

Discussion

The purpose of the study was to investigate whether or not Brackbill's "continuous stimulation effect" (C.S.E) phenomenon was present in 3-month-old infants. It was decided that evidence of the classic C.S.E as reported with very young infants (e.g. Brackbill, 1975) would be a lower arousal level under sound than under no sound as well as a lower arousal level under 75 db sound than under 65 db sound. Neither group of infants, whether male or female, met these criteria for evidence of the classic C.S.E. In this study, male infants showed a greater decrease in arousal level when presented with white noise at 75 db than at 65 db. This is consistent with one characteristic of Brackbill's C.S.E phenomenon in which there is a paradoxical inverse relationship between behavioral arousal level and the magnitude of stimulus intensity level. This paradoxical effect of decreased arousal level elicited by intense continuous stimulation was clearly shown in the male infants by the unchanging or constant level of behavioral arousal found with white noise at 75 db in contrast to the marked and steady increase in arousal level shown with white noise at 65 db. White noise presented at a high intensity level appeared to have suppressed arousal level to a degree that was clearly not evident at 65 db. Thus, the direction of the differences found with male infants under the two intensity levels was consistent with one characteristic of Brackbill's C.S.E phenomenon (Brackbill, 1975), such that arousal level was lower under 75 db than under 65 db. The constant and unchanging level of arousal for males found under the impact of white noise at 75 db is consistent with Irwin and Weiss' (1934) description of the effects of continuous stimulation. However, the classic C.S.E phenomenon is characterized by a reduction in arousal level during intense continuous auditory stimulation compared to no sound control periods. This was not seen with male infants during the presentation of white noise at 75 db. In addition, arousal level for the males actually increased under the impact of white noise at 65 db. This is not typical of the C.S.E phenomenon seen in neonates.

The findings for the female infants were contrary to those found for male infants. Namely, female infants showed greater decreases in arousal level when presented with white noise at 65 db than at 75 db. The quieting effects at 65 db were strongly evident by no changes in arousal level when sound was turned off following 8 minutes of white noise and a large drop in arousal level during white noise following the 8 minute silent period. The finding of lower arousal level during sound following the 8 minute silent period is consistent with one component of Brackbill's classic C.S.E. Inspection of the mean scores during the white noise conditions at 65 db for both orders indicated that the females approached a drowsy state. In fact, the greatest decrease in arousal level throughout the white noise period was greatest for females at 65 db. The quieting effects seen with the females during the presentation of white noise at 65 db are similar to the quieting effects reported with neonates under the impact of intense continuous auditory stimulation (Brackbill, 1973). On the other hand, male infants maintained an awake and quiet state throughout the presentation of white noise at 75 db. Arousal level for females tended to increase both following the presentation of white noise at 75 db in the first 8 minutes of the session and during white noise at 75 db following the 8 minute silent period. Inspection of the mean scores during the white noise conditions at 75 db for both orders showed that the females approached an awake and active state. These findings suggest an arousing effect of white noise at 75 db for females that was not present at 65 db. Thus, the finding of a reduction in arousal level elicited by the lower of two stimulus intensity levels is inconsistent with Brackbill's classic C.S.E phenomenon.

The findings which are inconsistent with the C.S.E, may be attributable to developmental changes in the C.S.E in infants at 3 months of age. Given that the C.S.E has been suggested to be mediated by a primitive subcortical mechanism (Brackbill, 1971), it stands to reason that the nature of the C.S.E would change in infants who are at the age which has been described to be the end of a transitional phase in CNS development in which cortical-subcortical connections become functional in the infant (Graham, Leavitt, & Strock, 1978). Neither males nor females met both criteria for evidence of the classic C.S.E. This supports the notion that at 3 months of age the nature of the C.S.E changes. The developmental changes in Brackbill's C.S.E phenomenon suggested by the findings in this study, were the quieting effects in females elicited by continuous white noise at the lower rather than the higher intensity level, and the unchanging and constant level of arousal during the presentation of white noise at 75 db for males, rather than a steady decrease in arousal level under the impact of intense sound which has been reported with neonates (Brackbill, 1973). However, for the males, white noise at 75 db appeared to have prevented behavioral arousal level from increasing throughout the experimental condition (as was the case at 65 db), for arousal level was maintained at an awake and quiet state. This state is characterized by the infant making no gross motor movements and being predominately motionless.

The developmental changes in the C.S.E phenomenon found with females are consistent with reports of a decrease in effectiveness of intense continuous white noise as a soothing stimulus in crying infants between 2 and 3 months of age (Kopp, 1970; D. Potvin, personal communication, August 1, 1985). Kopp and Potvin's studies suggest a developmental change in the pacification effect of continuous white noise between the ages of 2 and 3 months. On the other hand, the direction of the differences in arousal level elicited by intense continuous white noise seen with the males in this study was consistent with similar reports by Brackbill (1975) with 1-month-old infants. Given that it is possible that a lower arousal level during sound than during no sound may be a reflection of factors other than the C.S.E, such as attention to the stimulus, one indication of the existence of at least one component of the classic C.S.E would be the finding of a general characteristic of Brackbill's C.S.E phenomenon reported with one-month-old infants (Brackbill, 1975): namely, that a greater reduction in arousal level is elicited by the higher of two stimulus intensity levels. The male infants in this study showed this paradoxical inverse relationship between behavioral arousal level and the magnitude of stimulus intensity level. Given that the C.S.E has been suggested to be mediated by a primitive subcortical mechanism (Brackbill, 1971), male infants at 3 months of age may be showing the same immature response that has been reported with cortically-immature organisms, such as with neonates. The data in this study also suggest that 3-month-old female infants may be more mature than their male counterparts in terms of Central Nervous

