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Effects of the Pacifier Activated Lullaby on Weight Gain of Premature Infants

Andrea M. Cevasco, MME, MT-BC

Roy E. Grant, PhD, MT-BC

The University of Georgia

Within the past 5 years there has been an increase of premature infants surviving in the neonatal intensive care unit as well as an increasing cost for each day the infant is kept there. It is important for the premature infant to acquire the feeding skills necessary for weight gain, which lead to discharge from the hospital, and recent advancements have indicated the effectiveness in using contingent music to teach sucking skills to premature infants. The purpose of the first analysis in this study was to determine the effects of Pacifier Activated Lullaby (PAL) trials on weight gain of premature infants. During a 2-year time period, 62 infants from a sample of 188 met criteria for analysis. A one-way analysis of variance showed no significance in daily weight gain for the number of PAL trials completed. The mean weight gains for infants with 1 PAL trial = 13.85 grams, 2 trials = 26.67, 3 trials = 29.64, and 4 or more = 22.89. The Pearson product-moment correlation between the mean percent of music earned via nonnutritive sucking (NNS) and mean weight gain of all trials approached significance ($p = .077$, $r = 0.18$). In a second analysis, weight gained prior to use of PAL, during use of PAL, and post use of PAL was analyzed. Results indicated no significant difference between weight gain 1 day prior to use of PAL, the day of PAL trial, and 1 day post use of PAL. Mean weight gain for those infants who participated in 1 PAL trial was 8.49 grams for 1 day prior to use of PAL, 18.73 the day of PAL trial, and 24.81 for 1 day post use of PAL. Mean weight gain for 3 days prior to using the PAL was 10.78, 11.30 on the day of PAL trial, and 24.78 grams for 3 days

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post PAL use. The analyses show definite trends of greater weight gain with PAL use; however, individual variability within groups was greater than group differences leading to no significance in statistical analysis. In the third analysis the effect of proximity between premature infants' feeding schedule and PAL trial on amount of time the infant received contingent music via NNS was examined; the infants' feeding and sleep schedules were divided into 5 blocks of time. Results indicated no statistical significance among the amount of time premature infants sucked/received music according to their schedule, although there were noticeable differences in the average percent of music reinforcement received according to assigned block. Infants who participated in PAL trials 30 minutes prior to feeding scored the highest average at 77.25 %, followed by 71% for infants who participated in PAL trials during feeding. Other times, primarily after the infants' feeding, resulted in averages of 59% and 54.5%; these infants often fell asleep after their feeding and did not complete the full 15-minute trial. Based on this research and previous research on NNS, it seems beneficial for premature infants to participate in PAL opportunities 30 minutes prior to feeding.

Over the past several years the survival rate of premature infants in the neonatal intensive care unit (NICU) has increased as well as the cost of hospitalization for these infants (Marbella, Chetty, & Layde, 1998). Clinicians have been researching factors that affect routines in daily care that will benefit premature infants in their growth. Meanwhile, the American Academy of Pediatrics (1998) proposed guidelines for hospital discharge of high-risk neonates, delineating skills and behaviors infants must evince prior to discharge. Considerations included the ability to coordinate the suck, swallow, and breathe responses while feeding from breast or bottle; to continuously gain weight; and to grow across a specified period of time. Recent research has determined that nonnutritive sucking (NNS) has many beneficial outcomes for premature infants, especially for their behavioral state as well as physiological functioning (DiPietro, Cusson, Caughy, & Fox, 1994; Gill, Behnke, Conlon, McNeely, & Anderson, 1988; McCain, 1992, 1995; Pickler, Frankel, Walsh, & Thompson, 1996; Pickler, Higgins, & Crummette, 1993).

Effects of Nonnutritive Sucking on Oxygen Saturation and Apnea

Research has shown that NNS increases oxygen saturation levels, a critical factor for protection of eyesight. Pauldetto, Robertson, Hack, Shivpuri, and Martin (1984) found an increase in oxygenation or transcutaneous oxygen tension for premature infants during NNS. Additionally, infants who engaged in NNS prior to feeding had higher oxygen saturation levels immediately before feeding and at the end of feeding, compared to infants without pacifier opportunities (Pickler et al., 1993, 1996). Similarly, providing a pacifier after nipple feeding also increased oxygen saturation rates (Pickler et al., 1993). The effects occurred even during gavage feeding opportunities. Premature infants had fewer bradycardia and oxygen desaturation episodes when given pacifiers during gavage feeding (Pickler et al., 1996).

