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NICU music therapy: song of kin as critical lullaby in research and practice

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Music therapy can improve neonatal function and reduce anxiety in parents during neonatal intensive care unit (NICU) stays. Live music entrained to an infant's observed vital signs, provided by a certified music therapist with First Sounds RBL (rhythm, breath, and lullaby) training, enhanced bonding for infant–parent dyads and triads. The author's *song of kin* intervention, which employs parent-selected songs, is compared to the presentation of a well-known folk theme ("Twinkle") in 272 neonates. Culturally based, parent-selected, personalized musical tunes provided in song, as a noninvasive intervention, foster optimal, continuous quality of care. Music psychotherapy sessions for parents before working with their infants can instill a potent means of nonconfrontational support, allowing for expression of fear or anxiety related to the premature birth. Although most attention is typically directed to their infant, using music can support the parents' grief and assist in the expression of hope that can instill a sense of security and containment. From the NICU to home, a familiar thread-line theme can be resourced directly from the family and/or parent and applied effortlessly throughout the growing baby's transitional moments.

Keywords: NICU music therapy; song of kin; neonatal lullabies

Introduction

Live music provided in a music therapy context can improve neonatal vital signs and reduce anxiety perception in parents during neonatal intensive care unit (NICU) stays. Data collection from 272 infants in 11 NICUs measured weight gain, sucking patterns, heart rate, oxygen saturation, sleep, and parental stress and indicate the effectiveness of entrained live music.[1] *Song of kin* provided by a certified music therapist with First Sounds RBL (rhythm, breath, and lullaby) training has the capacity to improve vital signs and attachment focus for infant–parent dyads and triads. A trend in live music interventions that are provided in the moment, utilizing music therapy, has reflected an increased weight gain and better sleep patterns, as well as prolonged quiet–alert states that can strengthen neurological mechanisms related to attention, sleep, and familiarity. This paper examines the author's song of kin intervention in view of the data collected in a broader study.[1] Parent-selected songs as an accessible intervention enhance bonding and can maintain optimal continuous quality of care from the NICU into the home as a familiar theme derived from the parent and applied naturally and effortlessly throughout the growing baby's transitional moments.

The specific elements of replicated live womb sounds inclusive of the independent variables of rhythm (heart beat) and timbre ("whoosh" intrauterine sounds) and lullabies were studied,[1] and previously, the impact of live singing with infants and toddlers in successful sedation for medical testing when compared with pharmacologic regimens was measured as well.[2] Past clinical trials in NICU and early infant research reflected that live singing[3,4] has therapeutic benefits in comparison to speaking[5] but did not specifically include the mother, father, or families' song of kin in neonatal care. Music psychotherapists' best practice strategies reflect that live

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music that imbues the cultural practices of patients' life-world may have the greatest efficacy in fostering a sense of containment and resiliency, as it represents what is safe and familiar.

Early attachment research has compared the effects of live versus artificial nurturance in the first days of life[6] and indicates that entrainment to breathing sounds occurs spontaneously, particularly when provided for vulnerable NICU infants.[7] A central focus of both practice and research in the RBL training model has instituted the practice of teaching parents how to entrain to the vital rhythms of their infants in the moment, with live breath sounds and, most particularly, songs of kin, thus adapting to the moment-to-moment changes of the relationship. Entrainment is the synchronization and control of a physiological rhythm by an external stimulus. Infants habituate to their environment as a mechanism of survival, and this can have hazardous effects, particularly in prematurity.[8,9] For example, when noisy beeps of monitors are frequently sounding in the NICU, an infant's sleep can risk interruption. Entrainment provides a clinical means of influencing the body's ability to regulate through the use of purposeful music interventions.[10,11] Unlike a recording of music, music therapy fosters a live, direct means of entrainment, particularly when supported through a parent–infant application.

