Music Therapy Following Suctioning: Four Case Studies

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This descriptive study evaluates and compares the effectiveness of music, presented both aurally and vibrotactilely, in reducing agitation and physiological instability following a stress-producing intervention (suctioning) in infants with bronchopulmonary dysplasia. Heart rate, oxygen saturation levels, level of arousal, stressful facial expressions, and autonomic indicators were recorded for each of four preterm infants. All infants experienced a reduction in the level of arousal during the taped music intervention when compared with the control condition. Three infants spent an increased amount of time in a quiet alert state and had improved oxygen saturation levels during the vibrotactile intervention. All infants spent more time sleeping during the taped music condition than without music or with the vibrotactile intervention. Results suggest that music is effective in reducing stress-related behaviors for some infants.

MUSIC THERAPY, THE systematic application of music to promote positive changes in behavior, has been used successfully in a variety of hospital settings.[1-11] The effectiveness of music interventions has been measured both physiologically and behaviorally.[2,7,12-16] Although the number of investigations involving music and its effects on health is increasing, there are few studies specifically addressing the effects of music on infants born prematurely.[3,17,18]

Preterm infants as young as 25 weeks gestational age can hear and process sound. Starr and colleagues recorded auditory brain stem potentials of preterm infants and reported that the ability to hear moderately low frequencies is developed, but the ability to hear the extreme lower and higher frequencies apparently does not occur until later in the developmental process.[19] Grimwade and associates reported that the unborn child responds to sound by demonstrating changes in heart rate.[20]

In addition to auditory stimulation, vibrotactile stimulation has been used to promote positive behavioral and physiological changes. Vibrotactile stimulation involves both the sense of hearing and the tactile sense. Recent literature reports benefits of vibrotactile interventions for children and adults.[21-23] The Somatron, a specially designed and commercially available mattress with built-in speakers, provides vibrotactile and auditory stimulation and has been used with hearing-impaired children to improve their ability to identify rhythmic change and as a means of communicating rhythmic patterns.[21] However, no information is available on the use of vibrotactile interventions with newborn infants.

In a study published in 1991 by Madsen, Standley, and Gregory, 60 college students were presented with sedative and stimulative music played through the Somatron mattress.[22] Physiological and psychological responses were observed and reported. There was no significant difference in heart rate as a result of either type of music; however, the researchers reported observing affective responses that suggested the Somatron was both stimulating and relaxing at the same time.

In Norway, VibroAcoustic interventions have been used with a variety of patient populations to reduce spasticity, promote muscle relaxation, and reduce situational stress. Both the Somatron and VibroAcoustic therapy allow the body to feel all the frequencies that are normally only heard. The vibrations and sensations appear to facilitate the relaxation response by reducing the activity of the sympathetic nervous system.[23] Preterm infants may benefit from the structure and rhythmic predictability of specific music that may help to recreate the rhythmic environment experienced by the fetus *in utero*.

PURPOSE

The purpose of this descriptive study was to evaluate and compare the effectiveness of music presented both aurally and vibrotactilely in reducing agitation and physiological instability following stress-producing interventions in infants with bronchopulmonary dysplasia (BPD). Using the neonate as his own control, this study was designed to answer the following questions:

1. Do music interventions decrease "negative" behaviors (crying, facial grimacing, limb movement, rigid or startle responses) when compared to the control condition?
2. Do heart rate and oxygen saturation levels remain within the normal range (120–160 bpm and 95–100 percent,

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respectively) for longer periods of time during the music interventions than in the control condition? (Although oxygen saturation levels of 95–100 percent may be somewhat high, this was the goal of the physicians at the time of this study. Today, 90–100 percent is probably used more.)

3. Is the vibrotactile application of music more effective in reducing agitation, as shown by decreased limb movement and decreased levels of arousal, than either the taped music or the control condition?

METHODS

Over a three-month period, four prematurely born infants requiring continuous ventilatory support were enrolled in this study, which was carried out in the NICU at a tertiary care hospital in the Southeast. Although technically BPD is not diagnosed until day 28 of oxygen requirement, infants who required continual oxygen support after an acute phase of respiratory distress syndrome and who had x-ray findings consistent with the clinical course of BPD were considered eligible for inclusion in the study.

Additional criteria for inclusion consisted of a minimal weight of 2,000 gm so that the infant would be able to maintain thermal regulation in an open crib (necessary for the use of the Somatron mattress), the need for frequent suctioning (every three to four hours), and medical stability as determined by the attending physician. In addition, each infant's auditory capacity must have been determined to be within normal limits according to an auditory evoked potential which measures neurologic responses to sound.

Infants with known congenital anomalies were excluded from the study. Postconceptional ages at the time of the study were 33 weeks, 34 weeks, 35 weeks, and 57 weeks. Three subjects were male and one was female. Prior to being included in the study, the mother of each infant read and signed a consent form that described the purpose of the study. The study was approved by the Institutional Review Board of the hospital.

PROCEDURE

To control for extraneous noise, we conducted the study in an isolation room separated from the main intensive care nursery room by a half-wall and window. Entrance into this room was through a separate door. Once informed consent was obtained from a parent, the infant was brought into the room and remained there in an open crib on a Somatron mattress for the duration of the study. Data collection was not started until the following day. An audiotape using specific tones was used to cue the beginning and end of the observation and recording periods.

Each trial consisted of (1) 1 minute of baseline data collection prior to suctioning, (2) suctioning (oral/endotracheal), and (3) 15 minutes of postintervention assessment. Each infant received 18 trials (288 minutes) with the exception of the first subject, who completed only 17 trials. Baseline data were taken after vital signs and chest percussion were completed. Observation prior to vital signs and chest percussion was not done. Following a 1-minute observation period, nasal-oral pharynx and/or endotracheal tube suctioning was performed. This was part of the routine care of the infant and not an additional intervention.