Effects of Nonnutritive Sucking on Heart Rate

Research regarding the effects of NNS on heart rate of premature infants shows promise but results have been inconsistent. Woodson and Hamilton (1988) utilized a pacifier in two different treatments and found that infants who engaged in NNS in alternating intervals for a 12-hour time span had a decrease in heart rate compared to infants who engaged in NNS for one 30-minute trial; both groups had significantly lower average heart rates during NNS opportunities. Other research efforts indicated a significant difference in mean heart rates for infants engaging in NNS, and lower heart rates occurred between the NNS condition and during following feedings (McCain, 1992, 1995). Other researchers, however, found no significant difference between NNS and no sucking conditions (Pickler et al., 1993, 1996). Pauldetto et al. (1984) found an increase in heart rate for infants, significant for infants ages 34 to 35 weeks and 36 to 37 weeks.

Effects of Nonnutritive Sucking on Behavior States

Results of some studies have indicated that NNS reduced behavioral distress and decreased the length of time for infants to fall asleep after feeding. Premature infants evinced significantly fewer changes in behavior states during feeding when engaged in NNS prior to the feeding compared to the no sucking condition (McCain, 1995). Infants who engaged in NNS often evinced alert inac-

tive, quiet awake, and alert states during feedings following NNS (McCain, 1995; Pickler et al., 1996). Premature infants who had a pacifier prior to and after gavage feedings evinced less behavioral distress, fussy time, and active awake states during both conditions compared to when they did not receive a pacifier (DiPietro et al., 1994; Gill et al., 1988; McCain, 1992). Furthermore, when infants engaged in NNS they returned to quiescent behavior state or sleep state significantly faster, most notably within 5 minutes, decreasing the time to fall asleep from 11.4 minutes to 3 minutes. The decreased sleep time was especially noted with the infants younger than 32 weeks of age (DiPietro et al., 1994). Gill et al. (1988) discovered that sleep states decreased for premature infants engaging in NNS prior to bottle feedings versus infants who did not receive a pacifier. Restless states were three times less frequent for infants in the NNS group. The researchers concluded that the NNS condition seemed to create an optimal behavior state for feeding.

McCain (1995) concluded that alert inactive and quiet awake states are evidence of neurological organization, and successful feeding is a result of optimal states prior to feeding. Furthermore, NNS seemed to help premature infants adjust, reorganize their behavior, and return to a resting state more quickly after confronting the stress of feeding (Pickler et al., 1993).

Effects of Nonnutritive Sucking on Nipple Feeding Success

Formula intake and rate are increased with NNS opportunities (McCain, 1995; Pickler et al., 1996). Pickler et al. (1996) reported that premature infants who participated in NNS before feeding initiated nutritive sucking (NS) sooner, which was more rapid and longer in duration, than infants who did not receive the NNS. Compared to the control condition, infants who engaged in NNS more often finished prescribed amounts of breast milk or formula and had higher feeding scores (McCain, 1995; Pickler et al., 1993). McCain (1995) found that infants completed 17 nipple feedings after engaging in NNS compared to the 12 feedings that the control infants completed.

Field et al. (1982) found that premature infants who received pacifiers during tube feedings were ready for bottle feedings 3 days earlier than the control group, had fewer tube feedings, gained an average of 2.8 grams per day, and were discharged an average of 8 days earlier than the control infants. Though the two groups did not differ in formula intake, the experimental group had greater

weight gain. The authors theorized that this might be due to NNS, which may have lowered the activity levels of the infants, thus saving energy and increasing weight gain. Pickler et al. (1993) concluded that NNS opportunities might help prepare infants for the bottle and improve early bottle feeding skills.

