The Continuous Stimulation Effect in Preterm and Fullterm Infants of Equivalent Postconceptional Age

Diane Potvin

A Thesis
in
The Department
of
Psychology

Presented in Partial Fulfillment of the Requirements
for the degree of Master of Arts at
Concordia University
Montréal, Québec, Canada

March 1984

ABSTRACT

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The purpose of the study was to investigate whether prematurity per se is associated with a slower rate of neurophysiological maturation than that experienced by fullterm infants of equivalent postconceptional age using Brackbill's continuous stimulation effect paradigm (Brackbill, 1970). Fifteen fullterm and 15 preterm infants screened for major complications were videotaped in their cribs 2 and 3 months after their expected date of birth under 8-min no noise, 80db continuous white noise, and 80db intermittent white noise conditions. Videotapes were rated once for time in 6 behavioral states, fussing, and yawns, and again for gross motor activity. Nonparametric analyses provided evidence of the continuous stimulation effect in fullterm infants at 2 and 3 months of age: under continuous white noise, time spent in quiet awake increased, while active awake and motor activity decreased; combined fussing and crying decreased, but only at 2 months. Increases in motor activity and fussing/crying under continuous white noise indicated the effect weakened between 2 and 3 months. At 2 months corrected age, preterms showed only a marginally significant decrease in active awake under continuous white noise, and a marked increase in fussing/crying under the intermittent noise condition; these data were interpreted as evidence of CNS hyperexcitability. At 3 months corrected age, preterms

demonstrated the continuous stimulation effect by increased quiet awake, more yawns, less fussing/crying, and decreased motor activity under continuous white noise. The data were suggested to reflect either a slower rate, or a different pattern, of neural maturation in preterm infants.

Acknowledgements

I am greatly indebted to my thesis supervisor, Dr. Nancy Taylor for the guidance, support, and devotion that she showed during the development, investigation, and writing of this thesis. I would like to thank the members of my committee, Dr. Ron Hooper, Dr. Maria Ramsay, and Dr. Jacynthe Baribeau-Braun for their interest and helpful suggestions.

This study would not have been possible without the cooperation and support of Dr. A. Papageorgiou, Neonatologist-in-Chief of the Jewish General Hospital, who permitted access to the infants in both the Neonatal Intensive Care Unit and the Main Nursery, and who with Dr. Kunos helped establish the selection criteria for our infants. Thanks are also due to all the mothers who allowed me into their homes to test their infants and to the infants themselves.

I am particularly grateful to my parents and family for their encouragement and support. It provided me with the added incentive to carry out my work. I wish to express special thanks to Lorraine Cramp for her help with the selection of appropriate subjects and the testing of infants as well as for her devotion. A sincere thank you to Stella Lumia and Mary Lagiorgia who rated the videotapes.

This project was supported by grants to Dr. N. Taylor from the "Fonds FCAC pour l'aide et le soutien à la recherche" Grant EQ 1924 and from the Concordia University FCAC General Research Grant.

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The Continuous Stimulation Effect in Preterm and Fullterm Infants of Equivalent Postconceptional Age

This study is an investigation of one hypothesized effect of birth before term in the human infant: specifically, that prematurity per se is associated in early infancy with a slower rate of neurophysiological maturation than that experienced by the fullterm infant at an equivalent biological age. By biological age is meant age from conception (postconceptional age) in contrast to age from birth (chronological age). Preterm infants defined as infants born at less than 37 weeks gestational age (GA) are thought to be at greater risk than fullterm infants, whose GA ranges from 38 to 42 weeks, for such impairments as mental retardation, and vision and hearing deficits. Although the quality of care has greatly improved in the last decade, as is suggested by increased rate of survival of very low birthweight preterm infants from 25% to 50%, preterm infants remain at risk for these and numerous other impairments (Pape, Buncic, Ashby, & Fitzhardinge, 1978). Even preterm infants who have benefited from the increased quality of care and have apparently escaped specific impairments, show delays in areas of motor and cognitive development (Siegel, Saigal, Rosenbaum, Young, Berenbaum, & Stoskopf, 1979). When preterm and fullterm infants are tested at equivalent chronological ages (CA), the significant differences found between preterm and fullterm infants' performance may be a function of comparing infants at different biological ages and not necessarily reflect delays in preterm infants' functioning. Hunt and Rhodes (1977) found preterm infants' test scores were closely related to their biological age and suggested that adjusting test scores for prematurity provides a more accurate account of preterm infants' level of functioning. Although more accurate, adjusted scores were found to overcorrect at the third and fourth months for preterm infants of less than 35 weeks GA. In recent follow-up studies, however, preterm infants have been shown to have a poorer performance than that of fullterm infants even when test scores or assessment dates were corrected for prematurity. Differences between preterm and fullterm groups were found to persist through to 5 years of age (Field, Dempsey, & Shuman, 1981, 1983; Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Ungerer & Sigman, 1983). Experimental studies of visual information processing have also shown poorer performance of preterm infants relative to fullterm infants of equivalent biological age (Rose, Gottfried, & Bridger, 1979; Rose, 1983). These findings imply a delay or slower rate of neurophysiological development or possibly a deficit in preterm infants' functioning. Whether the poorer performance of preterm infants is a reflection of prematurity per se or of complications associated with prematurity is difficult to establish, since investigators have either made no attempt to screen for complications associated with prematurity or have studied special groups of preterm infants such as those with Respiratory Distress Syndrome (RDS).

"Relatively intact" (Caputo, Goldstein, & Taub, 1979, p. 223) moderately premature children have been shown to differ from children born at term. In a longitudinal study, Caputo, Goldstein, and Taub (1979) compared 137 preterm and 96 fullterm infants born between 1965 and 1969. Preterm infants who weighed between 1400 and 2500 gms and who were not judged by their physician to be at severe medical risk were solicited for the study. Although infants were screened for hyaline membrane disease, cardiac dysfunction and anomalies requiring surgery, these infants did not have the benefits of contemporary improvements in quality of medical care. The preterm sample consisted of middle class, moderately premature infants having a mean GA of 34.9 weeks and a mean birthweight (BW) of 2168 gms. At 1 year CA the Cattell Infant Intelligence Scale and the Gesell Motor and Personal-Social Scales were administered. When the children reached 7 - $9^1/2$ years CA, the WISC-R and the Bender Visual Motor Gestalt Test were given. The results indicated that moderate prematurity was associated with poorer performance on the Cattell Scale at 1 year CA as well as lowered scores on the Performance Scale of the WISC-R and poorer performance on the Bender Gestalt Test at 7 - $9^1/2$ years CA. The poorer performance at 7 - $9^1/2$ years of children born prematurely led the authors to suggest that children who have experienced premature birth suffer from a subtle visuomotor deficit and not a delay in functioning.

Despite the increased quality of care since 1970, preterm infants remain at risk for numerous problems. In a Canadian 2-year follow-up study of very low birthweight (less than 1001 gms) infants born in 1974, Pape, Buncic, Ashby, and Fitzhardinge (1978) reported that 35% of the infants developed lower respiratory tract infections during the first 2 years, 16% had retrolental fibroplasia, 9% suffered major neurologic defects, and 21% evidenced severe developmental delay.

In another recent Canadian study, Siegel, Saigal, Rosenbaum, Young, Berenbaum, and Stoskopf (1979) also reported deficits in preterm infants who had benefited from the increased quality of care. Eighty low birthweight (under 1500 gms) preterm infants were compared to a fullterm sample on the Bayley Scales of Infant Development at CA of 4, 8, 12, 18, and 24 months; on the Caldwell Inventory of Home Stimulation at a CA of 12 months; on the Reynell Developmental Language Scales at a CA of 24 months. All preterm infants whose birthweight was under 1500 gms were enrolled in the study and no screening for complications was done. Greater discrepancies between the preterm and fullterm groups were seen when the scores were not corrected for prematurity. In the latter case, the preterm infants had significantly lower mental and motor Bayley test scores at 4, 8, 12, 18, and 24 months and lower Reynell scores at 24 months. When corrected for prematurity, the preterm infants' scores were significantly lower at 8, 12, 18, and 24 months than those of the fullterm infants on the Bayley motor development scale.

In a 5-year follow-up study of these infants, poorer performance by the preterm group relative to the fullterm group was still evident (Siegel, 1983). In addition to the tests mentioned earlier, children were administered the Stanford-Binet at 3 years; the McCarthy Scale of Children's Abilities, the ITPA Grammatic Closure, the Northwestern Syntax Screening Test, the Beery Developmental Test of Visual Motor Integration, and the Peabody Picture Vocabulary Test at 5 years. When uncorrected scores were compared, children born prematurely had significantly poorer performance on all but the language measures. Although the uncorrected McCarthy General Cognitive Index for the preterm group was significantly lower than for the fullterm group, it was still within the average range. When corrected for prematurity, the scores of children born prematurely were significantly lower than those of children born at term only on the Beery test, which is a measure of perceptual-motor skills. Since perceptual-motor skills are thought to reflect the maturation of the nervous system, these data suggest a different, possibly slower rate of neurophysiological maturation in preterm infants.