FIGURE 1 ■ Coding sheet

	HR	O_2	HR	O_2
Behavioral state	1 2 3 4 5 6		1 2 3 4 5 6	
Facial expression	C G Y O N S		C G Y O N S	
Limb movement	1 2 3 4 5		1 2 3 4 5	
Autonomic indicator	N A S T C		N A S T C	

Behavioral state was coded as (1) quiet sleep, (2) active sleep, (3) drowsy or transitional state, (4) awake and alert, (5) active/awake, and (6) crying.[24] Facial expressions were coded as cry (C), grimacing (G), yawning (Y), ooh face (O), neutral (N), smiling (S). Limb movement was assessed on a scale of 1–5, with 5 including all limbs and the head. Autonomic indicators ranged from none (N) to arching (A), startle (S), tremor (T), and clonic movement (C).

Immediately following this procedure, the infant was exposed to one of the following three conditions: (A) music played for 15 minutes through a Somatron mattress, (B) music played through a Panasonic RXFS450 tape player placed at the foot of the infant's crib for 15 minutes, and (C) normal NICU isolation room environment. Each infant received each condition six times in a counterbalanced order (ABC-BCA-CAB-ABC-BCA-CAB) to control for a possible conditioning effect.

Observations were made and recorded every 20 seconds for the next 15 minutes for a total of 45 observations per trial and 270 observations per condition. Recordings of heart rate and oxygen saturation were taken by viewing monitors next to the infant's bed. Arousal state, facial expression, limb movement, and autonomic indicators were recorded by making behavioral observations. Data were collected during late morning, early afternoon, or late afternoon but not during late evening hours (to control for the possible influence of circadian rhythms).

Data were collected by either a registered music therapist or a registered nurse. Interobserver reliability was assessed at 90 percent by performing observations simultaneously and comparing data. Total time for the completion of 18 trials ranged from 8 to 21 days.

INSTRUMENT

A coding sheet, developed by the investigators, was used to determine the presence or absence of selected behaviors and to record both heart rate and oxygen saturation levels. Behavioral codes were state, body movements, facial expressions, and autonomic indicators (Figure 1).

EQUIPMENT

The Somatron mattress used in this study was made specif-

FIGURE 2A ■ Subject A: Minutes spent in each state

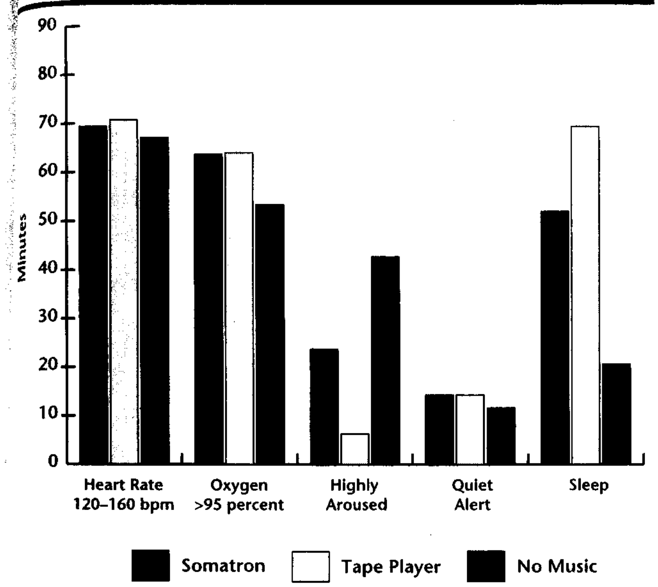
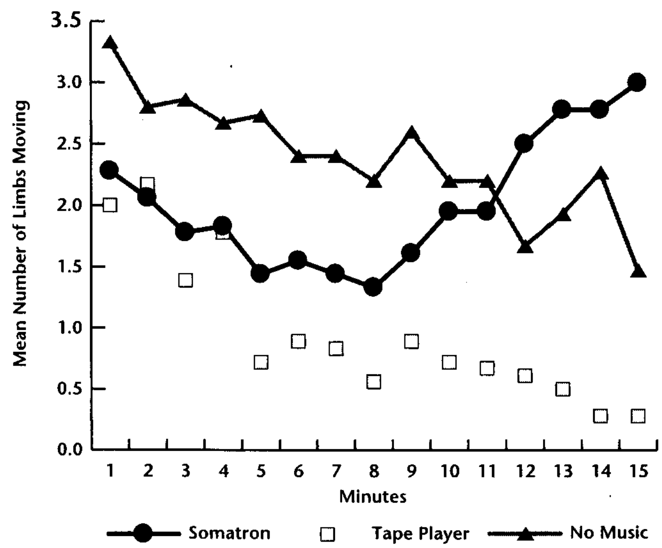


FIGURE 2B ■ Subject A: Limb movement



ically for a newborn crib. The dimension of the Somatron mattress is approximately 50 × 26 × 5 inches and is made up of 1 inch of dacron stuffing, 1 inch of high-density foam, ¼ inch of mahogany sound board, ½ inch of air space, one patented speaker measuring 12 × 14½ inches with a maximum power output of 25 watts rms, a frequency range of 55 Hz–20,000 Hz, sensitivity of 105 db/m (decibels/meter) for 1 watt of electrical input, and an input impedance of 8 ohms. The external fabric is a waterproof vinyl, which meets federal flammability specifications and may be sterilized after each use. The Somatron is supported by a Realistic car stereo cassette player, a UL-approved power source, and a Realistic 40-watt stereo frequency equalizer.