Benefits of Music for Premature Infants

Many positive benefits of music for premature infants in the NICU have been noted in recent years (Caine, 1991; Cassidy & Standley, 1995; Standley, 2000, 2003; Standley & Moore, 1995). Premature infants who listened to lullabies had a significant reduction in weight loss; length of NICU, isolette, and hospital stay; and daily mean of stress behaviors (Caine, 1991). Cassidy and Standley (1995) found positive effects of lullabies on oxygen saturation rate, heart rate, and respiratory rate for premature infants receiving music for the first time compared to infants who received no music intervention. Music stabilized the infants' oxygen saturation level more than the mother's voice, and no negative effects concerning apnea/bradycardia episodes occurred when infants listened to music (Cassidy & Standley, 1995; Standley & Moore, 1995). In Caine's study (1991) premature infants who listened to lullabies in the NICU had significantly lower total number of days for oral feedings compared to the control infants who did not listen to music. Furthermore, the experimental infants had an increase in formula and caloric intake, resulting in daily average weight gain.

Decasper and Fifer (1980) found that newborns, one-day-old, changed their sucking rate to produce their mother's voice versus another female's voice. Further research determined that newborns learned to produce music contingent on sucking (DeCasper & Carstens, 1981). Standley (2000) researched the effects of contingent music on increasing NNS of 12 premature infants; amount of sucking increased from the no music baseline to the first contingent music segment. Sucking continued to increase throughout the first contingent music segment and dropped during the second no-music baseline condition. Sucking rates during music segments were 2.43 times greater than during silence, and infant learning and discrimination took place during music segments. Furthermore, infants did not startle when the music started and stopped in accordance with their sucking behavior. Further research by Standley (2003) involved 16 premature infants utilizing the Pacifier Activated Lullaby (PAL) for contingent music for one 15 to 20-minute

trial; the infants performed significantly better in the following nipple feeding compared to 16 control infants. The author concluded that the music reinforcement from the PAL influenced the premature infants' pacing skills during nipple feeding.

The purpose of this post-hoc research was to (a) determine the effects of PAL use on weight gain of premature infants, including number of trials and the percentage of music received via sucking; and (b) compare proximity of PAL trial to feeding schedule on percentage of music earned via sucking.

Analysis I: Number of PAL Trials

Participants

Infants ($N = 188$) received music therapy treatments involving the PAL during a 2-year time period. Infants were chosen for music therapy based on clearance by the neonatologist and availability at the time of the music therapists' and NICU nurses' schedules. Complete compilation of data were compiled for 62 infants born between 32 weeks and 36 weeks gestation age; these 62 infants served as subjects for the data analysis herein.

Materials

The Pacifier Activated Lullaby (PAL), designed by Standley (2000), consisted of an adapted pacifier so that each suck activated a CD player to play lullabies for a 10-second interval and each resulting suck reset the 10-second interval; thus, music continued for only 10 seconds after the last suck. This was due to a pressure transducer in a transmitter inserted into the nipple with the pressure criterion for music reinforcement set at the lowest designation on the PAL. A light on the CD player remained lit for the entire duration that the music played. This light was used for data collections throughout the study. Music selections consisted of a CD of lullabies sung by an 8-year-old child with keyboard accompaniment and another CD with lullabies from around the world and other music performed as vocal or instrumental solos or instrumental duets by music therapy students at The University of Georgia (see Table 1).

Procedure

Speakers were placed in the corners of the infant's incubator or crib, near the head. Music volume was maintained at approximately 65dB(C)/58dB(A), thus the sound was limited to the infant

TABLE 1
Music Selections Used Throughout the Research Study

Music performed by 8-year-old girl	All the Little Horses Sleep Baby Sleep Brahm's Lullaby Sleep My Baby Lulla, Lullaby	Too Ra Loo Ra Loo Ra Twinkle, Twinkle Little Star Amazing Grace Hush Little Baby
Music performed by students from The University of Georgia	Strains of Guitar Daisies O Mio Babbino Caro (Pucinni's) Golden Slumbers The Water is Wide A La Ru Ru Ru Going Home Theme (Dvorak's New World Symphony) My Baby	Swedish Cradle Song Night Wind's Lullaby Lullaby (Brahams) Come Dreams Mama's Lullaby How I Love You All the Pretty Little Horses Rock-a-bye, Baby Sweet Lullaby Everybody's Sleeping

