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The Effects of Music on the Selected Stress Behaviors, Weight, Caloric and Formula Intake, and Length of Hospital Stay of Premature and Low Birth Weight Neonates in a Newborn Intensive Care Unit

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The purpose of this study was to examine the effects of music on selected stress behaviors, weight, caloric and formula intake, and length of hospital stay. Subjects were 52 preterm and low birth weight newborns in a newborn intensive care unit (NBICU) who were in stable condition and restricted to isolettes. Subjects in the experimental and control groups were matched for equivalency based on sex, birth weight, and diagnostic criticality. Eleven males and 15 females were assigned to the control group and received routine auditory stimulation. The experimental group of 11 males and 15 females received music stimulation, which consisted of approximately 60 minutes of tape recorded vocal music, including lullabies and children's music, and routine auditory stimulation. Thirty-minute segments of the recording were played alternatively with 30 minutes of routine auditory stimulation three times daily. Exposure to music stimulation occurred only during the infants' stay in the NBICU. Results suggest music stimulation may have significantly reduced initial weight loss, increased daily average weight, increased formula and caloric intake, significantly reduced length of the NBICU and total hospital stays, and significantly reduced the daily group mean of stress behaviors for the experimental group. Data analyses suggest the length of hospital stay may be correlated with the amount of stress experienced by the neonate and not with weight gains. Theoretical and practical aspects of these results are discussed.

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Regardless of their health, preterm infants are not simply immature full-term infants (Gardner, Karmel, & Dowd, 1984), but are born with uncoordinated physiological systems that are not yet well adapted to extrauterine life. Infants born at risk for poor development, especially the very low birth weight infant, may deviate from the basic developmental pattern and may experience significant stress (Gardner et al., 1984).

The sensory system appears to be highly dependent on the different senses receiving suitable input at appropriate levels of maturity (Gardner et al., 1984). As these systems mature experience may play a normal part in maintaining, facilitating, inducing, and determining development of early neural maturation and behavior pre- and postnatally. Stimulation may aid this process (Korner, 1987).

In reference to the environment of the Newborn Intensive Care Unit (NBICU), some researchers support a theory of stimulation deprivation (Katz, 1971; Kramer & Pierpont, 1976; Peltzman, Kitterman, Ostwald, Manchester, & Heath, 1970; Rothschild, 1967). This theory holds that the NBICU does not furnish the constantly changing and stimulating environment provided by the uterus (Korner, 1987; Schaefer, Hatcher, & Barglow, 1980).

Other researchers believe the hospital provides a monotonous and inappropriate sensory environment for the premature infant (Barnard & Bee, 1983; Malloy, 1979; Gottfried & Hodgman, 1984; Gottfried, Wallace-Lande, Sherman-Brown, King, Coen, & Hodgman, 1981; Lawson, Daum, & Turkewitz, 1977; Segall, 1972). This environment is a potential stressor and contributor to the delays experienced by preterm infants (Schanberg & Field, 1987).

Since the 1970s, investigators have been evaluating the behavioral responses of preterm infants to stimulation. Before then, studies concerned mainly term infants (Friedman & Sigman, 1981).

In her discussion of the sensory experience of the very low birth weight infant, Campbell (1985) tells of the short-term advantages of extra stimulation reported by studies, including faster weight gain, better scores on neurological and developmental assessments, improved motor development, and increased abilities to process visual and auditory input. Barnard

and Bee (1983) report lower activity levels or increased quietness.

Although Owens (1979) found no significant effect of regular music stimulation on weight loss, crying, or limb movement of term newborns, other researchers have had different results. Chapman (1979) found both speech and music appeared to facilitate the developmental sequence of limb movement. Chapman suggested that music stimulation conserves energy and permits use of calories for weight gain, and proposed that speech allows the premature infant to adapt more rapidly to new elements in the environment. Birns, Blank, Bridger, and Escalona (1965) stated the inhibition caused by auditory stimulation lowered activity levels and body tension and significantly reduced crying (Birns et al., 1965).