Further evidence of persisting differences between preterm and fullterm infants was reported in a 5-year follow-up study of white, middle-class children by Field, Dempsey, and Shuman (1981, 1983). Preterm infants with RDS and postterm infants presenting with postmaturity syndrome were compared to term infants in an attempt to describe the developmental course of both risk groups. Subjects were administered a variety of assessments including the Brazelton Neonatal Behavioral Assessment Scale (BNBAS) at 40 weeks biological age; the Denver Developmental Screening Test at 4 months corrected age; the Bayley Scales of Infant Development at 8 months, 1 and 2 years corrected age; and the McCarthy scales at 3, 4, and 5 years corrected age. Preterm infants received significantly lower interactive and motoric processes on the Brazelton scales at 40 weeks postconceptional age and scored lower on personal-social and gross motor items of the Denver Developmental test at 4 months corrected age. They also scored significantly lower than fullterm infants on the Bayley mental and motor scales at 8 months as well as 1 and 2 years corrected age and were found to have the greatest number of complications during the first two years of life as measured by the Pediatric Complications Scale. From 3 to 5 years, children born prematurely had lower weight, lower mental age, more behavior problems, inferior language production, and shorter attention span than children born at term. Although preterm and postterm infants' performance was poorer than that of fullterm infants, qualitative differences were seen between the nonterm groups.

According to the Brazelton test, preterm infants were floppy, hypotonic, difficult to arouse and alert, had weak reflexes, and flat affect, whereas postterm infants were very active, hyperirritable, extremely labile, hypertonic, and difficult to console. Unlike preterm infants, no significant difference was found between postterm and fullterm groups on any measures of motor development.

Persisting poorer performance of preterm infants relative to fullterm infants were also found in a follow-up study by Ungerer and Sigman (1983). Preterm infants with a mean GA of 31 weeks and a mean BW of 1800 gms were compared to fullterm infants at both postnatal and corrected ages of $13^1/2$, 22, and 36 months on tasks measuring freeplay, sensorimotor development, language, and general developmental skills. Preterm infants were not screened for complications such as RDS, ventilatory assistance, infection, temperature disturbance, hyperbilirubinemia, noninfectious illnesses, metabolic disturbances, convulsions, surgery, and feeding problems. Greater discrepancies between preterm and fullterm infants' performance were found when infants were tested at equivalent postnatal ages. At $13^1/2$ months postnatal age preterm infants demonstrated less diverse functional and symbolic play, and fewer different sequences of related acts than fullterm infants. Poorer sensorimotor skills and poorer general developmental skills were found in preterm infants at $13^1/2$, 22, and 36 months postnatal age. When infants were compared at equivalent biological ages, preterm infants still had poorer sensorimotor functioning, as well as lower scores on the gross motor and personal-social scales of the Gesell at $13^1/2$ months. Although these differences were not maintained at 22 months corrected age, preterm infants were found to have difficulties in other areas. At 22 months corrected age, preterm infants were found to have poorer language skills than fullterm infants. Problems in visual information processing and/or perceptual motor skills were found in preterm infants at 36 months corrected age. The latter finding led the authors to suggest a continuity between impairments in information processing found in infancy and the perceptual-motor deficits identified in the later school years.

Crnic, Ragozin, Greenberg, Robinson, and Basham (1983) have also reported poorer performance of preterm infants relative to fullterm infants of equivalent biological age on measures of cognitive and language development. Their sample consisted of 42 fullterm infants and 37 preterm infants. Preterm infants had a mean GA of 31 weeks and a mean BW of 1400 gms and 46% were diagnosed as having RDS. Infants were assessed on the Bzoch and League Receptive-Expressive Emergent Language Scale at 1 month postnatal age and on the Bayley Scales of Infant Development at 4, 8, and 12 months corrected age. Although scores were in the normal range, preterm infants had significantly lower Bayley mental and motor scores than fullterm infants at both 4 and 12 months corrected age. Preterm infants were also found to vocalize less than fullterm infants in structured vocal elicitation episodes and performed significantly less well than fullterm infants on measures of early language expression. The language deficiencies found in preterm infants were thought to be a function of a neurophysiological lag associated with prematurity.

Numerous developmental follow-up studies of preterm infants suggest persisting poorer performance of this group compared to fullterm infants of equivalent biological age. Like the follow-up studies, experimental studies investigating preterm and fullterm infants have also reported poorer performance of preterm infants relative to fullterm infants of equivalent biological age. Rose, Gottfried, and Bridger (1979) investigated the effect of haptic exploration on visual recognition in preterm and fullterm infants of 6 and 12 months of age. Although infants were screened for visual and neurological abnormalities, no mention was made of screening preterm infants for complications associated with prematurity such as RDS. Preterm infants had a mean GA of 33 weeks and a mean BW of 1700 gms. Unlike the 6-month-old fullterm infants, preterm infants showed no evidence of visual recognition memory at 6 months corrected age. At 12 months corrected age, the performance of preterm infants was inferior to that of 12-month-old fullterm infants who showed evidence of recognition memory in all conditions. At 12 months corrected age, preterm infants' performance was comparable to that of 6-month-old fullterm infants with both groups showing evidence of memory in the visual condition and no evidence of memory in the condition that involved manipulation. These findings suggest a lag in preterm infants' ability to process visual information and their ability to deal with haptic and visual cues simultaneously.

In a subsequent study, Rose (1983) investigated the effect of increasing familiarization time on the visual recognition memory of moderately premature infants and fullterm infants of 6 and 12 months. As for the previous study, infants were screened for visual and neurological abnormalities, however, no mention was made of screening preterm infants for complications associated with prematurity.

Preterm infants had a mean GA of 35 weeks and a mean BW of 1800 gms. The results indicated that older infants showed evidence of recognition memory after less familiarization time than younger infants and preterm infants required considerably longer familiarization time than fullterm infants at both 6 and 12 months corrected age. On the basis of these findings, the author has suggested that preterm infants are slower than fullterm infants to encode information.

Both follow-up and experimental studies have reported inferior performance of preterm infants relative to fullterm infants of equivalent biological age on measures of motor development, perceptual-motor skills and visual information processing. Less consistent are the findings of poorer performance on cognitive measures in preterm infants as well as differences between preterm and fullterm groups persisting into childhood when scores are corrected for prematurity. Although the literature is not conclusive, suggestions have been made that poorer performance of the preterm infants on different tasks may reflect a slower rate of neurophysiological maturation. Whether prematurity per se is associated with a slower rate of neurophysiological maturation at equivalent postconceptional ages than birth at term is still an unresolved issue. Persisting differences found in studies that have used samples of preterm infants unscreened for RDS may in fact be accounted for in terms of a deficit. Research on the question has been hampered by the lack of a task which closely reflects neurophysiological development and is capable of differentiating a delay from a deficit. Although motor development is thought to most closely reflect neurophysiological development, its sensitivity to experiential factors renders it less representative of neurophysiological development alone.

An appropriate task would be one that shows a maturational shift in fullterm infants, and while sensitive to neurophysiological development remains insensitive to experiential factors. One phenomenon that appears to meet these criteria is the continuous stimulation effect (Brackbill, 1970; Brackbill, 1971).

Brackbill (1970) investigated the effects of no sound, intermittent sound and continuous sound on infants' level of arousal. Moderately intense continuous white noise at 85db was shown to produce an increase in quiet sleep, and a decrease in time spent awake and crying, along with slower heart rate and decreased motor activity. As was not the case in the continuous noise condition, infants exposed to intermittent white noise showed increased levels of arousal with more rapid heart rate and a decrease in total sleep time. Furthermore, in the intermittent noise condition the infants spent 26% of the time crying, compared to no recorded instance of crying under continuous sound.

In a subsequent study, Brackbill (1971) found the pacifying effect of continuous stimulation to be cumulative across modalities. Lowered arousal levels as reflected by an increase in quiet sleep time, a decrease in the amount of crying, lowered heart rate, more regular respiration, and decreased motor activity were obtained using continuous stimulation provided by a tape-recorded heartbeat played at 85db, swaddling, increased illumination, and increased room temperature. Lowered heart rate and more regular respiration were also reported for an anencephalic infant who was submitted in separate sessions to the continuous auditory and proprioceptive-tactile stimulation. Since the infant was shown at autopsy to have only an intact brainstem and cerebellum, this finding was interpreted as suggesting that the continuous stimulation effect is governed by a subcortical mechanism. As far as can be ascertained, however, no further research has been done by Brackbill or others to clarify the nature of the mechanism underlying the effect.

Brackbill's studies dealt with 1-month-old infants. In a study of 2- and 3-month-old fullterm infants, Kopp (1970) investigated the effectiveness of auditory, vestibular, and visual stimuli in the pacification of crying infants. She reported a change in the pacifying effect of continuous white noise between 2 and 3 months of age. At 2 months of age, continuous white noise soothed crying infants; at 3 months, however, the same stimulus caused the infant to increase its motility and was less effective in soothing it. This finding is consistent with suggestions by Schmidt (1975) that continuous stimulation is arousing in adult human beings. The change in the pacification effect of continuous white noise between the second and third month presumably reflects some maturational development of the central nervous system, possibly the fact that cortical-subcortical connections become functional at that time (Graham, Leavitt, & Strock, 1978).