A Panasonic RXFS450 tape player was used for the second intervention. This model was selected because of its graphic equalizer, which made the auditory presentation as similar to the Somatron as possible. Appropriate decibel levels for both the tape player and the Somatron were determined to be 65 dB by an audiologist. The appropriate volume level was marked on each volume control knob using surgical tape. The tape player was then placed approximately 65 cm from each subject's head and was adjusted to produce the same decibel level as the music presented on the Somatron.

The music used was the audiocassette entitled "Transitions" (Placenta Music, Inc., Atlanta, Georgia), consisting of sounds of the intrauterine maternal pulse, designed to emulate natural womb sounds, blended with synthesized female voices.

Another portable cassette player was used to play timed beeps signaling the beginning and ending of each observation period. A Novametrics pulse oximeter was used to determine oxygen saturation levels. A Horizon 2000 bedside heart monitor was used to determine heart rate during the observations.

ANALYSIS

Observational recordings of data were analyzed individually and compositely to determine the number of minutes, out of a total of 90 minutes, that each infant spent (1) with heart rate within normal limits (120–160 bpm), (2) with arterial oxygen saturation levels at 95 percent or higher, (3) in a highly aroused state (agitated or crying), (4) in a quiet alert state, and (5) in a low arousal state (sleeping or drowsy). Limb movement was analyzed over 15-minute periods and averaged to find a minute-to-minute average limb movement. Data from all subjects were compiled to see whether a particular condition was more effective for all infants combined. The number of stressful facial expressions (crying, grimacing, or yawning) and the number of autonomic indicators (arching, startle, tremor, clonic) noted during each intervention were recorded.

RESULTS

Subject A

Subject A was a 575 gm baby girl born at 25 weeks gestation to an 18-year-old black female via cesarean section for severe pre-eclampsia. At the initiation of the study, the subject was 261 days old and weighed 2,440 gm. At the completion of the study, she was 281 days old and weighed 2,560 gm. Her initial medical problem was respiratory distress syndrome (RDS) that required mechanical ventilation. Two extubation trials were unsuccessful.

At the time of study, the infant had a diagnosis of cystic BPD based on chest x-ray findings and her clinical course.

FIGURE 3A ■ Subject B: Minutes spent in each state

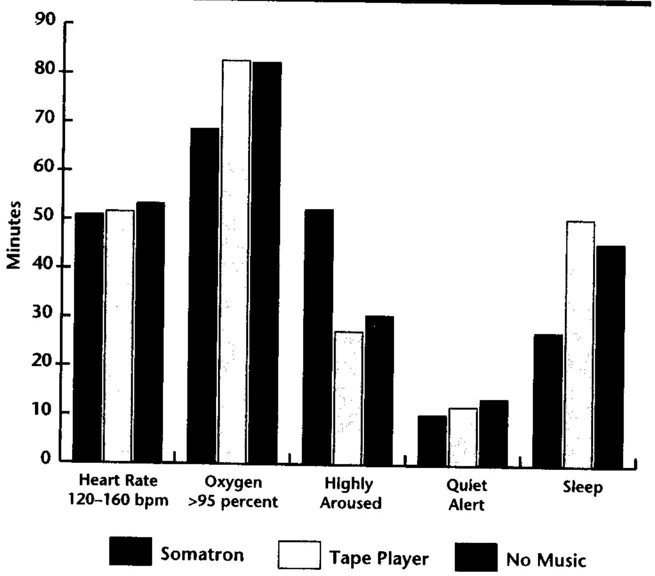
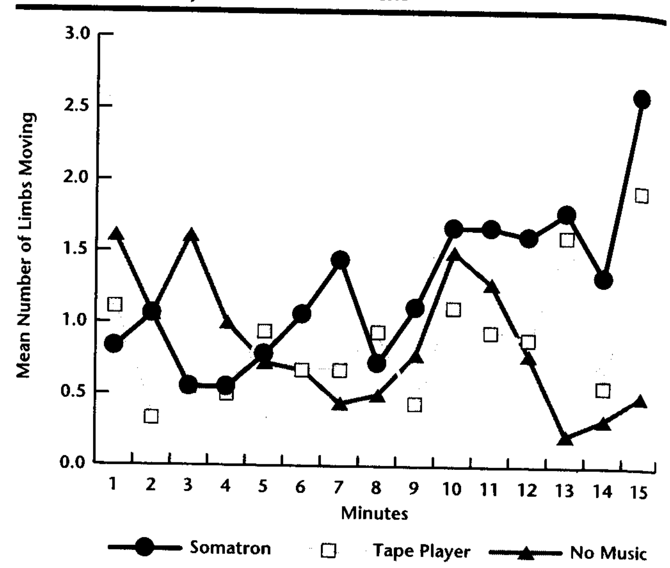


FIGURE 3B ■ Subject B: Limb movement



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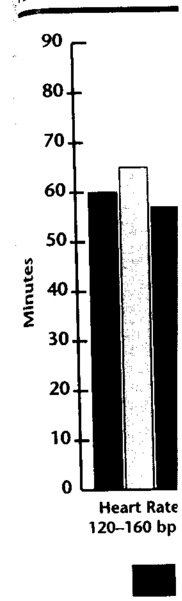

This infant was extremely sensitive to stimulation and had required fentanyl, lorazepam, and morphine for sedation. During the study, data were not collected if narcotics had been administered within the last six hours.