receiving treatment so infants in the next side-by-side incubator or open crib could not hear the music. Each participant had the opportunity to use the PAL for 15 minutes per trial with no more than one trial per day. Each trial began the instant the nipple was placed on the infant's lips. All trials ceased when a baby experienced reflux or other undue stress or if the infant fell asleep for 2 minutes; if the infant participated for at least 2 minutes of the trial, data were used for analysis. Data collection throughout each PAL trial consisted of a running-time schedule for 15 minutes, unless the trial was terminated due to stress or infant's cessation of sucking. The therapists compiled and recorded the data as shown in Tables 3 and 4. These data showed the amount of time receiving music, via sucking, and the amount of time the infant was not sucking, thus no music.

Results

A one-way analysis of variance was used to determine whether the number of PAL trials affected mean weight gain on days the infants utilized the PAL. PAL trials were grouped accordingly: 1 trial, 2 trials, 3 trials, and 4 or more trials. Data consisted of daily weight gain or loss in grams. Results indicated no statistically significant difference among the four groups, $F(0.52)$; $p > .05$. The mean weight gained for infants completing 1 PAL trial was = 13.85 grams,

TABLE 2

Mean Group Demographics of Infants According to Number of PAL Trials Completed

	n	Gestation age at time of 1st trial	Music % of 1st trial	Av. Music % of all trials	Wt. gain in g on day of 1st trial	Av. wt. gain in g of all trials
1 Trial	20	34.7	72.1	72.1	13.85	13.85
2 Trials	12	33.7	71.9	71.3	24.17	26.67
3 Trials	11	34.4	66.36	76.36	19.00	29.64
4+ Trials	19	33.5	69.6	71.7	9.42	22.89

2 trials = 26.67, 3 trials = 29.64, and 4 or more = 22.89 (see Table 2). A Pearson product-moment correlation was utilized to determine whether a correlation existed between the percent of music an infant earned during the first trial and the amount of weight gained or lost on that day. Data consisted of cumulative seconds of music played via nonnutritive sucking and weight gain in grams. Results were not statistically significant ($p > .05$). A linear correlation and regressions test was completed to determine whether a correlation existed between the mean percent of music earned and the mean weight gain for all trials, and results indicated $p = .077$, $r = 0.18$.

Discussion

A correlation of the average percent music in all trials by average weight gain during all trials approached significance, $p = .077$. Infants who participated in 2 or 3 PAL trials gained additional weight with each trial (see Table 2). Infants with 4 or more trials had an increase of 13.47 grams from their first trial, the greatest increase compared to infants who had only 2 or 3 PAL trials. Both groups, infants who participated in 3 trials and those who participated in 4 or more trials, had the lowest percent of music earned during the first music therapy trial compared to the infants who participated in only 1 trial or 2 trials. Infants who had 3 or 4 trials, however, increased the amount of time spent sucking, indicated by the percent of music earned for all trials (see Table 2).

During the course of this study data collected for each trial, especially the patterns of music (via sucking) and no music segments, provided additional information regarding the behavior and the learning process of each premature infant. One infant, A, seemingly evinced the skills required for feeding by the sixth trial, as indicated by the music percentage, via sucking, for each trial (see

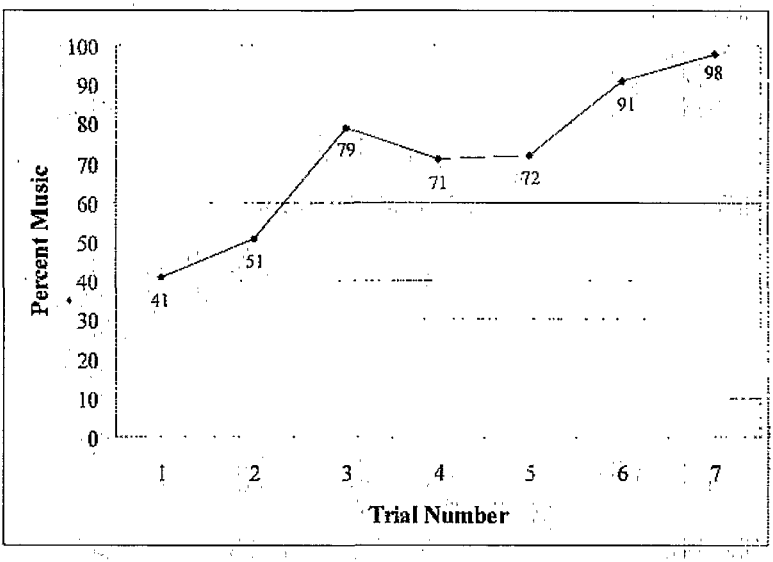

FIGURE 1.
Infant A's average music percent (via sucking) for each PAL trial.