The purpose of the present study was to use the apparent developmental shift in the response to continuous white noise between 2 and 3 months of age to investigate whether there is a slower rate of maturation of the central nervous system in preterm infants relative to fullterm infants of equivalent postconceptional age. Accordingly, fullterm and preterm infants were tested at 2 and 3 months after their expected date of birth. The first hypothesis based on Kopp's work (Kopp, 1970) is that the continuous stimulation effect changes in fullterm infants between 2 and 3 months of age with the effect of continuous white noise in reducing arousal level being weaker at 3 months than at 2 months. Specifically it was predicted that there would be more crying and more gross motor activity under the continuous white noise condition at 3 months than at 2 months of age. The second and major hypothesis is that preterm infants do experience a slower rate of neural maturation and that consequently the effect of continuous white noise on their level of arousal is no weaker at 3 months corrected age than it is at 2 months. Specifically it was predicted that preterm infants would demonstrate decreased arousal relative to a no noise baseline condition under the continuous white noise condition at both 2 and 3 months corrected age. Since the intention was to assess the effect of prematurity per se as distinct from the effect of the complications associated with prematurity, preterm infants were screened for all major complications as well as for a history of mechanical ventilation. Finally, to facilitate our recruiting of subjects and to eliminate the need for infants to adapt to a strange environment, infants were tested in their homes. Thus, ratings of behavioral state and gross motor activity from videotapes and not physiological measures such as heart rate and respiration were chosen as the dependent variables.

Method

Subjects

The subjects were 15 clinically healthy preterm and 15 fullterm singletons. An additional 7 subjects were lost from the study because of parental loss of interest (1 preterm, 2 fullterm infants), procedural error (2 fullterm infants), and inability to control background noise (1 preterm and 1 fullterm infant). There was a sex ratio of 9 females to 6 males in each group. Infants who were selected were among those born at the Jewish General Hospital in Montreal between November 1, 1982 and June 30, 1983. Criteria for the selection of preterm infants were the following: gestational age (GA) 36 weeks or less, appropriate weight for gestational age (AGA), no fetal distress or serious complications, no congenital anomalies, no known hearing loss, no history of mechanical ventilation, and 1-min Apgar score of at least 5 and 5-min Apgar score of at least 7 to screen out infants suffering from anoxia. All mothers of preterm infants who met these criteria were solicited for the study by discussing the study with the mother over the telephone a few weeks prior to the infant's appropriate date of testing. Of the 29 preterm infants' mothers who were approached, 62% agreed to participate in the study. With the exception of two subjects with a history of mild RDS who were among the first babies to be enlisted into the study, preterm subjects were screened for RDS (mild, moderate, and severe) and maternal complications. The mother of one of the preterm infants had suffered from high blood pressure. A total of 5 preterm infants' mothers received Betamethasone prior to delivery. Three preterm infants (the two infants with mild RDS and the infant with maternal high blood pressure) were delivered by Caesarian section, and four preterm infants had hyperbilirubinemia.

Fullterm infants were selected from clinically healthy infants with a birthweight of at least 2600 gms, a GA of 39.6 to 40.6 weeks and 1-min and 5-min Apgar scores of at least 7. Three fullterm infants were delivered by Caesarian section. Fullterm infants were solicited for the study by either discussing the study with the mother while she and the infant were in the hospital, or by contacting her at her home a few weeks prior to the infant's appropriate date of testing. Of the 45 fullterm infants' mothers who were approached, 44% agreed to participate in the study. Table 1 summarizes information on infant characteristics of both preterm and fullterm groups. Table 2 summarizes maternal characteristics of both preterm and fullterm groups.

Stimulus Tape and Equipment

A 24-minute experimental tape consisting of 8 minutes of no noise, 8 minutes of continuous white noise, and 8 minutes of intermittent white noise was used. The continuous white noise and intermittent sound conditions were a recording of white noise as produced by a white noise generator. In the intermittent noise condition there were alternating .5-sec periods of white noise and quiet. Both continuous and intermittent white noise had a rise and decay in peak of 10 msec. Videotaping was done using a Sony Betamax videocassette recorder SLO 340 and Sony camera HVC2200 with Velbon tripod V6B32. A General Radio sound survey meter 1555A was used to measure ambient noise, an Abbeon relative humidity indicator AB62B to record humidity, and a Weston laboratory thermometer W1-623 to measure room temperature. Viewing of the videotapes was done using a Sony Trinitron color receiver/monitor CVM-1900. Coding was done using two MORE data

Table 1

Characteristics of Preterm and Fullterm Groups

Variable		Preterm	Fullterm
Birthweight (grams)	$\bar{X}$	2097.0	3378.2
	s.d.	499.1	369.5
	range	1100–2840	2630–4010
GA (weeks)	$\bar{X}$	33.6	40.0
	s.d.	2.3	0.3
	range	28–36	39.6–40.6
Apgar Score 1-min	$\bar{X}$	7.2	8.1
	s.d.	0.9	0.4
	range	5–9	7–9
Apgar Score 5-min	$\bar{X}$	8.7	8.8
	s.d.	0.4	0.8
	range	8–9	9–10
Corrected Age at Test 1 (weeks)	$\bar{X}$	8.7	8.7
	s.d.	0.5	0.6
	range	8.0–9.7	8.0–9.6
Corrected Age at Test 2 (weeks)	$\bar{X}$	12.5	12.6
	s.d.	0.6	0.5
	range	11.3–13.6	11.7–13.3
Chronological Age at Test 1 (weeks)	$\bar{X}$	14.6	8.7
	s.d.	2.2	0.7
	range	11.9–19.9	7.3–9.7
Chronological Age at Test 2 (weeks)	$\bar{X}$	18.4	12.6
	s.d.	2.7	0.3
	range	15.9–23.7	12.0–13.3

Table 2

Parental Characteristics of Preterm and Fullterm Groups

Variable		Preterm	Fullterm
Maternal Age	$\overline{X}$	31.0	29.7
	s.d.	3.7	4.3
	range	24-38	24-38
Maternal Education	$\overline{X}$	13.0	14.6
	s.d.	2.2	2.6
	range	10-18	10-20
Maternal Parity	One child	5	7
	>One child	10	8
	range	1-5	1-3
Maternal Language	English	6	9
	French	7	6
	Other	2	0
Birthplace of Parents	Both parents born in Canada	8	12
	One parent born in Canada	4	3
	Neither parent born in Canada	3	0

collection units capable of timing multiple events simultaneously with an accuracy of 1 second. The MORE software package was used to summarize the data on a host computer.

Measures

Brackbill Infant Behavioral State Scale. The Brackbill Infant Behavioral State Scale (Brackbill & Fitzgerald, 1969) was used to rate infant states, which are believed to reflect qualitatively different patterns of neurophysiological activity, rather than simply different levels of arousal (Hutt, Lenard, & Prechtl, 1969). The states consist of (1) quiet sleep, (2) active sleep, (3) drowsiness, (4) quiet awake, (5) active awake, (6) crying. A description of the states is found in Appendix A. With respect to the infant's behaviors, the states are exhaustive and mutually exclusive. The scale is suitable for infants up to six months of age and has been shown to produce a rater reliability of 0.98 with unskilled raters (Brackbill & Fitzgerald, 1969).

Specific Behaviors. Fussiness was coded when the infant produced two or fewer consecutive vocalizations which were of the cranky, fussy variety. More than two such vocalizations was rated as crying. These arbitrary definitions for fussing and crying were used to facilitate rating of these behaviors since at times fussing and crying were difficult to differentiate. Vocalization was coded when the infant produced vocalizations of a nonfussy nature, e.g. cooing. Yawning was also recorded. Fussiness, vocalization, and yawning were coded while states were being rated.

Gross Motor Activity. Gross motor activity defined as the movement of arms from the shoulder, and/or movement of the legs from the hip was scored using a 5-point scale ranging from 0 to 4. Infants were given 0 when no movement was detected while 1 point was given for each of the limbs in movement for a maximum score of 4 points when both legs and arms were moving. Gross motor activity was time-sampled at 10-second intervals in an independent rating of the tapes.

Procedure

Each infant was seen in its home at the second (8-9 weeks) and third month (12-13 weeks) after its expected date of birth. Each session was videotaped. Testing was done 20 to 30 minutes after the infant's last feeding. The infant's toys and mobiles were removed from the crib and the infant was placed on its back, without covers, in its crib. Although parents were allowed to remain in the room while testing was being conducted, they were asked to keep out of the infant's field of vision and to maintain silence. When the infant was in an awake but not actively crying state, the camera was started, followed by the audiotape. Repeat visits were made for two infants (1 preterm, 1 fullterm) who could not be soothed to allow testing to begin.

In each experimental session, while in its crib, the infant was exposed to three stimulus conditions: no noise, continuous white noise, and intermittent white noise. Both continuous white noise and intermittent white noise were played at 80db as measured with a sound level meter at the infant's head. The conditions were presented in the fixed order indicated because pilot work showed intermittent white noise to be highly irritating for some infants, possibly jeopardizing the completion of the session. If an infant cried for as long as one minute in any condition, the condition was terminated and the audiotape advanced to the next condition. A summary of the data regarding the number of infants whose crying led to early termination of various conditions and the average time spent by infants in the shortened conditions is found in Appendix B.

Ambient noise was recorded during the no noise condition. Room temperature and humidity were recorded at the end of each session. A summary of the data concerning ambient noise, humidity, and temperature measures is found in Appendix C. Analyses of variance of humidity, ambient noise, and temperature showed no evidence of differences between these measures at the first and second testing and between the preterm and fullterm groups. The analyses of variance source tables may be found in Appendix C.

Two trained raters subsequently rated behavioral state continuously from the videotapes using the Brackbill and Fitzgerald 6-point scale and also coded specific behaviors: fussing, nonfussy vocalizations, and yawns. Raters were pretrained on a series of pilot tapes of infants of similar ages to those of our subjects. Reliability was established by calculating for each infant session % agreement between raters on mean time spent per second in each state under each condition. Rater reliability for the experimental tapes was >90%. Percent agreement for each state for the baseline, continuous, and intermittent conditions in order were the following: quiet sleep, 81.2%, 92.3%, 94.8%; active sleep, 68.9%, 50.9%, 67.6%; drowsiness, 83%, 85.7%, 52.7%; quiet awake, 81.4%, 85.3%, 82%; active awake, 95.1%, 90.5%, 93.1%; crying, 96.3%, 80.3%, 93.7%. In scoring the videotapes where 1 minute of steady crying had led to the curtailment of a condition infants were credited with crying for the omitted time in the condition.