Neurobehavioral research reveals greater efficacy in infant development within the context of a social learning environment when nurturance is enhanced in response to a live human being rather than to a machine.[5,6] Attachment, a precursor to bonding, fosters physical contact and early involvement between the infant and caregiver.[12] In some instances, NICU noise and machinery threaten the infant–parent bonding experience. In addition, dependence on healthcare professionals, while so profoundly needed, may undermine a bonding process of attunement between parent and infant.[13]

Singing to attach and attune

Attachment fostered through bonding is enhanced through maternal and paternal singing, particularly when the caregiver is attuned to the infant.[3,4] When caregivers are distressed, traumatic responses risk being transferred physiologically, albeit unknowingly to their newborns. It is recognized that parents of premature infants are at risk.[14] An important role of music therapy may be to assist parents in developing psychotherapeutic ways to provide interactive and stimulating nurturance at appropriate times, as this affects infant development neurobiologically.[15,16] Surprisingly, however, there are few studies that distinctly address how a caregiver's attention to the application of live singing affects specific parameters of premature infant growth. Music can intricately affect the growing infant's care because the culture and musical preferences are audible to the infant in the womb.[16,17] Infants have a natural tendency to entrain to sounds.[18] The music therapist's attention to parents' voices and lullabies of their culture was studied and effectively implemented into the continuum of care with promising outcomes.[2]

Methods

A prior report of this study's results compared three interventions including entrained sounds of rhythm, breath, and lullaby.[1] The main focus of this paper is to view the outcomes of precomposed versus parent-selected music. Our analysis will be relegated to comparing song of kin to the use of a standard popular lullaby "Twinkle, Twinkle" as the lullaby intervention that was provided by the parent or music therapist. The infants received three live interventions as randomized over a 2-week period and applied either in the morning or afternoon three times per week. The other 4 days with no intervention served as a secondary control measure. We also tabulated long-term outcomes by collecting daily flowchart stats. Recruitment of certified music therapists through mid-Atlantic pediatric hospital settings where music therapy programs in the NICU were identified, or where NICU MD directors allowed music therapy research to occur, preceded the training of 17 music therapists and 8 graduate interns. Our 3-year study time ensured that the applications were offered in a replicable method. Seven MDs and numerous RNs assisted in the development and application of the protocol. The piloted hypotheses included investigation of the informed use of domains of functioning in premature infants with RDS, SGA, and sepsis. These three diagnoses were identified as being common to most hospitals. Each infant's development involved observation and collection of data over a variety of physiological domains before, during, and after the intervention and daily throughout the 2-week period of investigation.

Song of kin intervention

Lullabies specifically identified by parents and implemented into the new relationship have the potential to bring familial cultural heritage to the forefront of personalized treatment. Music therapists met with parents to identify their level of stress as well as to support them in using an identifiable song of kin (Appendix S1). Our survey and the evaluation involved their identification of a song of kin or preferred lullaby. Furthermore, the vocal range of the mother or father was notated, and we attempted to sing the melodies in the range of the parent (alto-soprano-tenor-bass) when the parent could not physically be present or when the parent chose not to sing. Our study included both female and male music therapists and mothers and fathers of the infant study subjects. We did encourage parents to sing as a first option of intervention and as they were available. We instructed participating parents and caregivers in how to entrain to their baby's breath rate and/or activity level. The interventions included a mix of music therapist and parent applications of the lullabies over the course of the study period of 2.5 years.

In such cases where the parents had no identifiable melody, we used "Twinkle, Twinkle Little Star" as the default lullaby. Most critical was the identification of a song and, second, that no matter what song was selected, or even whether or not the pitch was accurate, it be a "go to" melody and tool for the parents in the growing relationship with their babies. We explain to parents in our music therapy sessions that their voices have been audible to their infants in the womb for many months and how this becomes an anchor and a means of familiarity whereby the infant acclimates—it is a comfort timbre, rhythm, and pitch zone. "Twinkle" is a melody that is well known to parents of all cultures in the United States and is the basis for familiar infant folk themes such as A, B, C, and Ba Ba Black Sheep. It is based on a perfect fifth and has a small melodic range and repetitive patterns with a simplified structure easily sung by "nonmusician" adults.

NICU studies defining an applied pitch range as "higher" or "lower" for therapeutic singing are not conclusive.[19] Results of the studies suggest that the sounds and music should be neither high nor low voices but rather suggestive of a range that is "familiar" and "recognized."[20,21] Songs of kin stemming from mother or father as a familiar source,[20] where continuity of care can continue beyond the hospital, are ideal.