Subject A completed six 15-minute trials each for the vibrotactile and auditory conditions, and five 15-minute trials for the no music condition. The final trial (no music) was not administered because of medical complications. There were no significant differences in heart rate during the three conditions, as determined by the number of minutes spent within normal limits. However, subject A spent more time with her heart rate within normal limits during both of the music conditions (3.5 percent more with the Somatron, 5.5 percent more with the tape) than during the control condition (Figure 2A). Oxygen saturation levels were higher during both the Somatron (19.4 percent) and taped music condition (20 percent) than during the no music condition.

This subject spent 44.5 and 85.2 percent less time, respectively, in a highly aroused state during the Somatron and taped music conditions and 22.8 percent more time in a quiet alert state during both of the music conditions when compared to the control condition. The infant had an increase in sleep time of 152 percent with the Somatron and 235 percent with the taped music when compared to the no music condition.

Limb movement was also less during the music conditions, with the most significant reduction occurring during the taped condition (Figure 2B). There was a decrease in stressful facial expressions during the taped condition when compared to both the control condition and the Somatron. Subject A did not exhibit any autonomic indicators such as tremors or startle reflexes during the trials.

Subject B

Subject B was a 1,600 gm male infant born at 31 weeks gestation by emergency cesarean section for prolapsed umbilical cord. The infant was admitted to the NICU with the diagnosis of severe RDS, for which he received Exosurf and required ventilatory support for several days. He also received vasopressors for treatment of hypotension and experienced problems with hypoglycemia for the first few days of life. On the tenth day of life, a head ultrasound revealed a Grade I intraventricular hemorrhage, but there were no noticeable neurological effects or behavioral changes.

The infant entered the study on day 21 of life, at which time he was receiving oxygen via nasal cannula at 40 percent, at a flow rate of ⅒ liter per minute. He was under phototherapy and received parenteral and enteral nutrition. Behaviorally, the subject had a history of bronchospastic reactions to stress, but he had not required narcotics or sedatives.

Subject B received six 15-minute trials for each condition (Figure 3A). There was no notable difference in the heart rate during the music conditions when compared with the no music condition. The number of minutes spent in a highly oxygenated state was similar during the taped and no music conditions but decreased by 16.6 percent during the Somatron condition.

Limb movement generally increased during the Somatron condition (Figure 3B). For this infant, music presented via the Somatron seemed to provide too much stimulation, resulting in increased arousal (70.6 percent more of the time than with no music), stressful facial expressions, increased limb movement, and greater autonomic indicators.

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FIGURE 4A ■ Subject C: Minutes spent in each state

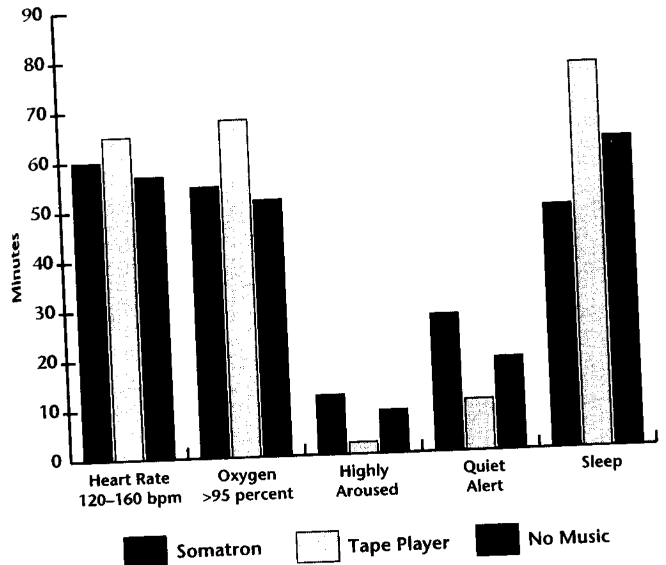
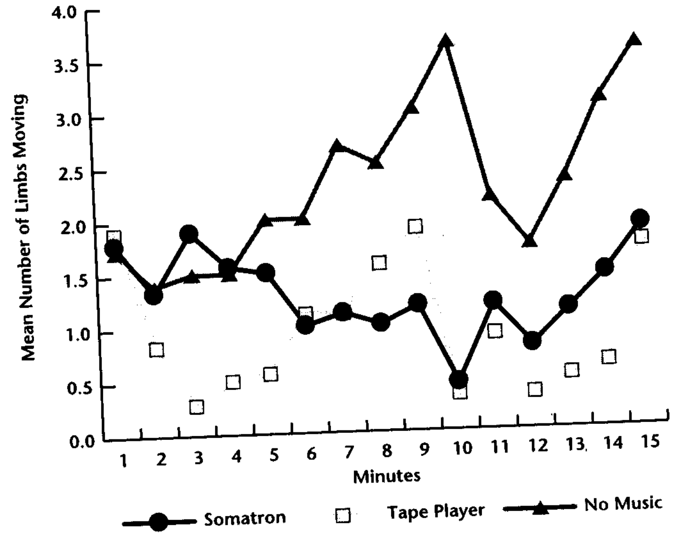


FIGURE 4B ■ Subject C: Limb movement



Subject C

Subject C was a 1,100 gm male born at 28 weeks gestation via standard vaginal delivery for preterm labor. The mother had received no prenatal care. The infant was admitted with a diagnosis of RDS, received Exosurf, and required ventilatory support for 39 days, including 7 days of high-frequency oscillatory ventilation for treatment of pulmonary interstitial emphysema. He also required chest tube placement in response to pleural effusion and pneumothorax. Vasopressor support was used during the first 9 days of life for treatment of hypotension. He required indomethacin for closure of his patent ductus arteriosus.