System (CNS) development. The restriction of the quieting effect to lower intensity continuous auditory stimulation seen in the females in this study is consistent with the presumed adult response to the same intensities of stimulation (Brackbill & Fitzgerald, 1969). This is consistent with evidence on tests of neurologic function in newborns that females are about 1 week more mature than males at the time of birth as assessed by EEG responses to flashes of light and the conduction velocity of the peripheral nerves (Tanner, 1974).

The developmental changes in the C.S.E suggested by the findings with white noise for males and females in this study, essentially reflect a weakening in this effect at 3 months of age. It is postulated that the response to monotonous auditory stimulation in the form of white noise in 3-month-olds is mediated by cortical rather than sub-cortical connections. In addition, it appears that at 3 months of age, monotonous auditory stimulation with white noise that is not too intense has a hypnotic, soothing effect on infants.

Tape-recorded mother-talk clearly had no effect in reducing behavioral arousal level. Arousal level was lower in the first 8 minutes of the session than in the latter 8 minutes whether or not sound was on or off. Thus, the findings for mother-talk do not suggest the presence of Brackbill's C.S.E phenomenon. Inspection of the mean arousal scores suggested that male infants under 65 db, maintained an awake and quiet state during the mother-talk condition when it was presented in the first 8 minutes of the session, and showed a marked increase in arousal level to a fussing state by minute 3 during the second 8 minutes when sound was off. These data suggested an attentional response to tape-recorded mother-talk. However, further analysis of other behaviors such as the infant's facial expressions would be beneficial in clarifying the possible attentional responses or emotion expressions (Izard, 1979) (such as interest or fear) to the mother-talk stimulus in all groups of infants.

Tape-recorded continuous speech (edited motherese spoken by an unfamiliar woman) was implemented as a contrast stimulus in order to clarify the nature of the C.S.E phenomenon. Brackbill (1970) presented intermittent white noise to neonates as a control stimulus and found an increase rather than a decrease in arousal level. The findings for speech in this study suggest that it is an appropriate contrast for the paradigm implemented in this study for it was not found to be irritating or arousing; infants responded differently to speech than to white noise in that no sex differences were found for speech, and some infants did seem to find it interesting. It should be noted that responses to unedited motherese spoken by an unfamiliar woman might well be different from those obtained in the present study in which speech samples had been edited to produce greater uniformity in intensity and pacing.

Results from the correlational analysis suggested that infants who were inclined to spend more time emitting nondistress vocalizations to their mother than to the experimenter, did not tolerate the tape-recorded mother-talk condition. The infants who emitted larger durations of nondistress vocalizations to their mother than to the experimenter and therefore were more responsive to their mother (although this difference was not significant) were not particularly interested in motherese from an unfamiliar woman such that these infants generally fussed or cried throughout the tape recorded mother-talk period. These data suggest an experiential effect with mother-talk (or motherese) from the infant's mother.

There were no significant differences on Roe's task between the duration of nondistress vocalizations emitted to the mother and to the experimenter. Thus, Roe's finding of greater vocal responsiveness to mother than to stranger (Roe, Drivas, Karagellis, & Roe, 1985) was not replicated. It is not clear why Roe's finding was not replicated. Roe's task was carefully implemented in this study. In addition, every effort was made for the infants to be in a content state during testing. In fact, more than half of the infants sampled were administered Roe's task on a separate visit from the testing of infant state. It is possible that there may have been some subtle differences in the procedures implemented in this study for the testing and scoring of infant nondistress vocalizations compared to Roe's methods, but it is believed that in this study Roe's task was administered correctly.

Future research endeavors should include the presentation of white noise and mother-talk stimuli to young infants at 70 and 80 db, given that the infants in this study who were presented with auditory stimulation at 65 and 75 db met only certain characteristics of the C.S.E. It is possible if higher intensity stimulation was used in this study, the infants may have shown more characteristics of the C.S.E. In addition, studies which have reported the C.S.E with neonates have used stimulus intensities of 85 db (Brackbill, 1966, 1970, 1971, & 1973). A replication of this study should be done to confirm the fact that sex differences exist in infants 3 months of age when presented with differing intensities of continuous white noise. Given that all infants in this study were tested during the 2 week period falling between 12 and 14 weeks of both their expected and actual dates of birth, it is unlikely that these sex differences were found at random. Because white noise and mother-talk were presented in an identical fashion at identical intensity levels and sex differences were found with white noise but not with mother-talk, one can rule out differences in auditory acuity as an alternate explanation for the sex differences seen with white noise. Future research with the aim of replicating these sex differences should be executed with double the sample size (n=64) to insure an adequate number of subjects for subsequent analyses. Because more than half of the infants sampled in this study required a third visit to successfully complete Roe's Infant Vocalization Task, this measure should be implemented on a separate visit preferrably after the infant's nap and 30 minutes after the infant's last feeding.