The novel interventions of rhythm and breath sounds were never formally researched in the medical or music therapy literature. Once a decade of pilot trials with live music and entrained sound interventions took place, the Remo ocean disk and gato box played with entraining techniques showed that live music's capacity to employ responsive in-the-moment accuracy with provision of stability for premature infants who were over 32 weeks produced observable replicable outcomes. As a human being's vitality involves rhythm and breath, whereby a variety of medical interventions for years have indicated physiologically successful outcomes using inanimate machines, we were encouraged by our medical teams to research this phenomenon by pursuing study with live sounds and music.[1]

Design

Each music therapist attended training sessions at Mount Sinai Beth Israel and had the opportunity to observe live and video-recorded applications of the song of kin intervention to ensure accurate replication of the interventions before starting the study and throughout the study's 2-year period.

Randomization of the sequence of presentation was generated by computer in order to allow for separate sequences for morning and afternoon during the week so that no participant received the song of kin/lullaby stimulus at the same time over the course of the study. The allocation sequence was generated by a biostatistician who had no contact with the participants.

Description of the intervention

The live singing of song of kin or familial lullaby, entrained to match the breathing sounds of the infant's inhalation and exhalation meter, was provided in the AM or PM, and vital signs were collected by an uninformed assistant at 1-min intervals during the 10-min phase before intervention or no intervention (before), the 10-min phase during (during), and the 10-min phase after intervention or no intervention (after). The mean number of each of these readings was then calculated for each phase for analysis among the vital numbers collected for a 1-min period before, during, and after the interventions or no intervention.

Measurements

Parental/caregiver use of music during pregnancy as well as the participant's song of kin was assessed before intervention. Parental level of stress (Appendix S1) was assessed using a rating scale and questionnaire administered at the beginning and end of the 2-week intervention period. Infant outcomes included vitals (heart rate, respiratory rate, and O_2 saturation (SAT) levels) and the infants' activity level. The order of presentation of intervention or control was randomized. The interventions were given in the AM or PM on a daily basis during the 2-week study period. The infants' development was recorded daily throughout the 2-week period by research assistants via the nursing flow sheet.

Statistical analysis

Normally distributed variables (e.g., heart rate) were described in terms of mean ± standard deviation, and categorical variables (e.g., sleep patterns) were described in terms of frequency (percentage). Repeated-measures mixed regression was used to analyze changes in normally distributed variables over time, and a generalized linear model (generalized estimation equation) was used for categorical outcomes. All analyses were carried out using SAS 9.1 (SAS, Inc., Cary, NC, USA). A level of significance of 0.05 was used for all analyses. The originally anticipated sample of 150 infants was estimated to allow for at least 80% power to detect a small size (Cohen's *d*) of 0.23. The final sample of 272 allowed for 91% power to detect an effect size of 0.20.

Results

Characteristics of the infants

The demographic and clinical characteristics of the sample are shown in Table 1. The mean age was 32.87 weeks; 49% of the infants presented with respiratory distress (RD), 91% with sepsis, and 99% were small for gestational age.

Within-session changes in outcome

There was a significant change in interaction between time and interaction for lullaby and activity level found within each session in response to the singing (Fig. 1). Quiet–alert time showed a significant interaction between time and condition ($P = 0.05$, ES 18, 95% confidence interval (CI) 0.001–0.36) that was reflected in an increase in activity level from before to during in response to lullaby. Activity level after lullaby then decreased.

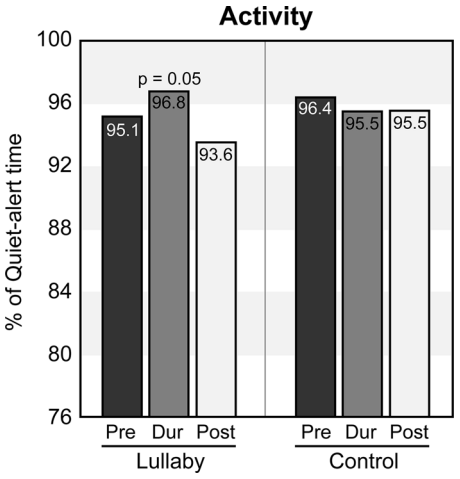

Figure 1. Comparison of RR before, during, and after lullaby.