The infant entered the study on day 74 of life, at which time he was on 50 percent oxygen via nasal cannula at ⅛ liter per minute. During the period of the study, oxygen was increased to 100 percent at ¼ liter per minute because of bradycardiac episodes. He reacted to environmental stress with agitated behavior and occasional bronchospasms.

Subject C received six 15-minute trials for each condition (Figure 4A). Both the Somatron and taped music conditions resulted in an increase in the number of minutes during which the heart rate was within normal limits (5.3 and 14 percent, respectively) when compared to the no music condition. Oxygen saturation levels were also higher during the music conditions (5.8 percent for the Somatron, 31.6 percent for the taped music) than in the control condition.

The infant spent significantly less time (73.1 percent) in a highly aroused state during the taped music condition than during either the no music or Somatron condition. However, the Somatron produced a 48.2 percent increase in the number of minutes spent in a quiet alert state—an optimal state for developmental interaction. When compared to the no music condition, the taped music condition produced an increase in sleep time of 24.1 percent. Stressful facial expressions were decreased during both of the music conditions. Limb movement was higher during the Somatron condition, possibly due to the increased time of being awake (Figure 4B). The fewest number of autonomic indicators was observed during the no music condition.

Subject D

Subject D was a 2,270 gm male infant born at 35 weeks gestation via emergency cesarean section for fetal decelerations. The mother had received no prenatal care. The infant was admitted with a diagnosis of RDS and required ventilatory support for 10 days. He was later diagnosed as having congenital syphilis and was treated with a 14-day course of antibiotics.

The infant entered the study on day 9 of life, at which time he was on minimal ventilatory support. He was extubated on the first day of the study and thereafter maintained on an oxygen hood of 28–40 percent. There was no evident central nervous system involvement from the syphilis, nor were there any other neurological abnormalities noted during his hospital course.

Subject D received six 15-minute trials for each condition (Figure 5A). There was a 114.2 percent increase in the number of minutes the heart rate was within normal limits during the taped music condition when compared to the no music condition. Oxygen saturation was improved during both of the music conditions, with the greatest improvement (72.2 percent) observed using the Somatron (compared to 36 percent with the taped music).

There was a decrease in the number of minutes the infant

FIGURE 5A ■ Subject D: Minutes spent in each state

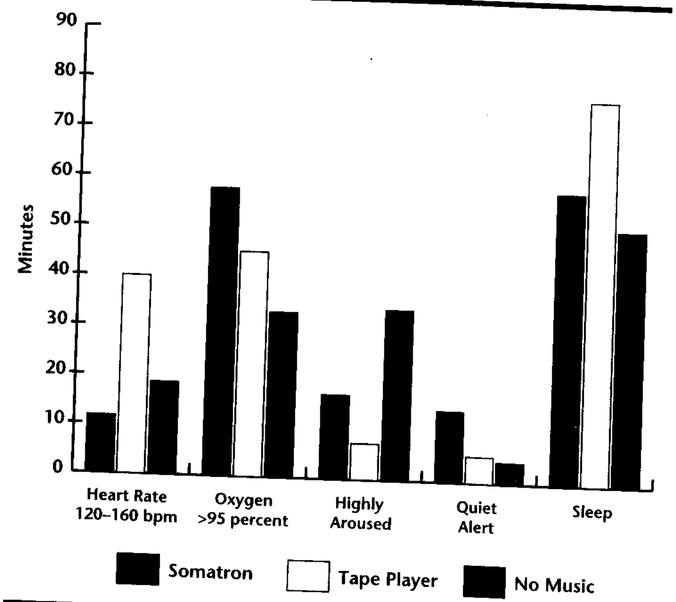
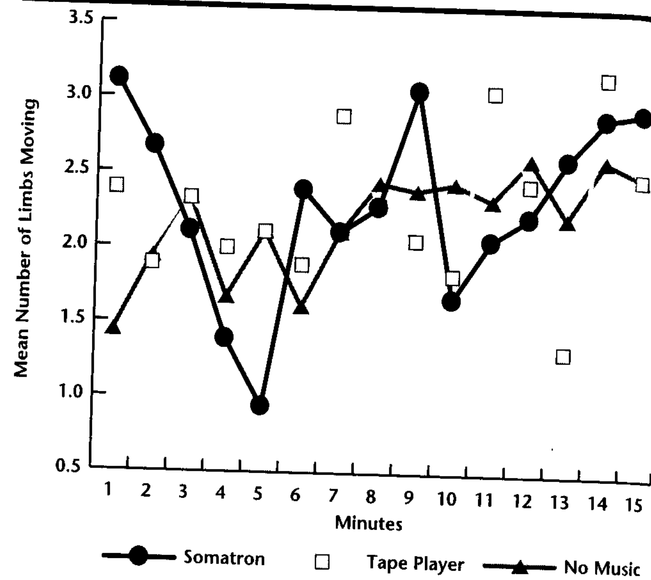


FIGURE 5B ■ Subject D: Limb movement



spent in a highly aroused state during both of the music conditions when compared to the control condition, with the greatest decrease occurring during the taped music condition (78.7 percent compared to 50.5 percent with the Somatron). The Somatron produced a 230.2 percent increase in the amount of time the infant spent in a quiet alert state. Both the Somatron and taped music conditions produced a higher number of minutes the infant was in a drowsy or sleepy state when compared to the no music condition, with the highest number of minutes observed during the taped music condition (50.6 percent compared to 14.3 percent for the Somatron).

Limb movement was increased during the no music intervention (Figure 5B). Stressful facial expressions and autonomic indicators were higher during the no music condition. For this infant, the music conditions seemed to affect both behavioral and physiological states, which resulted in less agitation and increased medical stability.