The developmental changes in the C.S.E phenomenon need to be studied in infants 2 months of age and in older infants to fully document the developmental pattern of the C.S.E. Based on reports that 3 months of age marks the end of a transitional phase in C.N.S development (Graham, Leavitt, & Strock, 1978) and that there is a dramatic change between 2 and 3 months in the infant's response to continuous white noise (Kopp, 1970; D. Potvin, personal communication, August 1, 1985), 2 and 3 months of age appear to be critical ages for study. Given that older infants are no longer content to lie quietly in their cribs and instead like to sit up, the paradigm used in this study would have to be altered to meet the growing needs of older infants. For example, infants could be tested in their infant seat or on their mother's lap while presented with continuous sound at varying intensity levels. The dependent measures could be the infant's level of arousal and emotion expressions (Izard,

1979) (such as interest) during the course of continuous auditory stimulation. Given that it was speculated that 3-month-old females may be more mature than males in terms of CNS development, it would be of ~~interest~~ to test infants in this age group on indices that assess neurologic function and CNS development, such as in the neurologic examination or on a scoring system for infants that assesses neuromaturational age.

Footnotes

The statistical analyses of arousal scores reported in the results section did not employ the Greenhouse-Geisser correction. When this correction is applied to tests for main effects and interactions involving the minutes factor, the following findings are not significant at the .05 level:

1) p.26-29 and Appendix G, Table 1 the sound type x minutes x intensity level interaction in the first analysis of arousal scores of all subjects in white noise and mother-talk sessions,

2) p.35, p.37 Figure 8, and Appendix G, Table 5 the main effect of minutes and the minutes x intensity level interaction in the anova of females arousal scores in the white noise sessions;

and the significance levels of the minutes main effects and interactions remaining significant are as follows:

1) Appendix G, Table 3 minutes x sex interaction $p<.01$, minutes x sex x intensity level interaction $p<.05$, on/off x minutes x sex x intensity level interaction $p<.05$ in the anova of all subjects arousal scores in white noise sessions.

2) p.32 and Appendix G, Table 4 the main effect of minutes $p<.002$, the on/off x minutes x intensity level interaction $p<.001$ in the anova of males arousal scores in white noise sessions.

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Appendix A

Infant Age at Testing

Infant Age at Testing

		Males		Females	
		V_1	V_2	V_1	V_2
Chronological Age (age from birth - in weeks)					
	M	13.3	13.3	12.9	13.3
	SD	0.50	0.46	0.41	0.49
	range	12 - 13.4	12.2 - 13.5	12 - 13.4	12.1 - 14.1
Post-Conceptional Age (age from expected date of birth - in weeks)					
	M	12.9	13.3	13.1	13.1
	SD	0.49	0.54	0.60	0.61
	range	12 - 13.4	12.1 - 13.6	12 - 13.6	12.1 - 14.1

Appendix B

Consent form

Consent Form

The purpose of this study is to see how babies differ in their levels of state (eg. asleep, drowsy, alert and quiet, alert and moving, fussing, and crying) when listening to different sounds. These sounds are (a) the recorded speech of an unfamiliar mother speaking to her own 3-month-old baby and (b) white noise (like the sound you hear when the television is on, but the television station has signed off for the night). Information from this study will tell us how experience with sounds affects babies' behaviors.

This study will constitute the M.A. thesis of Sharon Kader, a graduate student in Clinical Psychology at Concordia University. This research is under the supervision of, and supported by a grant to, Dr. Nancy Taylor, Associate Professor of Psychology.

Babies will be visited twice at home in the same week. Visits will be scheduled at the mother's convenience. Testings will take place thirty minutes after a feeding. At each visit, the baby will be lying on its back in the crib for 16 minutes as s/he hears eight minutes of silence plus eight minutes of sound. The sounds will be played moderately loud (at 65 or 75 db). A videorecording will be taken of the baby's movements during sound and no-sound periods. Testing will be stopped if the baby cries for 2 minutes. At the end of the second visit, we will obtain a standard measure of the baby's response to language. The baby will be videotaped sitting in an infant seat in three 3-minute segments: without sound, and then with the experimenter and the mother in turn talking to it and encouraging it to vocalize.

I, ______________________________, have read the above description of the research project investigating the effects of sound on the behavior state of babies, and had the study explained to me. I am willing to participate in the study with my baby. I am aware that I am free to withdraw my child from the study at any time. I have been informed that videotapes of me or my baby will not be seen by anyone other than research assistants involved with the project.

Date ____________________ Mother's Signature ____________________
Witness Signature ____________________

Mother's Name ____________________ Telephone (home) ____________
(office) ____________

Baby's Name ____________________

Address ____

Would you like a summary of the results for all subjects when the study is completed?

Yes ____________ No ____________

Appendix C

Sentences Spoken by Experimenter During D.V.R Measure and Instructions to Each Mother for the D.V.R Measure

Sentences Spoken by Experimenter During D.V.R Measure

Hi ___________ (name of infant).

Hello ___________ (name of infant).

Hi ___________ (name of infant).