Leib, Benfield, and Guidubaldi (1980) treated a group of preterm infants with a multimodal stimulation enrichment program of visual, tactile, kinesthetic, and auditory stimulation; activities included talking or singing during nipple feeding and approximately 5 minutes of listening to a music box after feeding. Treated infants performed at their chronological age level, as reflected by significantly better motor and mental development, while control infants performed below level. The experimental group consumed significantly fewer calories per kilogram per day. The experimental group appeared to use calories more efficiently than the control group, suggesting a link between early environmental intervention, caloric intake, and short-term growth (Leib et al., 1980).

Segall (1972) concluded that the premature infant is responsive to auditory stimuli, is able to habituate to an auditory stimulus, has different cardiac responses to auditory stimuli depending on behavioral state, and attends to the human voice when crying. Premature infants who received extra auditory stimulation demonstrated more adaptive responses to stimuli than did control infants. These conclusions and those previously mentioned in other studies appear to indicate that auditory stimuli may constitute a most important form of stimulation because of the developmental sequence of the sensory systems.

According to Olds (1986), the results of auditory stimulation studies are extremely encouraging and suggest that research must continue. It is also suggested that the therapeutic impli-

cations for use of sounds and music are extensive (Olds, 1986); however, few researchers continue to study the effects of music alone (Ulrich, 1984). Olds charges that much of the research using music with babies has been judged subjectively by nurses, parents, and psychiatrists. Because of the lack of empirical data in such cases, the information is weakened by lack of scientific evidence.

The purpose of this study was to examine the effects of music on the daily weight changes, formula and caloric intake, selected stress behaviors, and length of hospital stay of premature and low birth weight infants.

Method

A two-sample design was used, consisting of a control group receiving no treatment changes and an experimental group receiving music stimulation. Fifty-two preterm and low birth weight neonates who were in stable condition and restricted to isolettes were included in the study. Groups were matched for equivalency on the basis of sex, birth weight, and criticality of condition based on length of time on an open warmer, a more critical phase which precedes placement in an isolette on the NBICU (see Table 1). Eleven males and 15 females were assigned to the control group, and 11 males and 15 females were assigned to the experimental group. No significant difference was found in the mean age at which the neonates entered the isolettes.

The mothers of all potential subjects were interviewed by the investigator, who explained the study and asked the parent to sign a parental consent form before the infant participated in the study.

This study was conducted in the Newborn Intensive Care Unit (NBICU) at the Tallahassee Memorial Regional Medical Center in Tallahassee, Florida. After the stay in the NBICU, infants are usually transferred to the Intermediate Care Nursery.

The music stimulation was recorded onto a Maxell brand XLII-S 90 cassette tape to be used as a master copy for making microcassette tapes. Using a connecting cord from a JVC TD-W30 Stereo Cassette Deck to a General Electric Microcassette Recorder (model 3-5328), recordings were made onto Sony MC60

TABLE 1
Group Demographics

Group	Male/ Female	Total*	Birth Weight**	Mean Time on Open Warmer***	Age in Isolette****
Experimental	11/15	26	1,675.77 g	3.65 days	3.77 days
Control	11/15	26	1,678.85 g	4.19 days	4.37 days

* $df = 25$, $t = 0.000$, $p > .05$.
** $df = 25$, $t = 0.014$, $p > .05$.
*** $df = 25$, $t = -0.411$, $p > .05$.
**** $df = 25$, $t = 0.090$, $p > .05$.

microcassette tapes. The tapes consisted of approximately 60 minutes of vocal music, including lullabies and children's music.

The General Electric Microcassette Recorder and two Sanyo Microcassette Recorders (model M5430A) were used to play the tapes in the isolettes after daily disinfection using a soft cloth sprayed with Cavicide. The recorders were placed 10–20 inches from the infant's head and operated by the investigator. Each microcassette recorder was played in the normal position of 2.4 cm per second and was powered by two AA rechargeable batteries. The batteries were recharged daily in a General Electric Battery Charger (model BC4B). The decibel level was set in a range of 70–80 decibels as determined by a Realistic Sound Level Meter (model 33-2050) to mask the mechanical sounds of the isolette.