Composite Data

Figures 6A and 6B show the composite data on all four infants. Although it is important to keep in mind the individual temperaments and medical stability of each infant, the overall findings of this study indicate that (1) heart rate was not significantly affected by vibrotactile stimulation, but it was improved with the use of taped music; (2) oxygen saturation levels were improved during both of the music conditions; (3) both music conditions decreased the amount of time spent in a highly aroused state; (4) the Somatron increased the amount of time spent in a quiet alert state; (5) both music conditions increased the amount of time infants spent sleeping; and (6) infants displayed greater limb movement during the no music condition.

Figure 7 shows the percentage change from baseline for the two music conditions. The taped music condition increased the amount of time that infants spent with their heart rate within normal limits; and both conditions (1) increased the amount of time the infants spent in a well-oxygenated state, (2) decreased the amount of time spent in a highly agitated state, and (3) increased the amount of time infants spent sleeping. Each of these physiological changes promotes homeostasis, which increases medical stability and promotes physical well-being by reducing the effects of a stressful environment.

DISCUSSION

Data from this study suggest that music combined with intrauterine sounds is effective for some infants in reducing periods of agitation following a stressful intervention. It was hypothesized that the combination of vibrotactile and auditory stimulation provided by the Somatron would be the most effective in producing a relaxation response. However, in three of the infants observed, the greatest relaxation response (sleep) was noted during the periods of auditory stimulation alone. These findings support those of Leonard, who reported that three agitated neonates exhibited an "immediate response" to the "Transitions" tape, becoming organized and falling asleep.[25]

Although music played through both the Somatron and the tape player had a positive effect on decreasing levels of agitation for three of the infants when compared to the no music condition, the Somatron facilitated a higher number of minutes spent in the quiet alert state. This quiet alert state is

FIGURE 6A ■ Mean for all subjects (minutes spent in each state)

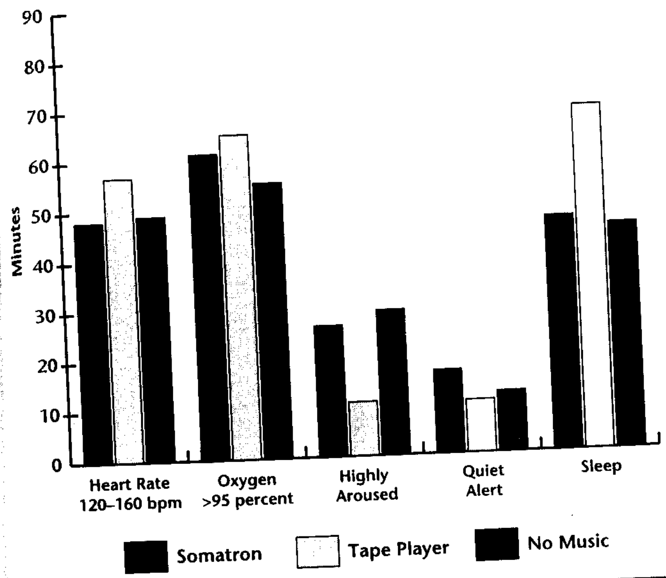
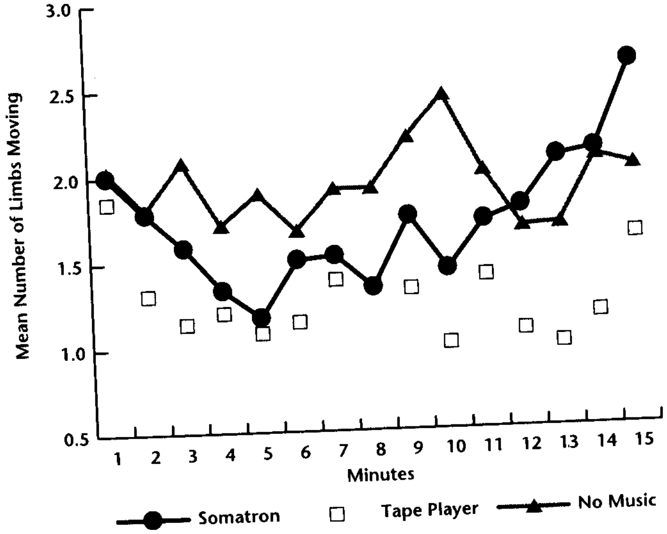


FIGURE 6B ■ Limb movement: All subjects



rarely seen in premature infants and is the optimal state for providing developmental interaction. Both low arousal and quiet alert states promote autonomic stability in the critically ill premature infant, thereby allowing for improved oxygenation and the conservation of calories required for growth and healing. The discovery of the increased quiet alert state was an unexpected and positive finding.

The fetus, according to Walker, Grimwade, and Wood, has a built-in "lullaby" consisting of blood pulsating through the placenta causing a "whooshing" sound with a mean noise level of 85 decibels.[26] Rosner and Doherty reported that these intrauterine sounds, when prerecorded, elicited soothing responses from fussy newborns but had minimal influence on babies who were awake and calm.[27]