Are you going to talk to me today?

Are you going to make sounds?

Do you like to talk?

You like to talk.

Yes you do.

Hi ___________ (name of infant).

How are you?

You make such nice sounds.

Are you a star?

Yes you are.

You are on film.

Do you like being on film?

Yes you do.

Hi ___________ (name of infant).

Are you sleepy?

Yes you are.

Are you going to sleep?

You are a good talker.

Yes you are.

You make such nice sounds.

Yes you do.

Would you like to say something else?

You are such a good talker.

Instructions to Each Mother for the D.V.R Measure

I would like you to talk to your baby, trying to get him or her to make as many vocalizations as possible back to you. It is important to make frequent pauses as you speak, in order to give your baby the opportunity to respond to you vocally. Please do not touch your baby as you speak as we are interested in seeing how he or she responds to your voice only. I will tell you when to begin and finish speaking.

Appendix D

Thelen Infant Arousal Scale and Definitions of Infant Vocalizations

Thelen Infant Arousal Scale

1.	Asleep	Eyes usually closed. Deep, regular breathing, body completely relaxed. The eyes may be slightly open, there may be facial grimaces, and there may be the occasional involuntary startle.
2.	Drowsy	Eyes must be glassy or glazed. Eyelids keep closing. The body is relaxed, and breathing is regular. If the infant yawns, he is drowsy. There may be the odd vocalization.
3.	Awake and Quiet	Eyes must be open, bright and shiny. The infant makes almost no gross motor movements and is predominately motionless. (A single headturn or movements of fingers and/or toes may occur). Quiet vocalizations may occur. Not more than one leg movement from the hip may occur. There may be movement from the elbow.
4.	Awake and Active	Eyes are open, bright and shiny. The infant makes repeated gross motor movements, (eg. waving the arm(s), "bicycling with the legs", or is almost constantly in motion thrashing around, moving the head and/or torso, arms and/or legs). Vocalizations may occur including the occasional isolated fuss. Gross motor movement is defined as movement of the leg from the hip, arm from the shoulder, and rolling over.
5.	Fussing	The infant is awake and is predominately engaged in making complaining, cranky sounds. This may

Thelen Infant Arousal Scale (cont'd)

	or may not be accompanied by gross motor activity. Eyes may not be visible if face is screwed up.
6. Crying Hard	The infant is making continuous, sustained, protesting sounds (the sound breaks only when the infant takes a breath). If tears are seen the infant is crying, but not all babies at this age will produce tears. If you feel the infant is sobbing or wailing, then it should be rated as crying.

The distinction between the upper limit of fussing and the lower limit of crying is a temporal one. Fussing is intermittent (ie. there are discrete isolated sounds that can be counted). Crying is continuous with the sound breaking off only to catch the breath. Some babies make a rapid transition from fussing to crying; others remain for a long time in a fussing state.

Infant Vocalizations

1. **Nondistress Vocalizations.**

These vocalizations include neutral talking which are sounds emitted spontaneously or in obvious response to the speaker that are not necessarily cooes or babbling sounds. Exclamations, shouting and calling to the speaker may occur. In addition, the infant may emit cooing or babbling sounds which are typically pleasant to listen to and convey nondistress.

2. **Fussing Vocalizations.**

These are brief vocalizations that occur in isolation or are repeated at short intervals and are definately unhappy, complaining, and whiny. They frequently build in intensity and frequency until the child begins to cry. These vocalizations convey distress, although the baby is not crying at this point. Nagging at the speaker may also occur.

3. **Crying Sounds.**

These are crying, sobbing, and/or wailing sounds which are interrupted when the child takes a breath. Crying may differ in intensity. For this measure the baby does not have to be "crying hard" to be scored as crying.

Appendix E

Percentage Agreement on the Rating of Behavioral State

Table E-1

Percentage Agreement on 9 Pilot Subjects

Initial Reliability Check on Behavioral State

	White Noise	Mother-Talk	No Sound
State			
1. Asleep	-	-	-
2. Drowsy	92.8	--	80.0
3. Quiet and Awake	89.2	88.6	91.4
4. Active and Awake	87.1	84.2	86.2
5. Fussing	89.4	85.7	89.7
6. Crying	98.8	97.8	95.5

Table E-2

Percentage Agreement on 7 Pilot Subjects

Half-Way Reliability Check on Behavioral State

State	White Noise	Mother-Talk	No Sound
1. Asleep	-	-	-
2. Drowsy	84.6	75.0	85.0
3. Quiet and Awake	91.3	90.2	92.9
4. Active and Awake	88.3	87.5	90.5
5. Fussing	85.0	83.3	93.9
6. Crying	88.5	95.6	97.8

Table E-3

Percentage Agreement on 12 Experimental Subjects

Reliability Check on Behavioral State (65 db)

65 db	White Noise Baseline	White Noise	Mother-Talk Baseline	Mother-Talk
State				
1. Asleep	100.0	97.6	-	-
2. Drowsy	80.0	88.4	93.9	87.9
3. Quiet and Awake	88.5	80.7	85.5	83.4
4. Active and Awake	78.6	81.7	80.4	81.3
5. Fussing	76.6	70.4	75.0	72.3
6. Crying	91.7	93.1	86.2	94.9