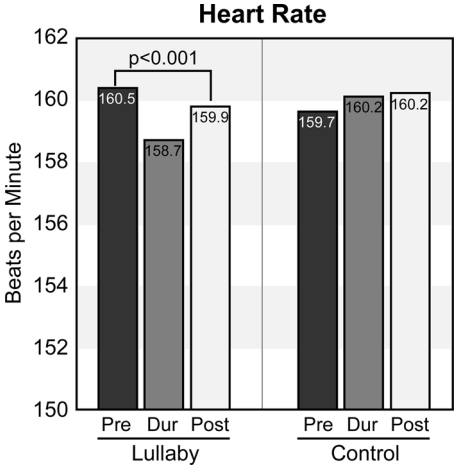

Figure 2. Comparison of heart rate (HR) before, during, and after lullaby.

Then, 141 (52%) infants heard Twinkle, and 131 (48%) heard song of kin; with only 12 using Twinkle as a default melody, we had a numerically even comparison between two lullaby types. Lower heart rates were recorded during the intervention *during* lullaby (Fig. 2). There was greater response to lullaby ($P < 0.001$) than control. The *P*-value for the lullaby intervention was $P < 0.001$.

Long-term changes in outcome

There was a marked increase in percentage of sleep time over 2 weeks with lullaby (Fig. 3).

Lullaby type and parental stress

There was a significant difference in oxygen saturation levels as a function of lullaby type: $P = 0.01$

Table 1. Demographic and clinical characteristics ($n = 272$)

Characteristics	
Age (weeks)	32.87 ± 2.15
Respiratory distress	134 (49%)
Sepsis	247 (91%)
Small for gestational age	268 (99%)
Values at baseline	
Weight	1596 ± 374.99
Heart rate	156.30 ± 8.45
Respiratory rate	50.58 ± 7.65
O_2 saturation	96.83 ± 2.65
Total calories	128.91 ± 50.56
Sucking rate	9.88 ± 2.77

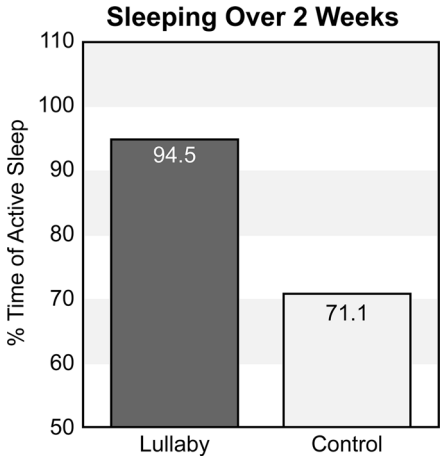

Figure 3. Overall sleep quality over 2 weeks.

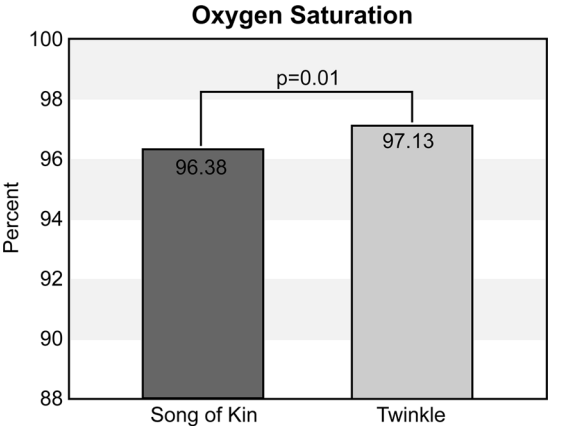

Figure 4. Oxygen saturation for song of kin versus Twinkle.

with Twinkle showing higher levels than song of kin (Fig. 4). This pattern was even more marked for infants with a sepsis diagnosis (O_2 SAT = 96.29 for song of kin vs. 97.73 for Twinkle; Fig. 5). Differences were also distinct for infants with an RD diagnosis ($P = 0.02$), where breathing patterns were better: 144.30 for song of kin versus 138.69 for Twinkle (Fig. 6). In addition, song of kin showed higher levels of sucking rate ($P = 0.02$; Fig. 7) and calorie intake ($P = 0.01$; Fig. 8). There was a significant decrease in parental stress from pre- to post-lullaby ($P < 0.001$; Fig. 9).