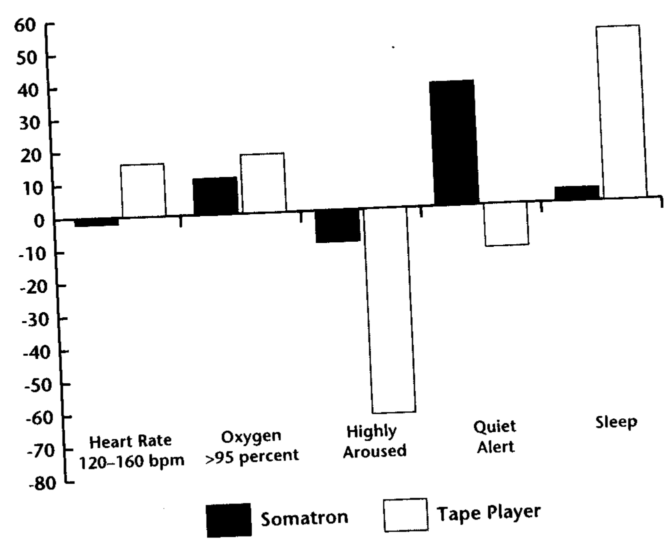
In addition, Glass has stated that "stimulation of the senses should begin with the most mature; and optimal stimulation for initial postnatal development resembles the sources naturally available to the fetus and infant—those that come from the mother."[28] Glass's statement supports the use of maternal sounds as an appropriate auditory stimulation for the premature infant.

It was believed that the "Transitions" tape would most closely resemble the auditory environment of the fetus *in utero* because it consists of prerecorded placental pulsing sounds combined with synthesized music. We found that both fussy and calm infants responded to these "whooshing" sounds, particularly during the vibrotactile intervention, as shown by visual attentiveness and quiet alertness.

According to Collins and Kuck, intubated, premature infants in an NICU who heard taped music blended with intrauterine sounds had a significant increase in oxygen saturation levels and a decrease in agitated behaviors (thrashing extremities, increased movements, or facial grimacing) when compared to baseline observations without auditory input.[17] The findings of our study support their observations.

In a study by Chapman, premature infants who received music in their incubators six times daily reached their target weight (4 lbs, 1 oz) sooner than the infants who did not receive music.[29] Using limb movement as an indicator of calories spent, our findings, which show a decrease in overall limb movement during the music conditions when compared to the

FIGURE 7 ■ Percent change from baseline for all subjects



no music condition, support the concept that music and/or vibrotactile stimulation can promote weight gain by decreasing thrashing or other limb movement, which burns calories.

Caine systematically played recorded lullabies to 52 preterm and low birth weight infants in their incubators. Results showed that the experimental group had significantly shorter NICU hospital days and overall hospital days as well as a significant decrease in initial weight loss. Nonstress behavioral indices (little or no body movement, lack of rigidity in limbs, not crying, and lack of facial grimaces) were also higher for the music group, suggesting that the controlled use of music may assist in reducing signs of overt stress in premature and low birth weight infants.[3] The results of this study support Caine's findings in that all infants in this study exhibited the least number of stressful facial expressions and spent less time crying during the taped music condition.

Standley and Madsen reported that infants between the ages of two and eight months manipulated their environment, using an electronic switch attached to their heels, to elicit preferred auditory stimulation. Although the mean listening time was slightly greater for the mother's voice and an alternate than for music, a behavioral analysis showed that the babies listened more intently (eye behavior was more fixated) during the music stimuli than other auditory stimuli and had less gross motor movement during music than during all other stimulus conditions.[30] This finding has important implications for preterm infants, who need to use their calories for growth rather than purposeless movement. Again, our results show that taped music appeared to reduce limb movement for two of the infants and that, overall, there was more limb movement during the no music condition.

In addition to music, other sounds have been used to elicit a variety of responses. Oehler, Eckerman, and Wilson reported that talking to very low birth weight infants led to a quiet, visually attentive state and touching produced a more active state.[31] The positive finding of this study was that even though some infants were more aroused during the Somatron experience (vibrotactile stimulation), this time was spent in a quiet alert state rather than a highly aroused state.

Limitations

The sample size of this study was small, with varying degrees of severity of illness within the group. A larger, more homogenous sample would lend itself to more conclusive findings. One contributing factor that led to a decrease in the number of available subjects was the increasing use of surfactant during the time the study was being conducted. The growing use of surfactant decreased the number of infants who developed chronic BPD and therefore the need for extended mechanical ventilation.

RECOMMENDATIONS

The individual differences among subjects in this study in their responses to both the auditory and vibrotactile stimuli are consistent with Yecco's observation that "stimulation that is responsive to the individual infant's behavioral and physiologic cues may prove to be most beneficial when combined with a preventive and developmentally supportive program."[32]

For some infants, the sensory experience of the Somatron was stimulating and therefore not effective in promoting sleep, although it appeared to reduce agitation when compared to a no music condition. Replication of this study using a larger sample and/or younger infants who might be more attuned to the intrauterine sounds and a longer baseline period for testing before and after intervention is needed to further examine whether there are particular types of infants who may benefit more from either auditory or vibrotactile stimulation.

Music, with and without vibrotactile stimulation, appears beneficial for the preterm infant in promoting physiological stability and reducing stress-related responses to noxious interventions. Future research might focus on (1) the effectiveness of the Somatron in facilitating developmental interaction, (2) the use of music (either auditory or vibrotactile) in promoting growth by decreasing limb movement and facilitating weight gain, and (3) reducing overall length of stay by promoting longer periods of stability, which may facilitate the healing process.