Table E-4

Percentage Agreement on 12 Experimental Subjects

Reliability Check on Behavioral State (75 db)

75 db State	White Noise Baseline	White Noise	Mother-Talk Baseline	Mother-Talk
1. Asleep	-	-	96.3	100.0
2. Drowsy	90.4	91.4	87.5	81.0
3. Quiet and Awake	81.7	81.6	83.1	90.2
4. Active and Awake	78.4	81.7	78.0	79.6
5. Fussing	83.1	71.4	66.7	88.9
6. Crying	81.8	76.9	85.2	92.0

Appendix F

Mean Arousal Scores for Infant Behavioral State

Mean Arousal Scores for Infant Behavioral State

Males	Min	1	2	3	4	5	6	7	8
Order 1/65 db White Noise									
	M	3.32	3.00	3.28	3.52	3.62	3.88	4.50	4.52
	SD	.57	.63	.58	.54	.24	.79	.92	1.26
Order 1/65 db No Sound									
	M	4.55	4.52	4.72	5.22	5.08	4.88	4.68	5.05
	SD	1.57	1.45	1.37	1.18	1.53	1.51	1.57	1.37
Order 2/65 db White Noise									
	M	3.78	3.90	4.42	4.50	4.58	4.75	5.05	5.38
	SD	1.29	1.55	1.60	1.68	1.64	1.45	1.11	1.25
Order 2/65 db No Sound									
	M	3.80	3.92	3.88	3.90	4.22	4.45	4.30	4.20
	SD	.72	.78	.56	.89	1.19	1.31	1.23	1.28

Note. The higher the score, the higher the behavioral arousal level. Order 1 = White Noise preceded silence. Order 2 = White Noise followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Males	Min	1	2	3	4	5	6	7	8
Order 1/75 db White Noise									
	M	2.98	3.10	2.98	3.00	3.00	3.15	2.88	2.88
	SD	.47	.12	.38	.36	.44	.13	.42	.26
Order 1/75 db No Sound									
	M	3.12	3.50	3.42	3.32	3.18	4.12	4.02	4.55
	SD	.10	.50	.56	.24	.67	.68	.56	.40
Order 2/75 db White Noise									
	M	3.28	3.60	3.72	3.70	3.65	3.80	3.70	3.70
	SD	.61	1.60	1.56	1.54	1.59	1.48	1.56	1.56
Order 2/75 db No Sound									
	M	3.18	3.25	3.62	3.70	3.62	4.00	4.20	3.75
	SD	.33	.40	1.08	1.57	1.05	1.30	.85	.91

Note: The higher the score, the higher the behavioral arousal level. Order 1 = White Noise preceded silence. Order 2 = White Noise followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Males	Min	1	2	3	4	5	6	7	8
Order 1/65 db Mother-Talk									
	M	2.90	3.05	3.00	3.15	2.90	2.95	3.25	3.22
	SD	.63	.60	.55	.53	.75	.73	.78	.61
Order 1/65 db No Sound									
	M	4.18	4.65	5.10	5.28	4.92	5.38	5.80	5.80
	SD	1.02	.88	.76	1.05	1.05	.92	.28	.28
Order 2/65 db Mother-Talk									
	M	4.48	4.72	4.92	4.98	5.15	5.25	5.22	5.15
	SD	1.53	1.50	1.29	1.37	1.33	1.50	1.55	1.57
Order 2/65 db No Sound									
	M	3.25	3.10	3.08	4.00	4.20	4.08	4.05	4.20
	SD	.34	.11	.22	1.01	1.21	1.31	1.33	1.25

Note. The higher the score, the higher the behavioral arousal level. Order 1 = Mother-Talk preceded silence. Order 2 = Mother-Talk followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Males	Min	1	2	3	4	5	6	7	8
Order 1/75 db Mother-Talk									
	M	3.12	3.35	3.40	3.55	4.02	4.28	4.28	4.40
	SD	.09	.24	.28	.65	.89	1.25	1.32	1.16
Order 1/75 db No Sound									
	M	4.38	4.52	4.50	4.42	4.62	4.42	4.58	4.38
	SD	1.18	1.28	1.33	1.40	1.53	1.40	1.65	1.45
Order 2/75 db Mother-Talk									
	M	3.42	3.68	3.60	3.32	3.55	3.72	3.78	3.95
	SD	.33	.41	.22	.39	.48	.62	.68	1.25
Order 2/75 db No Sound									
	M	3.30	3.32	3.18	3.42	3.38	3.70	3.92	3.88
	SD	.12	.22	.17	.32	.33	.22	1.27	1.04

Note. The higher the score, the higher the behavioral arousal level. Order 1 = Mother-Talk preceded silence. Order 2 = Mother-Talk followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Females	Min	1	2	3	4	5	6	7	8
Order 1/65 db White Noise									
	M	2.85	2.62	2.72	2.58	2.62	2.72	2.82	2.68
	SD	.53	.61	.85	1.20	1.13	1.65	1.65	1.73
Order 1/65 db No Sound									
	M	2.78	2.92	2.68	2.18	2.82	2.85	2.98	2.95
	SD	2.16	2.13	1.88	1.36	2.22	2.35	2.40	2.35
Order 2/65 db White Noise									
	M	3.38	3.30	2.58	2.12	1.95	1.80	1.88	2.10
	SD	1.41	1.36	.90	.78	.64	.75	1.04	1.31
Order 2/65 db No Sound									
	M	3.45	3.50	3.55	4.15	3.18	4.12	3.68	3.88
	SD	.17	.14	.60	1.29	.50	1.18	.43	1.37