In a second independent viewing of the videotapes, gross motor activity was rated by both raters. Raters were pretrained on the gross motor activity scale by rating a series of pilot tapes of infants of similar ages to those of our subjects until they reached 80% agreement. The experimental tapes were then rated by both raters at 10-second intervals. Reliability was established by calculating for each infant session % agreement between raters on the number of limbs involved in gross motor activity at each 10-second interval. Reliability for the experimental tapes was 81%. The score for each infant for each condition was the sum of the number of limbs involved in gross motor activity at each of the 48 10-second intervals. When a condition was terminated prior to its completion because of 1 minute of crying, the infant's mean motor activity score for the last minute was multiplied by the remaining number of 10-second segments and added to the infant's accumulated score prior to termination of the condition.

Throughout, raters were blind to the infants' ages and group membership and uninformed about the objectives of the study and the experimental hypotheses. Videotapes were rated in a random order with respect to test session and group membership. Scores from both raters were combined for analysis.

Results

Nonparametric statistics were considered most appropriate to analyze the data. Plotting of the baseline scores for each dependent variable indicated that the distribution was either positively or negatively skewed and often presented as a J-shaped distribution. Accordingly, Friedman Two-Way Analyses of Variance by Ranks were used to test for an effect of condition in each group at each age on each dependent variable. The dependent variables were the time spent in each of the following behavioral states: quiet sleep, active sleep, drowsiness, quiet awake, active awake, and crying; the time spent fussing and crying; the time spent producing nonfussy vocalizations; the number of yawns; and the total gross motor activity score.

The acceptable level of significance for all analyses in this report was set at .05 because the subjects in the present study constitute a subset of a larger sample being tested as part of an ongoing project and the data are thus considered preliminary. Effects significant at the .05 level are considered marginal. In actual fact use of the .01 level of significance would have had the effect of biasing the results in favour of the hypotheses.

A significant Friedman analysis was followed up by two-tailed Wilcoxon Matched-Pairs Signed-Ranks tests to find which conditions differed. When the Friedman χ_r^2 value did not reach significance, a conservative approach was adopted and no further comparisons were made between conditions. Because two fullterm infants were not tested under the intermittent white noise condition at 3 months after 1 minute of intense crying in the continuous white noise condition, Friedman analyses of the 3-month fullterm data and subsequent Wilcoxon tests involving the intermittent white noise condition for this group were calculated using a reduced N of 13.

In order to compare the response of the preterm and fullterm groups under each condition, Mann-Whitney U tests were applied. Finally, to test for developmental changes, Wilcoxon Matched-Pairs Signed-Ranks Tests were calculated comparing 2- and 3-month baseline conditions for the fullterm and preterm groups separately.

Median scores for time spent in each state under each condition at 2 and 3 months and Friedman χ_r^2 values are presented in Tables 3 and 4. No significant differences were found between preterm and fullterm infants in behavioral state baselines in the no noise condition, or in behavioral state under either of the white noise conditions with the exception of a marginal difference ($\underline{p} < .05$) in active awake state under continuous white noise at 2 months. Friedman analyses of the six behavioral states revealed a significant effect of condition for the fullterm infants only on time spent in the quiet awake state at both 2 months χ_r^2 (2, $\underline{N}$ = 15) = 11.2, $\underline{p} < .01$ and 3 months χ_r^2 (2, $\underline{N}$ = 15) = 11.5, $\underline{p} < .01$, and on time spent in the active awake state at both 2 months χ_r^2 (2, $\underline{N}$ = 15) = 10.5, $\underline{p} < .01$ and 3 months χ_r^2 (2, $\underline{N}$ = 13) = 6.6, $\underline{p} < .05$. Preterm and fullterm infants' patterns of response to the noise conditions were found to differ. For the preterm infants, Friedman analyses revealed a significant effect of condition only on time spent in the active awake state at the 2-month testing χ_r^2 (2, $\underline{N}$ = 15) = 6.6, $\underline{p} < .05$, and only on time spent in the quiet awake state at the 3-month testing χ_r^2 (2, $\underline{N}$ = 15) = 15.2, $\underline{p} < .001$.

Wilcoxon follow-up tests indicated that at 2 months fullterm infants spent more time in the quiet awake state under the continuous

Table 3

Mdn State Score in Seconds and Friedman χ_r^2 Values For Tests of Effect of Conditions at 2 Months

State		Baseline	Continuous	Intermittent	χ_r^2
Quiet Sleep	F	0.1	0.3	0.2	3.8
	P	0.1	0.1	0.2	0.6
Active Sleep	F	0.1	0.1	0.4	3.6
	P	0.1	0.1	0.2	0.6
Drowsiness	F	0.1	48.0	0.5	4.9
	P	0.0	0.3	0.2	2.1
Quiet Awake	F	80.5^a	125.5^b	30.5^a	11.2**
	P	78.5	90.5	49.5	5.2
Active Awake	F	315.5^a	167.0^b	127.5^b	10.5**
	P	353.0^a	319.5^b	304.5^{ab}	6.6*
Crying	F	0.3	0.2	10.5	4.4
	P	0.3	0.2	23.5	5.0

Note. In each row, values with the same superscripts do not differ significantly. Values with different superscripts differ significantly at the .05 level or better according to a two-tailed Wilcoxon Matched-Pairs Signed-Ranks test.

$^*p < .05$. $^{**}p < .01$.

Table 4

Mdn State Score in Seconds and Friedman χ_r^2 Values For Tests of Effect of Conditions at 3 Months

State		Baseline	Continuous	Intermittent[a]	χ_r^2
Quiet Sleep	F	0.0	0.1	0.2	1.2
	P	0.1	0.2	0.2	0.4
Active Sleep	F	0.0	0.1	0.2	1.2
	P	0.1	0.1	0.2	0.4
Drowsiness	F	0.0	0.3	0.2	1.6
	P	0.1	0.3	0.2	1.6
Quiet Awake	F	88.0^b	151.0^c	54.5^b	11.5**
	P	72.0^b	157.0^c	51.0^b	15.2***
Active Awake	F	370.0^b	224.5^c	325.0^{bc}	6.6*
	P	370.5	274.0	266.0	2.8
Crying	F	0.3	0.4	0.5	2.5
	P	0.2	0.2	0.3	1.7

Note. In each row, values with the same superscripts do not differ significantly. Values with different superscripts differ significantly at the .05 level or better according to a two-tailed Wilcoxon Matched-Pairs Signed-Ranks test.

[a] For the fullterm 3-month data involving the intermittent white noise condition, the median scores, the Friedman analyses, and the Wilcoxon tests are based on a sample of 13 subjects.

*$p < .02$. **$p < .01$. ***$p < .001$.

white noise condition than in either the baseline ($T = 16$, $n' = 15$, $p < .01$) or the intermittent white noise ($T = 10.5$, $n' = 15$, $p < .01$) conditions. They also indicated that at this age more time was spent in the active awake state during the baseline condition than during either the continuous white noise ($T = 9$, $n' = 15$, $p < .01$) or the intermittent white noise ($T = 25$, $n' = 15$, $p < .05$) conditions. The decrease in time spent in the active awake state under the intermittent white noise condition was accompanied by a nonsignificant decrease in time spent in the quiet awake state and a nonsignificant increase in time spent crying.

The six Wilcoxon within-group comparisons of fullterm baseline state scores at 2 and 3 months showed that the only significant developmental change was that fullterm infants spent more time in the active awake state during the baseline condition at 3 months than at 2 months ($T = 23$, $n' = 15$, $p < .05$). The Wilcoxon follow-up tests indicated that a decrease in arousal also occurred during the continuous white noise condition in the fullterm infants at 3 months. Fullterm infants still spent more time in the quiet awake state during the continuous white noise condition than in either the baseline ($T = 5$, $n' = 15$, $p < .01$) or the intermittent white noise ($T = 3$, $n' = 13$, $p < .01$) condition. They also spent less time in the active awake state during the continuous white noise condition than during the baseline condition ($T = 4$, $n' = 15$, $p < .01$).

The only significant effect found for the preterm infants at 2 months corrected age was that they spent significantly less time in the active awake state during the continuous white noise condition than in the baseline condition ($T = 20$, $n' = 15$, $p < .05$). They still spent more time in the active awake state under the continuous white noise condition, however, than the fullterm infants did $U = 63.5$, $p < .05$. Although a slight increase in time spent in the quiet awake state was seen during the continuous white noise condition, no significant effect of condition on this state was found for the preterm group at 2 months corrected age. No developmental changes between the 2-month and 3-month testing in state baseline scores were found for preterm infants. Like the fullterm infants at both 2 and 3 months, however, preterm infants experienced a significant decrease in arousal under the continuous white noise condition at 3 months corrected age. Preterm infants now spent significantly more time in the quiet awake state during the continuous white noise condition than in either the baseline ($T = 7$, $n' = 15$, $p < .01$) or intermittent white noise ($T = 2$, $n' = 15$, $p < .01$) condition. Concurrently, a decrease in time spent in the active awake state was seen during the continuous white noise condition; it did not, however, reach significance.