Figure 1). Another infant, B, scored 68%, 79%, and 96% music over the course of three trials. Data collected on this infant during the first and third 15-minute PAL trial indicate the differences of his pacing skills according to each trial and even the fluctuations within each 15-minute trial (see Tables 3 and 4). During the first trial the infant had 13 stops for an average of 22 seconds per stop and 14 music segments that averaged 43 seconds. By the third trial the infant increased the length of the music segments to 2 minutes and 3 seconds and the number of stops decreased to six, with each stop lasting only an average of 6 seconds. By the third trial this infant was demonstrating the effects of learning, improved coordination, and an increase in endurance. Similar to these two infants, many infants who participated in this study increased their music percentage with each subsequent trial.

Researchers have found that full-term infants engaged in nutritive and nonnutritive sucking for 65% during a 15-minute feeding interval (Rybski, Almli, Gisel, Powers, & Maurer, 1984). Premature infants in Standley's (2000) study engaged in nonnutritive sucking for 63%, 2.43 times more during the music conditions than silence

TABLE 3

Description of Music (via Sucking) and No Music Segments in Seconds for the First Trial of Infant B

Music	No music
23	3 seconds to start sucking
65	12
13	28
22	20
55	40
14	45
13	20
53	20
48	11
11	12
19	30
92	26
37	23
143	2
608 s	292 s
10 min and 8 s	4 min and 52 s
68%	32%
14 segments	13 stops (and 3 s to start)
Av = 43 s per segment	Av = 22 s per stop
Range = 11 s to 2 min and 23 s	Range = 2 s to 45 s

conditions. Infants in the present study who participated in three 15-minute PAL trials scored an average of 76% music, via nonnutritive sucking.

Benefits of the PAL merit further evaluation with a highly controlled sample, taking into consideration the infants' gestation age, number of trials each infant completes, percent of music, and time of PAL trial in relationship to feeding time. Future researchers must take into account the PAL and the mean percentage of time receiving music via sucking and whether this transfers to nutritive sucking. In this study we did not measure the length of time required to transfer the skills acquired in nonnutritive sucking to nutritive sucking. Though future research likely will provide additional guidelines and protocol for the use of the PAL with premature infants, clinicians working with these infants must take into consideration that each premature infant is a unique individual with specific needs. In this study data suggest that three trials seem to provide the experiences necessary for weight gain; however, some infants might need only one trial while others might

TABLE 4

Description of Music (via Sucking) and No Music Segments in Seconds for the Third Trial of Infant B

Music	No music
21	2 seconds to start sucking
225	5
192	6
12	8
34	3
152	9
226	5
862 s	38 s
14 min and 22 s	38 s
96%	4%
7 segments	6 stops (and 2 s to start)
Av = 2 min and 3 s per segment	Av = 6 s per stop
Range = 12 s to 3 min and 46 s	Range = 2 s to 9 s

need up to six or seven trials before they gain optimal benefits. Assessment, data collection, and evaluation will further assist clinicians in determining the needs of each infant in regards to the use of the PAL, and whether it is appropriate for all premature infants. The following questions remain: What are the criteria for inclusion beyond the boundaries of this study? Is it necessary and/or beneficial for all premature infants? At what age should the PAL begin? Are some babies more receptive to the music and how is this determined? These and other questions remain unanswered.

Analysis II: Weight Gain Pre, During, and Post PAL Use

The purpose of this analysis was to compare infants' weight gain pre, during, and post PAL trials. One analysis compared weight gain one day prior to using the PAL, on the day or consecutive days the PAL was used, and one day after the PAL was used. Further comparisons included mean weight gain 3 days prior to using the PAL, weight gain on the day or consecutive days the PAL was used, and the mean weight gain for the 3 days post use of the PAL.