Note. The higher the score, the higher the behavioral arousal level. Order 1 = White Noise preceded silence. Order 2 = White Noise followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Females	Min	1	2	3	4	5	6	7	8
Order 1/75 db White Noise									
	M	3.00	3.10	3.28	3.00	3.00	3.32	3.40	3.42
	SD	.36	.45	.21	.63	.41	.97	.72	1.16
Order 1/75 db No Sound									
	M	3.58	3.92	3.90	4.00	4.12	4.35	4.22	4.28
	SD	1.21	.99	1.19	.84	.99	1.02	.85	1.11
Order 2/75 db White Noise									
	M	3.18	3.25	3.02	3.35	3.72	4.12	3.18	3.78
	SD	.86	1.10	.89	1.35	1.49	1.63	1.31	1.67
Order 2/75 db No Sound									
	M	3.25	3.02	3.10	3.00	2.78	2.95	3.18	2.92
	SD	.37	.35	.26	.27	.50	.53	.54	1.02

Note. The higher the score, the higher the behavioral arousal level. Order 1 = White Noise preceded silence. Order 2 = White Noise followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Females	Min	1	2	3	4	5	6	7	8
Order 1/65 db Mother-Talk									
	M	3.50	3.42	3.50	3.65	3.98	3.90	3.58	3.70
	SD	.28	.29	.14	1.08	1.24	1.22	.48	.75
Order 1/65 db No Sound									
	M	3.90	3.95	3.92	3.98	3.90	4.05	4.18	4.38
	SD	1.38	1.44	1.40	1.47	1.46	1.31	1.23	1.19
Order 2/65 db Mother-Talk									
	M	4.98	4.95	5.25	5.38	5.32	5.28	5.42	5.18
	SD	1.42	1.54	1.37	1.25	1.35	1.45	1.15	1.65
Order 2/65 db No Sound									
	M	3.08	3.22	3.45	3.95	4.42	4.52	4.82	4.52
	SD	.22	.78	.98	.89	1.20	1.20	1.18	1.10

Note. The higher the score, the higher the behavioral arousal level. Order 1 = Mother-Talk preceded silence. Order 2 = Mother-Talk followed silence.

Mean Arousal Scores for Infant Behavioral State (cont'd)

Females	Min	1	2	3	4	5	6	7	8
Order 1/75 db Mother-Talk									
	M	3.52	3.50	3.45	3.78	3.68	3.70	3.98	3.72
	SD	.15	.45	.45	.89	.95	1.07	.96	1.33
Order 1/75 db No Sound									
	M	3.70	3.98	4.08	3.75	4.12	4.12	4.55	4.78
	SD	1.57	1.45	1.51	1.60	1.85	2.16	1.40	1.16
Order 2/75 db Mother-Talk									
	M	3.88	3.70	4.08	4.10	4.10	4.42	4.48	4.80
	SD	1.38	1.86	2.38	2.40	2.40	2.36	2.37	2.50
Order 2/75 db No Sound									
	M	3.30	2.92	2.68	2.62	2.82	3.72	3.60	4.00
	SD	.27	.12	.62	.74	1.16	2.17	1.90	2.20

Note. The higher the score, the higher the behavioral arousal level. Order 1 = Mother-Talk preceded silence. Order 2 = Mother-Talk followed silence.

Appendix G

Source Tables for Infant Behavioral State

Table G-1

Source Table for ANOVA on Arousal Scores for all Variables

Source	df	MS	F	P
Between Subjects				
Intensity Level (L)	1	.00166	.01	
Order (0)	1	.00182	.01	
L x 0	1	.44483	1.99	
Error	28	.22347		
Within Subjects				
Sound Type (ST)	1	.69103	2.67	
ST x L	1	.55073	2.13	
ST x 0	1	.11004	.43	
ST x L x 0	1	.00792	.03	
Error	28	.25876		
On/Off (0/0)	1	.11154	2.11	
0/0 x L	1	.00461	.09	
0/0 x 0	1	.02602	.49	
0/0 x L x 0	1	.04029	.76	
Error	28	.05295		
ST x 0/0	1	.05596	1.02	
ST x 0/0 x L	1	.00181	.03	
ST x 0/0 x 0	1	.24722	4.50	<.05
ST x 0/0 x L x 0	1	.41334	7.53	<.01
Error	28	.05488		
Min (M)	7	.00352	.61	
M x L	7	.00119	.20	
M x 0	7	.00387	.66	
M x L x 0	7	.00249	.43	
Error	196	.00582		

Table G-1

Source Table for ANOVA on Arousal Scores for all Variables (cont'd)