Other equipment included infant weight and caloric intake sheets, parental consent forms, behavioral observation sheets, pens, a clipboard, an observation tape, and a Sony Walkman Cassette Player (model WM-F41) with headphones.

Subjects in the control group were exposed only to routine auditory stimulation. Each infant's weight, formula intake, and caloric content of the formula were recorded daily by the nurses. The investigator transferred this information onto the infant weight and caloric intake sheets.

Beginning on the fourth day after birth or the first day in the isolette if a stable medical status was achieved after the infant was 5 days old, the infants were observed for a total of 300 seconds each, two times daily on a time sampling basis. During each 10-second interval, the observer recorded the infants' behaviors. The first observation occurred at approxi-

TABLE 2
Mean Group Hospital Stay

Group	NBICU*	NBICU Isolette**	Total Stay***
Experimental	10.65 days	6.81 days	26.00 days
Control	16.04 days	10.15 days	31.00 days

* $df = 25$, $t = 1.912$, $p < .05$.
** $df = 25$, $t = 2.002$, $p < .05$.
*** $df = 25$, $t = 1.847$, $p < .05$.

mately 10 minutes past the hour and the second observation occurred approximately 20 minutes before the next hour. Weekly reliability checks revealed a 97% average agreement between observers.

Subjects in the experimental group were exposed to music stimulation as well as routine auditory stimulation. Exposure to music stimulation occurred for approximately 30 minutes beginning on the hour for 3 consecutive hours. Observations took place during the third hour. Infants in the experimental group were exposed to music stimulation a minimum of 5 minutes in the third hour before being observed.

Results

Results of the data analyses show the experimental group had significantly shorter NBICU ($df = 25$, $t = 1.912$, $p < .05$), NBICU isolette ($df = 25$, $t = 2.002$, $p < .05$), and total hospital ($df = 25$, $t = 1.847$, $p < .05$) stays (see Table 2). These results suggest music had a positive effect on the length of hospital stay.

Results of the data analyses indicate initial weight loss was significantly lower for the experimental group during both the NBICU ($df = 25$, $t = 1.962$, $p < .05$) and total hospital ($df = 25$, $t = 2.528$, $p < .01$) stays. Thus, music may aid neonates in retaining a higher percentage of their birth weight. The number of days to maximum initial weight loss, however, was not significantly different ($df = 25$, $t = 0.556$, $p > .05$) (see Table 3). Therefore, music may also aid in producing a more modest rate of initial weight loss.

Weight gain after the initial weight loss was significantly lower for the experimental group than for the control group

TABLE 3
Mean Group Weight Loss

Group	NBICU*	Total**	Time Max*** Weight Loss
Experimental	100.00 g	108.08 g	5.54 days
Control	140.35 g	159.58 g	5.15 days

* $df = 25$, $t = 1.962$, $p < .05$.
** $df = 25$, $t = 2.528$, $p < .01$.
*** $df = 25$, $t = 0.556$, $p > .05$.

during the NBICU ($df = 25$, $t = 2.540$, $p < .01$), the NBICU isolette ($df = 25$, $t = 2.322$, $p < .025$), and total hospital stays ($df = 25$, $t = 1.904$, $p < .05$) (see Table 4). Thus, music may influence a more moderate weight gain after initial weight loss.

In comparison, the results of the main daily weight scores from birth to discharge show the experimental group had a significantly higher mean weight on the NBICU ($df = 25$, $t = 1.846$, $p < .01$) and in the NBICU isolette ($df = 25$, $t = 3.066$, $p < .005$) than did the control group. The mean total daily weight was not significantly different between the experimental and control groups ($df = 25$, $t = 0.191$, $p > .05$) (see Table 5). Therefore, the more moderate rate of weight gain of the experimental group appeared not to have a detrimental effect on the infants' daily weight.