Discussion

Use of parents' voices shows meaningful outcomes as seen in heart rate response, which was sustained over time across all three diagnoses. Although past studies have a wide variance of application in the singing of lullabies, particularly in a lack of parent song choice, these data show the song of kin to be of significant influence. However, there was a surprising finding with Twinkle, which was our study's default lullaby.

There was slightly better oxygen saturation with the "Twinkle, Twinkle" melody than there was with the song of kin. This could be because, musically, this melody presents a repeated perfect fifth, which has been associated with ease of learning and enhanced processing in listeners of all ages.[22] This song, often used as a lullaby, has small jumps of vocal range; these have been defined as an advantage to the early listener in terms of auditory processing.[23] Simplicity, particularly where melodic centers occur, is a firmly mentioned advantage in lullabies cross-culturally.[24]

Perhaps these factors played a part in the slightly better oxygenation with Twinkle as compared to the

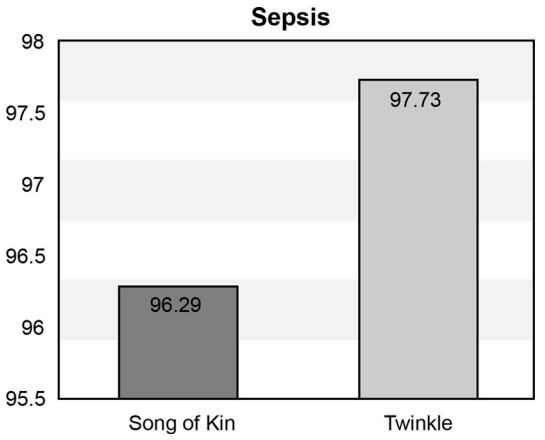

Figure 5. Oxygen saturation for song of kin versus Twinkle in neonates with sepsis diagnosis.

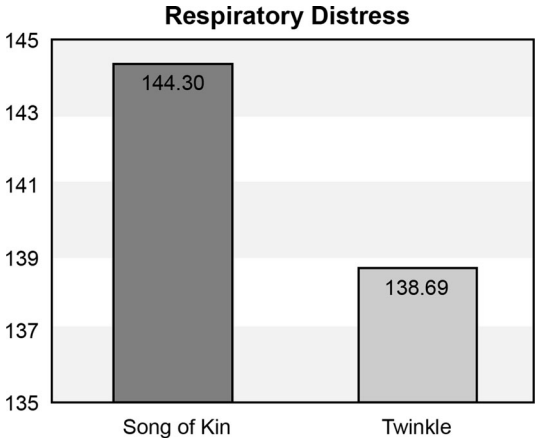

Figure 6. Breathing patterns for song of kin versus Twinkle in neonates with respiratory distress (RD) diagnosis.

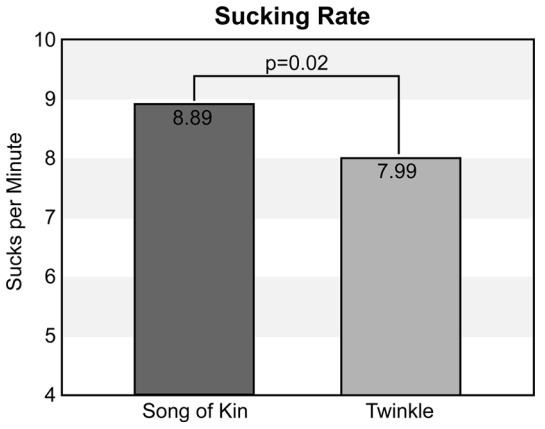

Figure 7. Feeding behavior for song of kin versus Twinkle.

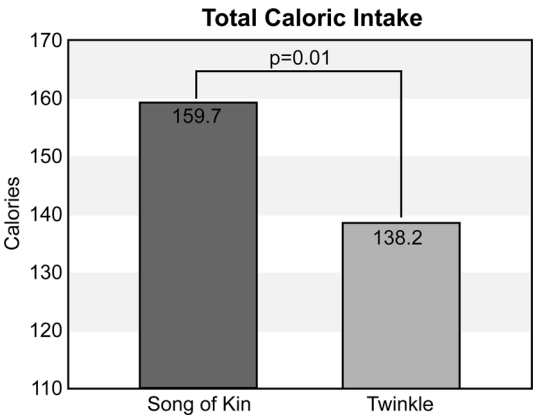

Figure 8. Caloric intake for song of kin versus Twinkle.