Source	df	MS	F	P
ST x M	7	.00684	1.07	
ST x M x L	7	.01634	2.55	<.02
ST x M x 0	7	.00078	.12	
ST x M x L x 0	7	.00407	.63	
Error	196	.00641		
0/0 x M	7	.00545	1.10	
0/0 x M x L	7	.00634	1.28	
0/0 x M x 0	7	.00295	.60	
0/0 x M x L x 0	7	.00530	1.07	
Error	196	.00493		
ST x 0/0 x M	7	.00205	.44	
ST x 0/0 x M x L	7	.00073	.16	
ST x 0/0 x M x 0	7	.00162	.35	
ST x 0/0 x M x L x 0	7	.00359	.78	
Error	196	.00463		

Table G-2

Source Table for ANOVA on Mother-Talk Arousal Scores

Source	df	MS	F	P
Between Subjects				
Sex (S)	1	.10249	.56	
Intensity Level (L)	1	.24595	1.35	
Order (O)	1	.04177	.23	
S x L	1	.13374	.74	
S x O	1	.02738	.15	
L x O	1	.28573	1.57	
S x L x O	1	.06603	.36	
Error	24	.18187		
Within Subjects				
On/Off (O/O)	1	.00474	.18	
O/O x S	1	.04617	1.74	
O/O x L	1	.00032	.01	
O/O x O	1	.21682	8.19	<.01
O/O x S x L	1	.01663	.63	
O/O x S x O	1	.04974	1.88	
O/O x L x O	1	.09777	3.69	
O/O x S x L x O	1	.01731	.65	
Error	24	.02647		
Min (M)	7	.00642	1.10	
M x S	7	.00324	.55	
M x L	7	.00596	1.02	
M x O	7	.00214	.37	
M x S x L	7	.00310	.53	
M x S x O	7	.00075	.13	
M x L x O	7	.00553	.95	
M x S x L x O	7	.00395	.68	
Error	168	.00585		

Table G-2

Source Table for ANOVA on Mother-Talk Arousal Scores (cont'd)

Source	df	MS	F	P
0/0 x M	7	.00086	.30	
0/0 x M x S	7	.00147	.52	
0/0 x M x L	7	.00361	1.28	
0/0 x M x 0	7	.00158	.56	
0/0 x M x S x L	7	.00059	.21	
0/0 x M x S x 0	7	.00121	.43	
0/0 x M x L x 0	7	.00058	.20	
0/0 x M x S x L x 0	7	.00277	.98	
Error	168	.00283		

Table G-3

Source Table for ANOVA on White Noise Arousal Scores

Source	df	MS	F	P
Between Subjects				
Sex (S)	1	1.55044	6.48	<.02
Intensity Level (L)	1	.30644	1.28	
Order (O)	1	.07008	.29	
S x L	1	1.27127	5.32	<.03
S x O	1	.02392	.10	
L x O	1	.16702	.70	
S x L x O	1	.22208	.93	
Error	24	.23917		
Within Subjects				
On/Off (O/O)	1	.16276	2.68	
O/O x S	1	.00725	.12	
O/O x L	1	.00610	.10	
O/O x O	1	.05642	.93	
O/O x S x L	1	.02214	.36	
O/O x S x O	1	.31077	5.11	<.03
O/O x L x O	1	.35586	5.86	<.02
O/O x S x L x O	1	.45563	7.50	<.01
Error	24	.06076		
Min (M)	7	.00394	.69	
M x S	7	.02866	5.00	<.0001
M x L	7	.01157	2.02	.056
M x O	7	.00251	.44	
M x S x L	7	.02062	3.60	<.01
M x S x O	7	.00322	.56	
M x L x O	7	.00104	.18	
M x S x L x O	7	.00094	.16	
Error	168	.00573		

Table G-3

Source Table for ANOVA on White Noise Arousal Scores (cont'd)

Source	df	MS	F	P
0/0 x M	7	.00664	1.03	
0/0 x M x S	7	.00767	1.19	
0/0 x M x L	7	.00346	.54	
0/0 x M x 0	7	.00299	.46	
0/0 x M x S x L	7	.02213	3.43	<.01
0/0 x M x S x 0	7	.00319	.50	
0/0 x M x L x 0	7	.00832	1.29	
0/0 x M x S x L x 0	7	.00615	.95	
Error	168	.00644		

Table G-4

Source Table for ANOVA on White Noise Arousal Scores
Males (n = 16)

Source	df	MS	F.	P
Between Subjects				
Intensity Level (L)	1	.16470	4.47	.056
Order (O)	1	.00606	.16	
L x O	1	.00196	.05	
Error	12	.03681		
Within Subjects				
On/Off (O/O)	1	.05066	3.03	
O/O x L	1	.00250	.15	
O/O x O	1	.05118	3.06	
O/O x L x O	1	.00308	.18	
Error	12	.01672		
Min (M)	7	.00948	6.10	<.0001
M x L	7	.00169	1.09	
M x O	7	.00046	.30	
M x L x O	7	.00076	.49	
Error	84	.00155		
O/O x M	7	.00033	.28	
O/O x M x L	7	.00651	5.52	<.0001
O/O x M x O	7	.00079	.67	
O/O x M x L x O	7	.00074	.63	
Error	84	.00118		

Table G-5

Source Table for ANOVA on White Noise Arousal Scores Females ($n = 16$)