Participants

Criteria for inclusion in this portion were the same for those in the first analysis; additionally, only infants with complete weight recordings in their medical charts were included in the analysis. Infants who had a PAL trial on the first 3 days following birth were

TABLE 5
Comparisons of Weight Gain in Grams 1 Day Prior to PAL Use, During PAL Use, and 1 Day Post PAL Use

# of PAL trials	*n*	Before PAL	During PAL	Post PAL
1	37	8.49	18.73	24.81
2–3	15	18.00	28.67	42.80

excluded from the analysis since weight decrease is typical for premature infants in the first few days of life. Similarly, infants who received a PAL trial and were discharged from the hospital the next day or during the 3 days post PAL use were excluded from the analysis. Of the 188 infants who received opportunities with the PAL, data for 52 infants met the above criteria for post-hoc analysis of weight gain one day prior to using the PAL, on the day or consecutive days the PAL was used, and 1 day post use of the PAL. Thirty-five infants were selected for postanalysis for weight gain 3 days prior to use of the PAL, on the day or consecutive days the PAL was used, and 3 days post use of the PAL, based on the same above criteria.

Procedure

Data were compiled for weight gain one day prior to using the PAL, on the day or consecutive days the PAL was used, and one day post use of the PAL. Of the 52 infants who met criteria, 37 infants participated in one PAL trial and 15 infants participated in two or three consecutive trials (7 infants having two consecutive trials and 8 infants having three consecutive trials). For those infants who had two or three consecutive days of PAL trials, the average weight gain was used.

Data were also compiled for the average weight gain three days prior to the PAL trials, weight gain on the day of the PAL trial or the average for the PAL trials, and the average weight gain three days post PAL trials. Of the 35 infants who met the criteria, 23 infants participated in only one trial and 12 infants participated in two or three consecutive trials on consecutive days (5 infants participating in two consecutive trials and 7 infants receiving three consecutive trials).

Results

A one-way repeated measures ANOVA indicated no significant difference between the weight gain one day prior to use of the

TABLE 6

Comparisons of Mean Weight Gain in Grams 3 Days Prior to PAL Use, During PAL Use, and 3 Days Post PAL Use

# of PAL trials	*n*	Before PAL	During PAL	Post PAL
1	23	10.78	11.30	24.78
2–3	12	25.02	29.63	32.17

PAL, on the day the PAL was used, and one day post use of PAL, $F(2, 51) = 1.54$; $p > .05$ (see Table 5). Differences of mean weight gain 3 days prior to using the PAL, on the day the PAL was used, and 3 days post PAL were not statistically significant, $F(2, 34) = 2.27$, $p > .05$ (see Table 6).

Discussion

Though results were not significant for weight gain pre, during, and post PAL use according to number of trials, the weight for infants who had only one PAL trial almost tripled from before the PAL trial to post PAL trial. Infants who had two or three trials gained twice as much weight during the time period post PAL trial compared to before the trial (see Table 5). For both groups of infants—those who received only one trial and those who received two or three trials—there was a steady increase in weight gain from pre PAL use through the 3 days post PAL use (see Table 6).

Weight gain for premature infants is crucial, as stated within the American Academy of Pediatrics (1998) proposed guidelines. Trends herein indicated that some premature infants might more than double their weight gain through use of the PAL. Furthermore, weight gain benefits were still evident 3 days post use of PAL. Further research utilizing the PAL is merited to determine the long-lasting effects of the PAL on weight gain according to number of trials. Research is merited to determine if the PAL method is uniquely different from other approaches, and if NNS and weight gain will occur developmentally just as well as contingent music, including the use of the PAL.

Analysis III: Proximity of PAL Use With Feeding Schedule

In this particular NICU the feeding schedule occurred in 3-hour increments. It occurred to us that the 3-hour interval, broken down into five blocks, might influence the results of PAL treat-

ment. The purpose of this analysis was to determine the effects of the feeding schedule on infants' participation during PAL trials.

Participants

Infants ($N = 62$) were selected for data analysis based on criteria listed previously. The infants had a combined total of 171 PAL trials.