As a result of seeing the videotape recordings, it was observed that although infants were producing vocalizations of a fussy nature, few infants actually reached the crying state. To obtain a more sensitive measure of infant irritability under the three noise conditions, the amount of time each infant spent fussing was added to its time spent crying. Median fuss/cry scores and Friedman χ_r^2 values for both preterm and fullterm infants on the 2- and 3-month tests are presented in Table 5. No significant differences were found between preterm and fullterm infants in fuss/cry baseline scores or scores under either noise condition. In addition, no significant developmental changes were seen between 2- and 3-month baseline scores for either the preterm or fullterm group on the fuss/cry measure. Friedman analyses

Table 5

Mdn Fuss/Cry Score in Seconds and Friedman χ_r^2 Values For Tests of Effect of Conditions at 2 and 3 Months

	Baseline	Continuous	Intermittent[a]	χ_r^2
2 months				
Fullterm	10.5^b	0.2^c	67.0^b	10.0**
Preterm	33.0^b	5.0^b	124.5^c	11.4**
3 months				
Fullterm	37.0	10.0	37.5	2.2
Preterm	11.0^b	2.0^c	11.5^b	6.7*

Note. In each row, values with the same superscripts do not differ significantly. Values with different superscripts differ significantly at the .05 level or better according to a two-tailed Wilcoxon Matched-Pairs Signed-Ranks test.

[a] For the fullterm 3-month data involving the intermittent white noise condition, the median scores, the Friedman analyses, and the Wilcoxon tests are based on a sample of 13 subjects.

*$p < .05$. **$p < .01$.

revealed a significant effect of condition on time spent fussing and crying for the fullterm group at 2 months only $\chi_r^2 (2, \underline{N} = 15) = 10.0$, $\underline{p} < .01$. As was the case for behavioral state, preterm infants were found to differ from fullterm infants in their pattern of response to the three noise conditions. For the preterm infants, a significant effect of condition was found at both the 2-month $\chi_r^2 (2, \underline{N} = 15) = 11.4$, $\underline{p} < .01$ and the 3-month $\chi_r^2 (2, \underline{N} = 15) = 6.7$, $\underline{p} < .05$ test sessions.

At 2 months fullterm infants spent significantly less time in fussing and crying during the continuous white noise condition relative to either the baseline ($T = 5$, $n' = 11$, $\underline{p} < .01$) or the intermittent white noise ($T = 0$, $n' = 12$, $\underline{p} < .01$) condition. This finding is consistent with the decrease in arousal under the continuous white noise condition shown by the 2-month-old fullterm group. Although there appeared to be more fussing and crying in the intermittent white noise condition than in the baseline condition, the difference was not significant. At 3 months, although a decrease in time spent fussing and crying was still seen during the continuous white noise condition, it did not reach significance. In addition, as was not the case at 2 months, fullterm infants now spent approximately the same amount of time fussing and crying during both the baseline and the intermittent white noise conditions. To test the hypothesis of an increase in fussing and crying under the continuous white noise condition in fullterm infants between 2 and 3 months of age, the fuss/cry scores obtained for the fullterm group under the continuous white noise condition at each age were compared by means of a Wilcoxon test. A significant increase in fuss/cry was found between 2 and 3 months under the continuous white noise condition in the fullterm group ($T = 11.5$, $n' = 14$, $p < .01$).

At 2 months corrected age, unlike the fullterm infants, preterm infants spent significantly more time fussing and crying in the intermittent white noise condition than in either the baseline ($T = 8$, $n' = 14$, $p < .01$) or the continuous white noise ($T = 0$, $n' = 13$, $p < .01$) condition, and they did not show a significant decrease in time spent fussing and crying under the continuous white noise condition relative to baseline. At 3 months corrected age, on the other hand, preterm infants were found to spend significantly less time fussing and crying under the continuous white noise condition than in either the baseline ($T = 7$, $n' = 13$, $p < .01$) or the intermittent white noise ($T = 7$, $n' = 11$, $p < .02$) condition. This is consistent with the significant increase in quiet awake found for this group under the continuous white noise condition at 3 months corrected age.

Median yawn scores and Friedman χ_r^2 values for both groups at both 2 and 3 months are shown in Table 6. No developmental changes were found between 2- and 3-month baseline scores for either the preterm or the fullterm group on the yawn measure. In addition, preterm and fullterm infants were not found to differ on yawn scores under any condition at either age. Friedman analyses revealed no significant overall effect of conditions in the number of yawns for the fullterm group at either age, or for the preterm group at 2 months corrected age. At 3 months corrected age, however, a significant effect of condition on number of yawns produced by preterm infants was found χ_r^2 (2, $N = 15$) $= 13.4$, $p < .01$. Preterm infants produced significantly more yawns during the continuous white noise condition than during either the

Table 6

Mdn Yawn Scores and Friedman χ_r^2 Values For Tests of Effect of Conditions at 2 and 3 Months

	Baseline	Continuous	Intermittent[a]	χ_r^2
2 months				
Fullterm	1.5	1.5	0.3	2.0
Preterm	1.2	1.5	0.3	5.0
3 months				
Fullterm	0.5	1.2	0.2	4.2
Preterm	0.5^b	2.0^c	0.2^b	13.4*

Note. In each row, values with the same superscripts do not differ significantly. Values with different superscripts differ significantly at the .05 level or better according to a two-tailed Wilcoxon Matched-Pairs Signed-Ranks test.

[a] For the fullterm 3-month data involving the intermittent white noise condition, the median scores, the Friedman analyses, and the Wilcoxon tests are based on a sample of 13 subjects.

*$p < .01$.

baseline condition ($T = 13$, $n' = 14$, $p < .01$) or the intermittent white noise condition ($T = 0$, $n' = 14$, $p < .01$).

Median scores for time spent emitting nonfussy vocalizations and Friedman χ_r^2 values for both groups at both ages are presented in Table 7. Nonfussy vocalization baseline scores and scores under noise conditions were not found to differ between preterm and fullterm infants at either 2 or 3 months. No significant developmental changes were found between 2- and 3-month baseline nonfussy vocalization scores for either the preterm or fullterm group. Friedman analyses revealed a significant overall effect of condition on time spent emitting nonfussy vocalizations for the preterm group only, at both the 2-month χ_r^2 $(2, N = 15) = 9.4$, $p < .01$ and 3-month χ_r^2 $(2, N = 15) = 8.2$, $p < .02$ test sessions. Preterm infants were found to produce significantly fewer nonfussy vocalizations during the continuous white noise condition than under the baseline condition at both the 2-month $T = 7$, $n' = 12$, $p < .01$ and 3-month $T = 16.5$, $n' = 13$, $p < .05$ test sessions.

A summary of the gross motor activity measure and the Friedman χ_r^2 values for both preterm and fullterm groups are presented in Table 8. No significant developmental changes were found between 2- and 3-month baseline gross motor activity scores for either the preterm or fullterm group. Gross motor activity scores under baseline and noise conditions, with the exception of the continuous white noise condition at 2 months, were not found to differ between preterm and fullterm infants at either 2 or 3 months. Friedman analyses revealed a significant effect of condition at both the 2-month χ_r^2 $(2, N = 15) = 14.5$, $p < .001$ and the 3-month χ_r^2 $(2, N = 13) = 8.3$, $p < .02$ test sessions for the fullterm group. A significant effect of condition was

Table 7

Mdn Nonfussy Vocalization Scores in Seconds and Friedman χ_r^2 Values For Tests of Effect of Condition at 2 and 3 Months

	Baseline	Continuous	Intermittent[a]	χ_r^2
2 months				
Fullterm	1.5	0.4	0.5	2.5
Preterm	4.0^{b}	0.2^{c}	1.0^{bc}	9.4**
3 months				
Fullterm	6.5	0.3	0.4	1.9
Preterm	4.5^{b}	0.3^{c}	1.5^{bc}	8.2*

Note. In each row, values with the same superscripts do not differ significantly. Values with different superscripts differ significantly at the .05 level or better according to a two-tailed Wilcoxon Matched-Pairs Signed-Ranks test.

[a] For the fullterm 3-month data involving the intermittent white noise condition, the median scores, the Friedman analyses, and the Wilcoxon tests are based on a sample of 13 subjects.

*$p < .02$. **$p < .01$.

Table 8

Mdn Gross Motor Activity Scores and Friedman χ_r^2 Values For Tests of Effect of Condition at 2 and 3 Months

	Baseline	Continuous	Intermittent[a]	χ_r^2
2 months				
Fullterm	137.0^b	76.0^c	131.5^b	14.5***
Preterm	152.0^b	130.0^c	155.5^b	13.3**
3 months				
Fullterm	146.5^b	113.5^c	135.1^c	8.3*
Preterm	141.5^b	112.5^c	148.5^b	10.0**

Note. In each row, values with the same superscripts do not differ significantly. Values with different superscripts differ significantly at the .05 level or better according to a two-tailed Wilcoxon Matched-Pairs Signed-Ranks test.

[a] For the fullterm 3-month data involving the intermittent white noise condition, the median scores, the Friedman analyses, and the Wilcoxon tests are based on a sample of 13 subjects.

*$p < .02$. **$p < .01$. ***$p < .001$.

also found at both the 2-month χ_r^2 (2, N = 15) = 13.3, $p < .01$ and the 3-month χ_r^2 (2, N = 15) = 10.0, $p < .01$ test sessions for the preterm group.