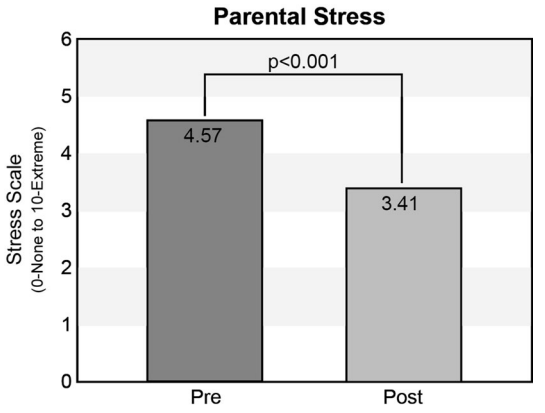

Figure 9. Level of parental stress before and after intervention.

other variety of lullabies used. These could not be collectively analyzed because of the perfect fifth and small steps of melodies presented. All of these are significant factors that are musically recommended for young infants.

The frequent singing of familiar themes, such as the song of kin, can be of aid during pregnancy and may have useful physiological and neurological influence not only at birth but also prior to birth. Researchers from Finland utilized Twinkle with effective outcomes in prenatal music application with long-term neural effects.[25]

Lullaby had a strong effect on prolonged activity level, suggesting that vocal familiarity can strengthen positive quiet–alert states. This is shown in the heart rate decreasing, whereas the activity level increased during lullaby application. Song of kin had the most profound effect on the infants with sepsis sleeping patterns, and yet these same babies had lower levels and shifts of O_2 saturation levels. This

should not be surprising, perhaps, as respiratory-diminished spontaneous activity and apnea are an expected part of this diagnosis.

It may be of interest to note that sucking rate was most profoundly active when song of kin was utilized. This outcome could imply that feeding incurs the most incentive for infants when parents are utilizing melodies that are original and unique to their culture or preference. Songs of kin were associated with tunes passed down from one generation to the next or that were favorite songs instituted in music therapy to be representative of melodies that parents could associate with a particularly meaningful time. In terms of bonding and learning to feed, whether at the breast or bottle, an infant's comfort can be induced with singing, and her/his level of comfort and willingness to suck occur in a continuum of trust and awareness. Former studies have viewed songs of kin's capacity to create comfort, safety, stability, and sleep with parent-selected singing in medical arenas.[1,2,11]

Future studies should continue to evaluate and bracket the impact of specific music, particularly music therapy elements and songs of kin[1,2,11] involving parents and caregivers, as part of a full integrative service in NICUs. Music therapy interventions can effectively encourage self-regulation and ensure that integrated music be monitored and applied purposefully, for prolonged quiet–alert, and sleep-state induction. In particular, with parent inclusivity, medical interventions become less stressful. Parents are most fragile when infants are admitted to the NICU. Their exclusive live singing in a music therapy context can foster psychotherapeutic support in a parallel process that makes parents more fully resilient in attending to their infants. The use of lullaby and song of kin provides assurance that, amid fragile circumstances, the soothing of their voice, and in particular their special melody or song of kin, will orient and serve as transitional support throughout infancy and toddlerhood.

Conflicts of interest

The authors declare no conflicts of interest.

Supporting Information

Additional supporting information may be found in the online version of this article.

Appendix S1. Parent/caretaker preintervention survey.