For the experimental group, the mean discharge weight from the NBICU ($df = 25$, $t = 2.762$, $p < .01$) was significantly lower than for the control group. This may reflect the experimental group's shorter stay in the NBICU. There was no significant difference in the mean discharge weight from the total hospital stay ($df = 25$, $t = -0.828$, $p > .05$) (see Table 6). Thus, weight

TABLE 4
Mean Group Weight Gain

Group	NBICU*	NBICU Isolette**	Total Stay***
Experimental	103.08 g	80.00 g	517.31 g
Control	232.27 g	170.73 g	590.96 g

* $df = 25$, $t = 2.540$, $p < .01$.
** $df = 25$, $t = 2.322$, $p < .025$.
*** $df = 25$, $t = 1.904$, $p < .05$.

TABLE 5
Mean Daily Group Weight

Group	NBICU*	NBICU Isolette**	Total Stay***
Experimental	1,658.04 g	1,692.96 g	1,793.88 g
Control	1,635.04 g	1,682.15 g	1,797.58 g

* $df = 25$, $t = 1.846$, $p < .01$.
** $df = 25$, $t = 3.066$, $p < .005$.
*** $df = 25$, $t = -0.191$, $p > .05$.

measure alone may not be a good dependent measure of progress.

During the NBICU stay, the experimental group had a significantly lower formula intake than the control group ($df = 25$, $t = 2.114$, $p < .025$); however, the experimental group's caloric intake was not significantly lower ($df = 25$, $t = 0.737$, $p > .05$). The number of days the experimental group received oral feedings was significantly lower ($df = 25$, $t = 2.162$, $p < .025$) than the control group (see Table 7). Although these data may reflect the experimental group's shorter stay in the NBICU, they may also reflect a positive effect of music on the infants' caloric intake.

Although the experimental group had higher mean scores than the control group, the total formula intake ($df = 25$, $t = 0.630$, $p > .05$) and total caloric intake ($df = 25$, $t = 0.352$, $p > .05$) of the two groups were not significantly different. The total days of oral feedings, however, were significantly lower for the experimental group ($df = 25$, $t = 1.867$, $p < .05$) (see Table 8). Therefore, music may have an overall positive effect on the formula and caloric consumption of neonates.

Analysis of the observational data included daily mean group scores of nonstress behaviors. Daily mean group nonstress be-

TABLE 6
Mean Group Discharge Weight

Group	Total Stay**	NBICU*
Experimental	2,084.62 g	1,680.38 g
Control	2,119.08 g	1,774.23 g

* $df = 25$, $t = 2.762$, $p < .01$.
** $df = 25$, $t = -0.828$, $p > .05$.

TABLE 7
NBICU Mean Group Formula and Caloric Intake

Group	Formula*	Calories**	Days*** Oral Feedings
Experimental	118.42 cc	88.88	6.46
Control	140.62 cc	97.38	10.46

* $df = 25$, $t = 2.114$, $p < .025$.
** $df = 25$, $t = 0.737$, $p > .05$.
*** $df = 25$, $t = 2.162$, $p < .025$.

havior scores were significantly higher for the experimental group than for the control group during the music time ($df = 93$, $t = 2.666$, $p < .005$) and the no music time ($df = 82.75$, $t = 2.231$, $p < .025$) (see Table 9). These results suggest the experimental group's non-stress behaviors improved across time.

Because weight measures alone did not appear to be a good dependent measure of neonate progress, the Spearman Rank Correlation Coefficient was used to analyze the association of length of total hospital stay and weight gain. No correlation was found between the total length of stay and weight gain ($df = 52$, $t = 1.327$, $p > .05$) (see Table 10). The association of total length of hospital stay and nonstress behaviors was also analyzed. A significant correlation was found between the total length of stay and nonstress behaviors ($df = 41$, $t = 4.341$, $p < .0005$) (see Table 11). These results suggest the length of hospital stay may be correlated with the amount of stress experienced by the neonate and not with weight gains. This study suggests music may assist in lowering stress levels of premature and low birth weight neonates.

TABLE 8
Total Mean Group Formula and Caloric Intake

Group	Formula*	Calories**	Days*** Oral Feedings
Experimental	227.31 cc	164.31	20.81
Control	226.31 cc	159.77	24.77

* $df = 25$, $t = 0.630$, $p > .05$.
** $df = 25$, $t = 0.352$, $p > .05$.
*** $df = 25$, $t = 1.867$, $p < .05$.