Follow-up Wilcoxon tests indicated that fullterm infants engaged in significantly less gross motor activity during the continuous white noise condition than during either the baseline (T = 0, n' = 15, $p < .01$) or the intermittent white noise (T = 14, n' = 15, $p < .01$) condition at 2 months of age. At 3 months, however, a decrease in motor activity was found for fullterm infants under both the continuous white noise condition (T = 2.5, n' = 14, $p < .01$) and the intermittent white noise condition (T = 13, n' = 13, $p < .02$) relative to baseline. Although there appeared to be more gross motor activity during the intermittent white noise condition than in the continuous white noise condition, the difference was not significant. To test the hypothesis of an increase in gross motor activity under the continuous white noise condition in fullterm infants between 2 and 3 months of age, the gross motor scores obtained for the fullterm group under the continuous white noise condition at each age were compared by means of a Wilcoxon test. A significant increase in gross motor activity was found between 2 and 3 months under the continuous white noise condition in the fullterm group (T = 14, n' = 15, $p < .01$).

At 2 months corrected age, preterm infants showed the same gross motor activity response pattern as that of 2-month fullterm infants. They engaged in significantly less gross motor activity during the continuous white noise condition than during either the baseline (T = 2, n' = 15, $p < .01$) or the intermittent white noise (T = 24.5, n' = 15, $p < .05$) condition. They engaged in more motor activity, however, than the fullterm infants in the continuous white noise condition U = 55.5, $p < .02$. At the 3-month testing preterm and fullterm infants' patterns of response differed. As they did at 2 months corrected age, preterm infants produced significantly less gross motor activity under the continuous white noise condition relative to both the baseline ($T = 12$, $n' = 15$, $p < .01$) and the intermittent white noise ($T = 17.5$, $n' = 15$, $p < .02$) condition.

Because the main interest of the study was in the effects of prematurity per se, the preterm data were subjected to two further sets of analyses. In the first set, all analyses were repeated on a sample of 13 preterm babies with the two infants with mild RDS excluded. These analyses indicated essentially the same pattern of significant and nonsignificant findings at 2- and 3-months corrected age as reported for the total sample of 15 preterm infants, although levels of significance tended to be stronger. In the second set of analyses, all analyses were repeated on the data obtained from the 10 preterm infants who had not been exposed to betamethasone prenatally. These analyses also yielded essentially the same pattern of findings at 2 and 3 months corrected age, except that levels of significance tended to be weaker.

Because environmental variables such as humidity, temperature, and ambient noise have been reported to affect behavioral state, Spearman Rank Order Correlations were calculated between these measures and both the fuss/cry score and the scores for the behavioral states that occurred with reasonable frequency. A marginally significant positive correlation was found between the active awake state and ambient noise only, where the Rho value for the fullterm group at 3 months was .52. The Spearman Rho values for these correlations are found in Appendix C.

Discussion

The findings clearly indicate the existence of Brackbill's continuous stimulation effect (Brackbill, 1970) in fullterm infants at 2 months of age. In addition, the hypothesis of a change towards a weaker effect of continuous white noise in fullterm infants at 3 months of age than at 2 months was confirmed. At 2 months, fullterm infants showed a significant decrease in arousal under the continuous white noise condition with more time spent in the quiet awake state, less time spent in the active awake state, less time spent fussing and crying, and reduced gross motor activity during this condition. Furthermore no instances of a shortened condition due to 1 minute of crying was recorded during the playing of continuous white noise for the fullterm group at 2 months. At 3 months, fullterm infants still showed a significant decrease in arousal under the continuous white noise condition. They still spent significantly more time in the quiet awake state, less time in the active awake state, and had reduced gross motor activity scores during the continuous white noise condition than in the baseline condition. Although a decrease in arousal level under the continuous white noise condition was still seen in fullterm infants at 3 months, certain findings indicate a weaker effect of this noise condition in fullterm infants at 3 months. The significant decrease relative to baseline in time spent fussing and crying during the continuous white noise condition found in fullterm infants at 2 months was no longer present at 3 months. Although crying in itself was not found to be a sensitive measure in this study, the significant increase in time spent fussing and crying under the continuous white noise condition for fullterm infants at 3 months relative to 2 months is consistent with the prediction made on the basis of Kopp's (1970) work of increased crying under the continuous white noise condition in fullterm infants at 3 months. Moreover, three fullterm infants required a shortened continuous white noise condition at 3 months of age because of 1 minute of intense crying. Finally, the prediction based on Kopp's (1970) work of an increase in gross motor activity under the continuous white noise condition for the fullterm infants at 3 months relative to 2 months was confirmed.

The response of fullterm infants to intermittent white noise was different from their response to continuous white noise. The decrease in arousal found in fullterm infants at 2 and 3 months under the continuous white noise condition was not seen under the intermittent white noise condition. Instead, higher arousal relative to the continuous white noise condition was found in fullterm infants under the intermittent white noise condition. At 2 months, fullterm infants spent less time in the quiet awake state, more time fussing and crying, and produced more gross motor activity during the intermittent white noise condition, whereas at 3 months less time was spent in the quiet awake state and more time was spent in the active awake state in this condition than in the continuous white noise condition. Since both noise conditions consisted of white noise, the quieting effect specific to continuous white noise is clearly due to the continuous nature of the stimulation. Thus, the effect of continuous white noise found in our study appears analogous to Brackbill's continuous stimulation effect.

The data obtained in the present study indicate that Brackbill's continuous stimulation effect persists through to 3 months of age in fullterm infants. Unlike Brackbill's (1970) 1-month-old fullterm subjects who spent a great deal of time sleeping and for whom no crying at all was recorded during the continuous white noise condition, very few infants in our study reached sleep states and crying was observed during the continuous white noise condition. Furthermore, time spent in the quiet awake state which Brackbill (1970) found to be unchanged when 1-month-old fullterm infants were exposed to continuous and intermittent white noise conditions, proved to be the measure most sensitive to the noise conditions for infants at 2 and 3 months. The fact that few infants reached sleep states at 2 months may in part be due to developmental changes in the amount of time infants spend sleeping between 1 and 2 months of age. These findings suggest that the quiet awake state and not sleep states is the most sensitive measure of the continuous stimulation effect in infants at 2 and 3 months of age. The differences between studies also suggest a somewhat weaker effect on arousal level of continuous white noise in fullterm infants at 2 months than at 1 month of age. The more mature response to continuous white noise therefore appears to be a weaker effect on arousal level of this noise condition with increased age. Brackbill (1966) has, however, reported decreased arousal in 34-month-old preschool children under continuous auditory stimulation at 80db of tape recordings of a heartbeat, a metronome beat, and lullabies. Thus there is some evidence that the continuous stimulation effect is still present in 3-year-olds. The weakening of the effect on arousal of continuous white noise with increasing age which was found in this study may be stimulus specific. Studies comparing the effects of continuous white noise to other types of continuous auditory stimulation at 2, 3, and 4 months of age are needed to clarify this issue.

The second and major hypothesis was that the continuous stimulation effect found in fullterm infants at 2 months occurs in preterm infants at both 2 and 3 months corrected age and that the effect is as strong at 3 months corrected age as it is at 2 months. Although the continuous stimulation effect was seen in preterm infants, the prediction of an absence of change in the effect between 2 and 3 months corrected age was not supported. Instead a marginal effect of continuous white noise on arousal level was found in preterm infants at 2 months corrected age, and clear evidence of the continuous stimulation effect was obtained only at 3 months corrected age when preterm infants' response to continuous white noise closely resembled that of the 2-month-old fullterm infants. At 2 months corrected age, the only measures that reflected some change in preterm infants under the continuous white noise condition were active awake, where the change was only marginally significant, gross motor activity, and nonfussy vocalizations. Preterm infants spent less time in the active awake state, produced fewer nonfussy vocalizations, and were involved in less gross motor activity during the continuous white noise condition. These findings, however, were not accompanied by any significant change in measures reflecting decreased arousal, such as increased time in quiet awake, or decreased time in crying. Therefore in themselves, they do not provide evidence of a strong effect of continuous stimulation in preterm infants at 2 months corrected age. At the 3-month testing, however, preterm infants spent more time in the quiet awake state, less time fussing and crying, less time vocalizing, produced a greater number of yawns, and were involved in less gross motor activity during the continuous white noise condition than in either the baseline or the intermittent white noise condition.

Like the fullterm infants, preterm infants also responded differentially to the intermittent white noise condition than to the continuous white noise condition. At both 2 and 3 months corrected age, they spent more time fussing and crying, and engaged in more gross motor activity during the intermittent white noise condition. At 3 months corrected age, preterm infants also spent less time in the quiet awake state during the intermittent white noise condition than during the continuous white noise condition. Unlike the fullterm infants, a strong irritating effect of intermittent white noise was found in preterm infants at 2 months corrected age. One third of the preterm infants tested had a shortened intermittent white noise condition due to 1 minute of crying and crying was found to occur shortly after the beginning of this condition. Furthermore, a significant increase in time spent fussing and crying during the intermittent white noise condition relative to the baseline condition was found in preterm infants at this age. At 3 months, the irritating effect of intermittent white noise had considerably diminished. The only measure that suggested that intermittent white noise was still found to be somewhat irritating was the short amount of time spent in this condition by preterm infants whose intermittent white noise condition was shortened.