References

1. Loewy, J., K. Stewart, A.M. Dassler, *et al.* 2013. The effects of music therapy on vital signs, feeding, and sleep in premature infants. *Pediatrics* **131:** 902–918.
2. Loewy, J., C. Hallan, E. Friedman & C. Martinez. 2006. Sleep/sedation in children undergoing EEG testing: a comparison of chloral hydrate and music therapy. *Am. J. Electroneurodiagn. Technol.* **12:** 23–34.
3. De l'Etoile, S.K. 2006. Infant-directed singing: a theory for clinical intervention. *Music Ther. Perspect.* **24:** 22–29.
4. Courtnage, A., H. Chawla, J. Loewy & P. Nolan. 2002. Effects of live, infant-directed singing on oxygen saturation, heart rates and respiratory rates of infants in the neonatal intensive care. *Pediatr. Res.* **2346:** 403A.
5. Nakata, T. & S.E. Trehub. 2004. Infants' responsiveness to maternal speech and singing. *Infant Behav. Dev.* **27:** 455–456.
6. Harlow, H. & S. Suomi. 1971. Social recovery by isolation-reared monkeys. *Proc. Natl. Acad. Sci. U.S.A.* **68:** 1534–1538.
7. Thoman, E., E. Ingersoll & C. Acebo. 1991. Premature infants seek rhythmic stimulation, and the experience facilitates neurobehavioral development. *J. Dev. Behav. Pediatr.* **12:** 11–18.
8. Bergman, I., R.P. Hirsch, T.J. Fria, *et al.* 1985. Cause of hearing loss in the high-risk premature infant. *J. Pediatr.* **106:** 95–101.
9. Boukydis, C.F., R. Bigsby & B.M. Lester. 2004. Clinical use of the neonatal intensive care unit network neurobehavioral scale. *Pediatrics* **113**(3 pt 2): 679–689.
10. Bradt, J. 2010. The effects of music entrainment on postoperative pain perception in pediatric patients. *Music Med.* **2:** 150–157.
11. Loewy, J. 2009. "Musical sedation: mechanisms of breathing entrainment." In *Music, the Breath & Health: Advances in Integrative Music Therapy*. R. Azoulay & J. V. Loewy, Eds.: 223–232. New York: Satchnote Press.
12. Bialoskurski, M., C.L. Cox & J.A. Hayes. 1999. The nature of attachment in a neonatal intensive care unit. *J. Perinat. Neonat. Nurs.* **13:** 66–77.
13. Hurst I. 2001. Vigilant watching over: mothers' actions to safeguard their premature babies in the newborn intensive care nursery. *J. Perinat. Neonat. Nurs.* **15:** 39–57.
14. Holditch-Davis, D., T.R. Bartlett, A.L. Blickman & M.S. Miles. 2003. Posttraumatic stress symptoms in mothers of premature infants. *J. Obstet. Gynecol. Neonat. Nurs.* **32:** 161–171.
15. Lawhon, G. 2002. Facilitation of parenting the premature infant within the newborn intensive care unit. *J. Perinat. Neonat. Nurs.* **16:** 71–82.
16. Olischar, M., H. Shoemark, T. Holton, *et al.* 2011. The influence of music on aEEG activity in neurologically healthy newborns ≤32 weeks' gestational age. *Acta Paediatr.* **100:** 670–675.

17. Shahidullah, S. & P.G. Hepper. 1994. Frequency discrimination by the fetus. *Early Hum. Dev.* **36:** 13–36.
18. Ingersoll, E. & E. Thoman. 1995. Breathing bear: effects on respiration in premature infants. *J. Physiol. Behav.* **56:** 855–859.
19. Tsang, C.D. & N.J. Conrad. 2009. Does the message matter? The effect of song type on infants' pitch preferences for lullabies and playsongs. *Infant Behav. Dev.* **33:** 96–100.
20. Volkova, A., S.E. Trehub & E.G. Schellenberg. 2006. Infants' memory for musical performances. *Dev. Sci.* **9:** 583–589.
21. Papousek M. 1994. Melodies in caregiver's speech: a species-specific guidance towards language. *Early Dev. Parenting* **3:** 5–17.
22. Schellenberg, E. & Trehub, S. 1994. Frequency ratios and the discrimination of pure tone sequences. *Percept. Psychophys.* **56:** 472–478.
23. Schellenberg, E. & S. Trehub. 1996. Natural musical intervals: evidence from infant listeners. *Psychol. Sci.* **7:** 272–277.
24. Unyk, A.M., S.E. Trehub, L.J. Trainor & E.G. Schellenberg. 1992. Lullabies and simplicity: a cross-cultural perspective. *Psychol. Music* **20:** 15–28.
25. Partanen, E., T. Kujala, M. Tervaniemi & M. Huotilainen. 2013. Prenatal music exposure induces long-term neural effects. *PLoS ONE* **8:** e78946. doi: 10.1371/journal.pone.0078946.