Procedure

Each PAL trial consisted of a 15-minute opportunity for music contingent on sucking; data were collected on the total time in seconds that each infant received music as reinforcement for nonnutritive sucking on a pacifier. Time spent sucking, and therefore listening to music, ranged from 120 to 900 seconds in the 15-minute trials.

The 3-hour feeding interval in which the PAL trial occurred was divided into the following five blocks and number of trials represented: Block 1, $n = 22$, occurred during the 30-minute feeding time; Block 2, $n = 35$, occurred 31 to 60 minutes postfeeding; Block 3, $n = 37$, occurred 61 to 120 minutes postfeeding, deep-sleep time; Block 4, $n = 12$, occurred 121 to 150 minutes postfeeding, or within 1 hour to 30 minutes of next feeding; and Block 5, $n = 65$, 151 to 180 minutes postfeeding, or within 30 minutes of next feeding. Due to disparate size of n, 20 trials were randomly selected for the data analysis from Blocks 1, 2, 3, and 5; all 12 trials were included in the data analysis for Block 4.

Results and Discussion

A Completely Randomized Design ANOVA revealed no statistical significance in total reinforcement time among the five blocks within the infants' 3-hour schedule, $F = 1.70$, $p > .05$. Though no significant differences occurred, there were noticeable trends in the average percent of music reinforcement/sucking according to the schedule blocks (see Table 7). Infants who participated in PAL trials 30 minutes prior to feeding (Block 5) scored the highest average of music via sucking at 77.25%, followed by 71 % for those during feeding (Block 1). Infants who had PAL trials during Block 2 and Block 3 often fell asleep after their feeding and did not complete the full 15-minute trial. Infants who participated in Block 4 scored 66.12% and sometimes fell asleep in the short time before their feeding.

TABLE 7

Mean Percent of Music (via Sucking) During PAL Trial According To the Five Schedule Blocks

	Block 1	Block 2	Block 3	Block 4	Block 5
	During feeding	31–60 min postfeeding	61–120 min postfeeding	121–150 min postfeeding (1 hr to 30 min prior to feeding)	151–180 min postfeeding (30 min prior to feeding)
n	20	20	20	12	20
Percent	71%	59%	54.5%	66.12%	77.25%
n of infants who fell asleep during trial	1	10	8	4	1

Previous research on nonnutritive sucking revealed that infants who engaged in nonnutritive sucking prior to feeding evinced significantly fewer changes in behavior states during feeding (McCain, 1995). Researchers found that infants who engaged in NNS were often in alert inactive, quiet awake, and alert states during those feedings following nonnutritive sucking; these behavioral states are optimal for premature infants (McCain, 1995; Pickler et al., 1996). McCain (1995) emphasized that successful feedings are the result of optimal states prior to feeding. Furthermore, infants who participated in nonnutritive sucking during tube feedings had fewer tube feedings, were ready for bottle feedings 3 days earlier, and were discharged an average of eight days earlier than control infants (Field et al., 1982).

Infants in the present study who participated in PAL trials prior to feeding or during feeding performed better during the PAL trial, as seen in the average percent of music reinforcement (via sucking), and also maintained an awake state during the PAL trial compared to the other times for PAL trials. One problem we noted in this study, however, was that a few infants experienced reflux or undue stress when participating in nutritive sucking with the PAL. For this reason the staff agreed to alter the time for all trials to Blocks 4 and 5, primarily a half-hour, but up to 1 hour before feeding. A note of interest is the fact that those infants receiving the PAL during feeding were receiving two rewards for sucking, music and food. Future studies may be designed to differentiate these factors. Of course, if facilities alleviate Block 1 as described herein as

a statement of policy, the issue is resolved. One factor that cannot be overlooked, however, is that babies who sucked during these conditions also ingested food, which is essential for gaining weight. Perhaps some infants are more prone to reflux under these conditions, thus another avenue for research.

Based on previous research findings, it seems beneficial for premature infants to participate in PAL opportunities 30 minutes prior to feeding. Further research is needed to specifically design PAL opportunities according to each infant's schedule and determine optimal times to participate in PAL trials and gain the greatest benefits.

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