Preterm infants have often been found to be more irritable than fullterm infants. In a study by Kurtzberg, Vaughan, Daum, Grellong, Albin, and Rotkin (1979) a low birthweight (primarily preterm) sample of infants were found to cry significantly more than fullterm infants at 40 weeks postconceptional age. Field, Dempsey, and Shuman (1980) also found preterm infants with RDS to be significantly more irritable than fullterm infants at corrected ages of 4, 8, and 12 months. Irritability in preterm infants has been linked to stressfulness of the test situation as well as to medical complications at birth. In a study comparing groups of preterm infants with different types of medical complications to fullterm infants, Goldberg, Brachfeld, and Divitto (1980) found preterm infants, including those who were complication-free, to be more irritable than fullterm infants in laboratory feedings at 4 months chronological age but less irritable in the home feeding situation. At 8 months chronological age, preterm infants with RDS were found to be significantly more irritable than fullterm infants in home and laboratory floor play sessions, whereas there were no differences in irritability between fullterm and complication-free preterm infants. Goldberg et al. (1980) have suggested that group differences in irritability may reflect the fact that infants were not tested at equivalent biological ages. The complication-free preterm infants in our study were not found to be more irritable than fullterm infants of equivalent biological age either 2 or 3 months after their expected date of birth under baseline conditions. Rather they were found to overreact when presented with the unpleasant intermittent white noise stimulus at 2 months corrected age. These findings are consistent with and extend those of Als and Brazelton (1981) in which a preterm infant at 4 weeks postterm was found to be hypersensitive to environmental input. Furthermore the hyperresponsiveness to unpleasant stimuli which is attributable in our sample to prematurity per se was transient and was no longer seen by

3 months corrected age. Our findings are thus also consistent with Goldberg et al. (1980) who found that complication-free preterm infants' greater irritability in a stressful situation such as that created by a laboratory testing was transient. Moreover our study establishes that the greater irritability of complication-free preterm infants at a particular age is not accounted for by their immaturity relative to fullterm infants since preterm and fullterm infants were tested at equivalent biological ages. Although preterm infants were no longer overreacting to intermittent white noise at 3 months corrected age, and therefore did not appear more irritable than fullterm infants, the possibility remains that older preterm infants might overreact to other stressful situations.

The only dependent measure which did not provide evidence of differences between preterm and fullterm infants' response to the continuous white noise condition at either 2 or 3 months was the gross motor activity measure. Both groups at both ages showed a significant decrease in gross motor activity during the continuous white noise condition. In a study comparing psychophysiological and behavioral responses to auditory stimulation in newborn fullterm infants, Miller and Byrne (1983) reported different findings for ratings of behavioral state and a motor activity measure. They suggested that the differences between behavioral state and motor activity measures might be related to these measures being regulated by different neurological structures.

Preterm infants' response to continuous white noise differed from that of fullterm infants in that the continuous stimulation effect was seen in preterm infants at 3 months corrected age only. Although one might argue that an experiential factor might be responsible for the difference between groups, the only difference in experience common to the preterm group was the newborn nursery intensive care experience and it is difficult to suggest how this might have produced the delayed emergence of the continuous stimulation effect in the preterm group. Furthermore environmental factors of humidity, ambient noise, and temperature on the day of testing cannot account for our findings since no group differences were found on these measures.

The absence of the continuous stimulation effect in preterm infants at 2 months corrected age was somewhat unexpected since it has been found on heart rate and respiration measures in an anencephalic infant who was exposed to swaddling and sound (Brackbill, 1971). The apparent inconsistency between these studies may be due to the different dependent measures being used. It is also possible, however, that the effect seen in the anencephalic infant was not really analogous to the continuous stimulation effect seen in infants with intact cerebral hemispheres. Turkewitz and Kenny (1982) have suggested that prematurity causes a reorganization of neurophysiological development because it forces all systems to become operational prior to their having reached their full development. This reorganization may be reflected in a different developmental pattern of neural maturation, and/or a slower rate of neural maturation. The sudden emergence of a strong continuous stimulation effect in preterm infants at 3 months corrected age is consistent with the notion of a slower rate of neurophysiological maturation in preterm infants relative to fullterm infants of equivalent biological age. If our findings do reflect simply a slower rate of neural maturation, the delayed appearance of the continuous stimulation effect would be related to the delayed maturation of some as yet unspecified reflex or inhibitory and controlling feedback mechanism. At 2 months corrected age, preterm infants appeared to have difficulty reaching the quiet awake state under the continuous white noise condition. Parmalee and Stern (1972) have suggested that the increase in time spent in the quiet awake state over the first months of life may reflect the development of inhibitory and controlling feedback mechanisms of the central nervous system which allow the organism to deal with its environment and maintain homeostasis. The contention of a slower rate of neural maturation in preterm infants is based on the assumption of an absence of the continuous stimulation effect in preterm infants at 1 month corrected age. Until information is available on the behavior of preterm infants under continuous stimulation at 1 month corrected age, however, the alternative hypothesis of a different developmental pattern of neural maturation for these babies cannot be rejected. Thus, the continuous stimulation effect should be investigated in preterm infants at 1 month corrected age to establish the nature of their response to the continuous stimulation at this age. Since both irritability in response to intermittent white noise and difficulty in reaching the quiet awake state under continuous white noise at 2 months corrected age may reflect a hyperexcitability of preterm infants' central nervous system, one might expect greater irritability to intermittent white noise at 1 month corrected age.

Since the noise conditions were presented in a fixed order, one might argue that the decrease in arousal under the continuous white noise condition is an effect of time and not an effect of the noise condition. If this were so, one would expect a consistent effect of time upon infants' response with levels of arousal continually decreasing until infants fell asleep in the intermittent white noise condition. The pattern that emerged, however, was one of decreased arousal under the continuous white noise condition followed by a return to the baseline level of arousal under the intermittent white noise condition. Furthermore, if an order effect was solely responsible for infants' response the same pattern of response should be seen at both ages. The change in infants' response between 2 and 3 months and the U pattern that emerged both suggest that infants were responding to the different noise conditions and their response were not simply an effect of time.

Given the stringent criteria for the selection of preterm infants for this study, their apparently less mature response to continuous white noise seems more likely to be attributable to prematurity per se rather than to complications often associated with prematurity. Although two infants with mild RDS were included in this study, the same pattern of findings emerged when analyses were repeated excluding the data for these two infants. Moreover the drug treatment of betamethasone to five mothers of preterm infants did not affect infants' pattern of response since similar findings were obtained when analyses were repeated excluding the data for these infants. Our findings provide support for the notion of a lag in neural maturation of preterm infants relative to fullterm infants of equivalent biological ages. Furthermore they are consistent with earlier findings of motor delay (Field et al., 1981; 1983), poorer language development (Crnic et al., 1983), and poorer visual information processing ability (Rose et al., 1979) in preterm infants relative to fullterm infants of equivalent postconceptional ages.

More importantly, our findings imply a difference in the pattern or rate of neural maturation in complication-free preterm infants and indicate the importance of studying this group further. Our findings also demonstrated the continuous stimulation effect paradigm is capable of differentiating complication-free preterm and fullterm infants 2 and 3 months after their expected date of birth. Its ability to do so appears related to its sensitivity to infants' ability to modulate state which emerges in the first few months of life. It is possible that differences between preterm infants who have not experienced complications and fullterm infants may only be found when infants are compared on a task which measures an emerging ability. Apart from Brackbill's (1971) suggestion that the continuous stimulation effect is regulated by a primitive brainstem mechanism, little is known as to the nature of the underlying mechanism of this effect. Further investigation into the nature of this mechanism is needed. Finally, given the apparently primitive nature of the continuous stimulation phenomenon and the fact that preterm infants' response to continuous stimulation appears delayed, one would expect to find further evidence of differences in neural maturation in complication-free preterm infants relative to fullterm infants of equivalent biological ages when higher order processes are investigated.

References

Als, H., & Brazelton, T. B. (1981). A new model of assessing the behavioral organization in preterm and fullterm infants. Journal of the American Academy of Child Psychiatry, 20, 239-263.

Brackbill, Y. (1970). Acoustic variation and arousal level in infants. Psychophysiology, 6(5), 517-526.

Brackbill, Y. (1971). Cumulative effects of continuous stimulation on arousal level in infants. Child Development, 42, 17-26.

Brackbill, Y., Adams, G., Crowell, D. H., & Gray-Libbie, M. (1966). Arousal level in neonates and preschool children under continuous auditory stimulation. Journal of Experimental Child Psychology, 4, 178-188.

Brackbill, Y., & Fitzgerald, H. E. (1969). Development of sensory analyzers during infancy. In L. P. Lipsitt & H. W. Reese (Eds.), Advances in child development and behavior (pp. 173-205). New York: Academic Press.

Brazelton, T. B. (1962). Crying in infancy. Pediatrics, 579-588.

Caputo, D. B., Goldstein, K. M., & Taub, H. B. (1979). The development of prematurely born children through middle childhood. In T. Field (Ed.), Infants born at risk: Behavior and development (pp. 219-247). New York: Spectrum Publications.

Crnic, K. A., Ragozin, A. S., Greenberg, M. T., Robinson, N. M., & Basham, R. B. (1983). Social interaction and developmental competence of preterm and full-term infants during the first year of life. Child Development, 54, 1199-1210.

Field, T., Dempsey, J., & Shuman, H. H. (1981). Developmental follow-up of pre- and postterm infants. In S. L. Friedman &

M. Sigman (Eds.), Preterm birth and psychological development (pp. 299-312). New York: Academic Press Inc.

Field, T., Dempsey, J., & Shuman, H. H. (1983). Five-year follow-up of preterm respiratory distress syndrome and post-term postmaturity syndrome infants. In T. Field & A. Sostek (Eds.), Infants born at risk: Physiological, perceptual and cognitive processes (pp. 317-335). New York: Grune & Stratton.