Source	df	MS	F	P
Between Subjects				
Intensity Level (L)	1	1.41301	3.20	
Order (0)	1	.08795	.20	
L x 0	1	.38714	.88	
Error	12	.44153		
Within Subjects				
On/Off (0/0)	1	.11935	1.14	
0/0 x L	1	.02574	.25	
0/0 x 0	1	.31601	3.02	
0/0 x L x 0	1	.80841	7.71	<.02
Error	12	.10480		
Min (M)	7	.02312	2.33	<.05
M x L	7	.03050	3.08	<.01
M x 0	7	.00527	.53	
M x L x 0	7	.00122	.12	
Error	84	.00991		
0/0 x M	7	.01399	1.19	
0/0 x M x L	7	.01909	1.63	
0/0 x M x 0	7	.00538	.46	
0/0 x M x L x 0	7	.01373	1.17	
Error	84	.01171		

Appendix H

Mean Time Scores and D.V.R Scores for Roe's Infant Vocalization Task

Table H-1

Mean Time ~~Scores for Roe~~'s Infant Vocalization Task (in seconds)

		Mother First Speaker		Experimenter First Speaker	
		Males (n = 6)	Females (n = 7)	Males (n = 8)	Females (n = 8)
Baseline	M	23.23	12.73	8.90	11.20
	SD	21.09	9.84	6.55	9.57
Mother	M	12.65	15.08	20.29	12.36
	SD	8.48	8.13	14.93	9.82
Exp	M	25.98	11.46	15.45	12.46
	SD	15.95	9.17	11.89	12.84
D.V.R.	M	-13.35	3.60	4.81	-.12
	SD	17.71	8.87	11.02	5.15

Note. The values represent mean duration of non-distress vocalizations during Roe's Infant Vocalization Task.

Table H-2

D.V.R. Scores for Roe's Infant Vocalization Task

Mother First Speaker		Experimenter First Speaker	
Males (n = 6)	Females (n = 7)	Males (n = 8)	Females (n = 8)
- 1.48	- 2.36	23.74	1.77
-34.89	- 6.35	.32	- 8.17
.08	1.52	-12.50	1.58
-37.27	13.39	9.23	6.88
- 1.76	- 4.18	13.61	- 2.05
- 4.73	16.37	- 3.68	- 6.51
	6.97	5.34	1.40
		2.64	4.14

Note. Positive scores indicate greater duration of non-distress vocalizations to the mother. Negative scores indicate greater duration of non-distress vocalizations to the experimenter.

Appendix I

Source Tables for Infant Vocalizations

Table I-1

Source Table for ANOVA on Baseline Scores for Roe's Infant Vocalization Task

Source	df	MS	F	P
Between Subjects				
Sex	1	.01997	.48	
Error	27	.04181		

Table I-2

Source Table for ANOVA on Scores for Baseline, Mother as Speaker and Experimenter as Speaker for Roe's Infant Vocalization Task (n = 29)

Source	df	MS	F	P
Between Subjects				
Sex	1	.00070	.01	
Order (O)	1	.02704	.35	
S x O	1	.00135	.02	
Error	25	.07667		
Within Subjects				
Periods (P)	2	.02484	.91	
P x S	2	.02574	.95	
P x O	2	.01820	.67	
P x S x O	2	.00607	.22	
Error	50	.02717		

Table I-3

Source Table for ANOVA on Scores for Baseline, Mother as Speaker and Experimenter as Speaker for Roe's Infant Vocalization Task (*n* = 17)

Source	df	MS	F	p
Within Subjects				
Periods	2	.03824	1.70	
Error	32	.02249		

Appendix J

Spearman Rho Intercorrelations

Table J-1

Spearman Rho Correlations between Arousal Scores during Presentation of Tape-recorded Mother-Talk (Order 1) and Three Measures from Roe's Elicited Vocalization Task ($n = 14$)

	Measure		
Arousal Score[a]	Duration of Vocalization to Mother	Duration of Vocalization to Experimenter	D.V.R.
Min 1	-.153	-.514*	.640*
2	.115	-.146	.448
3	-.083	-.254	.371
4	-.359	-.210	.113
5	.007	-.444	.625*
6	-.128	-.504*	.594*
7	-.373	-.540*	.566*
8	.134	-.234	.394
Mother	-	.548*	.132
Experimenter		-	-.644*

[a] Order of presentation for the mother-talk sessions was sound first followed by silence.

* $p < .05$

Table J-2

Spearman Rho Correlations between Arousal Scores during Presentation of Tape-recorded Mother-Talk (Order 2) and Three Measures from Roe's Elicited Vocalization Task (n = 15)

	Measure		
Arousal Score[a]	Duration of Vocalization to Mother	Duration of Vocalization to Experimenter	D.V.R.
Min 1	-.357	-.503*	.345
2	-.399	-.555*	.379
3	-.386	-.558*	.412
4	-.365	-.528*	.358
5	-.298	-.494*	.381
6	-.060	-.449*	.610*
7	[illegible].159	-.449*	.502*
8	-.134	-.361	.326
Mother	-	.558*	.329
Experimenter		-	-.404

[a] Order of presentation for the mother-talk sessions was silence first followed by sound.

* $p < .05$