TABLE 9
Daily Mean Group Nonstress Behaviors

Group	Music Time*	No Music Time**
Experimental	98.30%	97.34%
Control	95.67%	94.33%

* $df = 93.00$, $t = 2.666$, $p < .005$.
** $df = 82.75$, $t = 2.231$, $p < .025$.

Discussion

The NBICU environment is a potential stressor and contributor to the delays experienced by preterm infants (Schanberg & Field, 1987). Music was used in this study to reduce noxious auditory sensory stimulation and to reduce exposure to technical stimulation. As a result, the experimental group had a significantly lower mean initial weight loss and a significantly lower weight gain during hospitalization. Although the experimental group did not have a significantly higher mean total daily weight than the control group during hospitalization, the experimental group did have a significantly higher mean daily weight during the NBICU stay. On the NBICU, the experimental group had a significantly lower formula intake. During the total hospital stay, however, the experimental group's formula intake was higher than the control group's formula intake, but not significantly. Although the experimental group had a lower caloric intake on the NBICU and a higher caloric intake during the total hospital stay, there was no significant difference between the experimental and control groups concerning caloric intake. The NBICU and total hospital stays were significantly shorter for the experimental group. The total observed daily group mean of stress behaviors was significantly less for the experimental group than for the control group. Results of data analyses

TABLE 10
Correlation of Days in Hospital and Weight Gain

Group	Total Stay	Total Weight Gain
Experimental	26.00 days	517.31 g
Control	31.00 days	590.96 g

$df = 52$, $t = 1.327$, $p > .05$.

TABLE 11
Correlation of Days in Hospital and Nonstress Behaviors

Group	Total Stay	Nonstress Behaviors
Experimental	26.00 days	96.76%
Control	31.00 days	93.31%

$df = 41$, $t = 4.341$, $p < .005$.

suggest the total length of hospital stay was related to the amount of stress experienced by the neonate and not related to the amount of weight gain.

Results of this study support various aspects of previous auditory stimulation research. Earlier discharge (Field, Schanberg, Scafidi, Bauer, Vega-Lahr, Garcia, Nystrom, & Kuhn, 1986; White-Traut & Tubeszewski, 1986), pacification (Birns et al., 1965; Brackbill, Adams, Crowell, & Gray, 1966; Smith & Steinschneider, 1975), and better eating (Kramer & Pierpont, 1976) were noted for the experimental group. Increased caloric intake (White-Traut & Tubeszewski, 1986) was also observed for the experimental group in this study when comparing the insignificant difference in caloric intake with the significantly shorter hospital stay. Increased adaptive responses to new environmental elements (Chapman, 1979; Segall, 1972) may have resulted in the significantly lower stress behaviors of the experimental group on a daily basis in this experiment.

The music selected for this study was entirely vocal with instrumental accompaniment, and was age appropriate. Requirements for the particular music selections were that they be soothing and nonexcitatory, represent various styles which may be found in the family environments, have no mechanical or high-tech sounds found in popular or rock music or on the NBICU, have soothing vocal styles, have appropriate lyrics, and have no religious content. Vocal music was used as per Rheingold and Adams (1980), who state that auditory stimulation gives knowledge of the social world, exposes infants to their cultural language, and provides experiences of consequences for development of social behavior. Future research may include a study of music styles and their effects on premature and low birth weight neonates.

In summary, this study demonstrated that music has signif-

icant positive effects in lowering the stress levels of infants, improving feeding, lowering initial weight loss, and shortening the length of hospital stay. Future research has many implications. Aspects of study could include length of ventilator usage, use of Pavulon and other drugs, oxygen saturation levels, growth hormone levels, apnea, brachycardia, stress and irritability reduction, pre- and postsurgery effects, feeding development, weight changes, body temperature self-regulation, length of hospital stay, mental and motor development, long-term effects of music stimulation, and programs to develop parental bonding and interactions with the infants in the hospital and at home. The therapeutic use of music with high-risk neonates appears to be vast and promising.

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