Goldberg, S., Brachfeld, S., & Divitto, B. (1980). Feeding, fussing, and play: Parent-infant interaction in the first year as a function of prematurity and perinatal medical problems. In T. Field, S. Goldberg, D. Stern, & A. Sostek (Eds.), High-risk infants and children: Adult and peer interactions (pp. 133-153). New York: Academic Press.

Graham, F. K., Leavitt, L. A., & Strock, B. D. (1978). Precocious cardiac orienting in a human anencephalic infant. Science, 199, 322-324.

Hunt, J. V., & Rhodes, L. (1977). Mental development of preterm infants during the first year. Child Development, 48, 204-210.

Hutt, S. J., Lenard, H. G., & Prechtl, H. F. R. (1969). Psychophysiology of the newborn. In L. P. Lipsitt & H. W. Reese (Eds.), Advances in child development and behavior (pp. 128-172). New York: Academic Press.

Kopp, C. B. (1970). A comparison of stimuli effective in soothing distressed infants. Dissertation Abstracts International, 31, 7631-B. (University Microfilms No. 71-13, 707).

Kurtzberg, D., Vaughan, H. G., Daum, C., Grellong, B. A., Albin, S., & Rotkin, L. (1979). Neurobehavioral performance of low-birthweight infants at 40 weeks conceptional age: Comparison with normal fullterm infants. Developmental Medicine and Child Neurology, 21(5), 590-607.

Miller, C. L., & Byrne, J. M. (1983). Psychophysiologic and behavioral response to auditory stimuli in the newborn. Infant Behavior and Development, 6(3), 369-389.

Pape, K. E., Buncic, R. J., Ashby, S., & Fitzhardinge, P. M. (1978). The status at two years of low-birth-weight infants born in 1974 with birth weights of less than 1001 gms. The Journal of Pediatrics, 92(2), 253-260.

Parmalee, A. H., & Stern, E. (1972). Development of states in infants. In C. Clemente, D. Purpura, & F. Meyer (Eds.), Sleep and the maturing nervous system (pp. 199-228). New York: Academic Press.

Rose, S. A. (1983). Differential rates of visual information processing in fullterm and preterm infants. Child Development, 54, 1189-1198.

Rose, S. A., Gottfried, A. W., & Bridger, W. H. (1979). Effects of haptic cues on visual recognition memory in fullterm and preterm infants. Infant Behavior and Development, 2, 55-67.

Schmidt, K. (1975). The effect of continuous stimulation on the behavioral sleep of infants. Merrill-Palmer Quarterly, 21, 77-88.

Siegel, L. S. (1983). Correction for prematurity and its consequences for the assessment of the very low birth weight infant. Child Development, 54, 1176-1188.

Siegel, L. S. (1983). The prediction of possible learning disabilities in preterm and fullterm children. In T. Field & A. Sostek (Eds.), Infants born at risk: Physiological, perceptual and cognitive processes (pp. 295-315). New York: Grune & Stratton Inc.

Siegel, L. S., Saigal, S., Rosenbaum, P., Young, A., Berenbaum, S., & Stoskopf, B. (1979). Correlates and predictors of cognitive and language development of very low birthweight infants. Unpublished manuscript, McMaster University Medical Center, Hamilton.

Turkewitz, G., & Kenny, P. A. (1982). Limitations on input as a basis for neural organization and perceptual development: A preliminary theoretical statement. Developmental Psychobiology, 15, 357-368.

Ungerer, J. A., & Sigman, M. (1983). Developmental lags in preterm infants from one to three years of age. Child Development, 54, 1217-1228.

Appendix A

Infant Behavioral State Scale

Appendix A

Infant Behavioral State Scale (Brackbill & Fitzgerald, 1969, p. 175)

1. Quiet Sleep: The infant's whole body gives the appearance of general muscular relaxation. This is interrupted periodically, however, by brief startles of an apparently spontaneous nature. The infant's eyes are usually closed. Respiration is regular and is somewhat slower than in active sleep.

2. Active Sleep: Characteristic of this stage are diffuse movements of relatively frequent occurrences. These movements may involve the whole body but are most typically seen in the extremities and in the muscles of the face in the form of twitches, grimaces, smiling, sucking, and the like. In addition, one can sometimes see conjugate movements of the eyeballs. (As in state 1, the eyelids are usually closed.) Respiration is considerably more irregular and is somewhat faster than in quiet sleep.

3. Drowsiness: During this stage the infant's motor behavior is often much like that of sleepy people riding subway trains: he relaxes more and more as he gradually falls asleep, then suddenly jerks awake. His eyelids flutter, and his eyes, when visible, have a glassy appearance. Respiration is more apt to be marked by regularity than irregularity.

4. Quiet Awake: There is little gross motor activity, i.e., movements involving the whole body, although there may be some movements of the extremities and face. The baby's eyes are open and in Wolff's terms (1966) are characterized by a bright, shiny appearance. The major difference between this state and the other two waking states is that this is a peaceful state. Accordingly, the vocalizations that occur during this state are not of an "unhappy" variety. Respiration is relatively regular, though less regular than in quiet sleep.

5. Active Awake: This state is marked by a considerable amount of gross motor activity. For example, as an infant becomes unhappy he may begin to writhe. Respiration is often quite irregular. Within the spectrum of vocalizations occurring during this period are those of the cranky, fussy variety.

6. Crying: The criteria for this state are the same as those for the preceding state except that in addition the infant is crying. (He may or may not be producing tears; most very young infants do not.) The lower limit of crying is defined as protesting of a definite, sustained nature.

Appendix B

Average Proportion of Time Spent in Shortened Conditions By Infants Crying For 1-min.

Appendix B

Average Proportion of Time Spent in Shortened Conditions by Infants Crying for 1-min.

	Baseline	Continuous	Intermittent
2 Months			
Fullterm	.465 (3)	- (0)	.388 (3)
Preterm[a]	.375 (2)	.708 (1)	.225 (5)
3 Months			
Fullterm[b]	.548 (3)	.736 (3)	.114 (2)
Preterm[a]	.486 (3)	.750 (1)	.364 (4)

Note. The numbers appearing in parentheses represent the infants for whom the time in the condition was shortened due to 1-min. of crying.

[a] At both ages, all three conditions were shortened for 1 preterm infant, and both baseline and intermittent white noise conditions were shortened for another preterm infant.

[b] All three conditions were shortened for 1 fullterm infant. Two additional infants who cried intensely under the continuous white noise condition were not tested in the intermittent white noise condition.

Appendix C

Descriptive Statistics, Source Tables, and Correlations With Selected Dependent Variables of Ambient Noise, Humidity and Temperature Measures

Table C-1

Ambient Noise, Humidity, and Temperature Measures

Variable		Preterm		Fullterm	
		T_1	T_2	T_1	T_2
Temperature (degree C)	$\overline{X}$	23.5	24.0	23.7	23.5
	s.d.	3.0	2.9	3.0	3.2
	Range	19–28	19-32	20-31	20-31
Relative Humidity (percent)	$\overline{X}$	56.9	58.9	59.9	63.3
	s.d.	6.5	4.5	9.3	7.6
	Range	47–72	50-64	43-74	45-75
Ambient Noise (decibels)	$\overline{X}$	53.0	53.5	53.3	54.6
	s.d.	3.2	4.1	4.7	5.0
	Range	48–58	47-63	45-60	45-61

Table C-2

Source Table for Analysis of Variance of Humidity Measure

Source	SS	df	MS	F	p
Total	3426.8	59			
Between Subjects	2435.7	29			
Group	209.1	1	209.10	2.63	-
Error	2226.6	28	79.52		
Within Subjects	991.0	30			
Age	112.0	1	112.00	3.59	-
Age X Group	6.7	1	6.70	2.15	-
Error	872.3	28	31.15		

Note. To reach significance at the .05 level with df (1,28) F value must exceed 4.20.

Table C-3

Source Table for Analysis of Variance of Ambient Noise

Source	SS	df	MS	F	p
Total	1132.20	59			
Between Subjects	777.70	29			
Group	7.36	1	7.36	0.27	-
Error	770.34	28	27.51		
Within Subjects	354.50	30			
Age	12.16	1	12.16	1.00	-
Age X Group	1.97	1	1.97	0.16	-
Error	340.97	28	12.16		

Note. To reach significance at the .05 level with df (1,28) F value must exceed 4.20.

Table C-4

Source Table for Analysis of Variance of Temperature Measure

Source	SS	df	MS	F	p
Total	552.6	59	-		
Between Subjects	386.6	29			
Group	0.3	1	0.30	0.02	-
Error	386.3	28	13.79		
Within Subjects	166.0	30			
Age	0.3	1	0.30	0.05	-
Age X Group	1.7	1	1.70	0.29	-
Error	164.0	28	5.86		

Note. To reach significance at the .05 level with df (1,28) F value must exceed 4.20.

Table C-5

Spearman Rho Values for Intercorrelations Between Environmental Variables and Selected Dependent Variables

		Hum		Temp		Ambient Noise	
		2 mo	3 mo	2 mo	3 mo	2 mo	3 mo
Quiet Awake	F	−.06	.43	−.13	−.13	−.39	−.15
	P	.12	.34	−.19	.05	.02	.39
Active Awake	F	−.08	−.39	−.03	−.05	−.27	.52*
	P	−.16	−.07	−.27	−.20	.18	.13
Fuss/Cry	F	.17	.07	.21	.04	.33	−.42
	P	−.03	−.01	.43	.27	.28	−.14

Note. .525 is required for significance at the .05 level two-tailed with df of 13.