REFERENCES

1. Bailey LM. 1986. Music therapy in pain management. *Journal of Pain and Symptom Management* 1(1): 25–28.
2. Bonny HL. 1983. Music listening for intensive coronary care units: A pilot study. *Music Therapy* 3(1): 4–16.
3. Caine J. 1991. 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 neonatal intensive care unit. *Journal of Music Therapy* 28(4): 180–192.
4. Cook J. 1986. Music as an intervention in the oncology setting. *Cancer Nursing* 9(1): 23–28.
5. Curtis SL. 1986. The effect of music on pain relief and relaxation of the terminally ill. *Journal of Music Therapy* 23(1): 10–24.
6. Frank JM. 1985. The effects of music therapy and guided visual imagery on chemotherapy induced nausea and vomiting. *Oncology Nursing Forum* 12(5): 47–52.
7. Hanser SB, Larson SC, and O'Connell AS. 1983. The effect of music on relaxation of expectant mothers during labor. *Journal of Music Therapy* 20(2): 50–58.
8. Pickrell KL, et al. 1954. The use and therapeutic value of music in the hospital and operating room. In *Music Therapy,* Podolsky E, ed. New York: Philosophical Library, 170–186.
9. Rider MS. 1985. Entrainment mechanisms are involved in pain reduction, muscle relaxation and music mediated imagery. *Journal of Music Therapy* 22(1): 183–192.
10. Standley J. 1986. Music research in medical/dental treatment: Meta-analysis and clinical applications. *Journal of Music Therapy* 23(2): 56–122.
11. Taylor DB. 1981. Music in general hospital treatment from 1900 to 1950. *Journal of Music Therapy* 18(2): 62–73.

12. Rider MS, F
music, image
re-entrainme
22(1): 46–58
13. Locsin RG.
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19–25.
14. Beckett A. 1
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15. Moss VA. 1
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48(1): 64–6
16. Clark ME, M
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17. Collins SK,
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18. Standley JM
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19. Starr A, et a
born infants
69(6): 831–
20. Grimwade J
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21. Darrow AA,
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115–124.
22. Madsen CK
vibrotactile
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23. Skille O. 1
61–77.
24. Brazelton
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25. Leonard JE
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26. Walker D,
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Obstetrics a
27. Rosner B,
intrauter
Neurology
28. Glass P. 19
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Managem
and McD
29. Chapman
of short
Unpublis

12. Rider MS, Floyd JW, and Kirkpatrick J. 1985. The effect of music, imagery, and relaxation on adrenal corticosteroids and the re-entrainment of circadian rhythms. *Journal of Music Therapy* 22(1): 46–58.
13. Locsin RG. 1981. The effect of music on the pain of selected post-operative patients. *Journal of Advanced Nursing* 6(1): 19–25.
14. Beckett A. 1990. The effects of music on exercise as determined by physiological recovery heart rates and distance. *Journal of Music Therapy* 27(3): 126–136.
15. Moss VA. 1988. Music on the surgical patient: The effect of music on anxiety. *Association of Operating Room Nurses Journal* 48(1): 64–69.
16. Clark ME, McCorkle RR, and Williams SB. 1981. Music therapy–assisted labor. *Journal of Music Therapy* 18(2): 88–100.
17. Collins SK, and Kuck K. 1991. Music therapy in the neonatal intensive care unit. *Neonatal Network* 9(6): 23–26.
18. Standley JM. 1991. The role of music in pacification/stimulation of premature infants with low birthweights. *Music Therapy Perspectives* 9: 19–25.
19. Starr A, et al. 1977. Development of auditory function in newborn infants revealed by auditory brainstem potentials. *Pediatrics* 69(6): 831–839.
20. Grimwade JC, et al. 1971. Human fetal heart rate change and movement in response to sound and vibration. *American Journal of Obstetrics and Gynecology* 109(1): 86–90.
21. Darrow AA, and Goll H. 1989. The effect of vibrotactile stimuli via the Somatron on the identification of rhythmic concepts by hearing impaired children. *Journal of Music Therapy* 26(3): 115–124.
22. Madsen CK, Standley JM, and Gregory D. 1991. The effect of a vibrotactile device, Somatron, on physiological and psychological responses: Musicians versus nonmusicians. *Journal of Music Therapy* 28(1): 14–22.
23. Skille O. 1989. Vibroacoustic therapy. *Music Therapy* 8(1): 61–77.
24. Brazelton TB. 1973. *Neonatal Behavioral Assessment Scale.* Philadelphia: JB Lippincott.
25. Leonard JE. 1993. Music therapy: Fertile ground for application of research in practice. *Neonatal Network* 12(2): 47–48.
26. Walker D, Grimwade J, and Wood C. 1971. Intrauterine noise: A component of the fetal environment. *American Journal of Obstetrics and Gynecology* 109(1): 91–95.
27. Rosner B, and Doherty A. 1979. The response of neonates to intrauterine sounds. *Developmental Medicine and Child Neurology* 21(6): 723–729.
28. Glass P. 1994. The vulnerable neonate and the neonatal intensive care environment. In *Neonatology: Pathophysiology and Management of the Newborn,* 4th ed., Avery GB, Fletcher MA, and McDonald MG, eds. Philadelphia: JB Lippincott, 77–94.
29. Chapman JS. 1975. The relation between auditory stimulation of short gestation infants and their gross motor limb activity. Unpublished doctoral dissertation, New York University.
30. Standley J, and Madsen CK. 1990. Comparison of infant preferences and responses to auditory stimuli: Music, mother, and other female voice. *Journal of Music Therapy* 27(2): 54–97.
31. Oehler JM, Eckerman O, and Wilson WH. 1988. Social stimulation and the regulation of premature infants' state prior to term age. *Infant Behavior and Development* 11(3): 333–351.
32. Yecco GJ. 1993. Neurobehavioral development and developmental support of premature infants. *Journal of Perinatal and Neonatal Nursing* 7(1): 56–65.

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CORRECTION

On page 18 of the September 1995 issue (Vol. 14, No. 6) we inadvertently switched the x-rays for Figures 1 and 2. We sincerely apologize to our readers and to Ms. Parker for this error.