A R T I C L E

MUSIC THERAPY WITH HOSPITALIZED INFANTS—THE ART AND SCIENCE OF COMMUNICATIVE MUSICALITY

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ABSTRACT: Infants seek contingent, companionable interactions with others. Infants in a Neonatal Intensive Care Unit (NICU), while receiving care that optimizes their chances of survival, often do not have the kind of interactions that are optimal for their social development. Live music therapy (MT) with infants is an intervention that aims for contingent, social interaction between therapist and infant. This study, with a limited numbers of infants, examined the effectiveness of an MT intervention in the NICU at The Royal Children's Hospital Melbourne. Two groups of late pre-term and full-term infants were recruited to the study; one was given MT and the other was not. A healthy group of infants not given MT served as an additional control. The effect of MT was indexed using two measures reflecting infant social engagement: the Neurobehavioral Assessment of the Preterm Infant (NAPI) and the Alarm Distress Baby Scale (ADBB). Results suggest that the MT intervention used at The Royal Children's Hospital Melbourne supports infants' neurobehavioral development. In particular, hospitalized infants who received MT were better able to maintain self-regulation during social interaction with an adult, were less irritable and cried less, and were more positive in their response to adult handling, when compared with infants who did not receive the intervention. These are important prerequisites for social interaction and development. Further and larger scale research using MT with this population is indicated.

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Infants seek contingent, affectionate, companionable interactions with others (Trevarthen, 2001). However, we know little about the experience of hospitalized newborn infants who, due to the nature of the hospitalization, may suffer while being socially isolated, lack close support from a primary caregiver, and experience a lack of socially-nurturing interactions with hospital staff . How does this experience of intensive hospitalization impact upon the newborn infant? Can the baby's developmental need for companionship be supported by a stranger who nonetheless engages in contingent interactions with the infant? Can the communicative musicality model (Malloch, 1999; Malloch & Trevarthen, 2009a; Malloch & Trevarthen, 2009b) of healthy adult-infant companionship be applied as a therapeutic intervention? The study presented here sought to address such questions.

COMMUNICATIVE MUSICALITY

Malloch (1999) and Malloch and Trevarthen (2009a) proposed that adult–infant companionship is based in a *communicative musicality*. They stated that when caregiver and infant interact, communication takes place through the intentions and affect carried by the "music-like" qualities of their joint vocalizations in combination with the joint "dance-like" gestures of their bodies and facial movements—a communicative musicality taking place within a shared sense of time (Dissanayake, 2000; Malloch & Trevarthen, 2009b; Panksepp & Trevarthen, 2009; Stern, 2010; Trevarthen, 1999, 2001; Trevarthen & Malloch, 2000). The shared sense of time is expressed by both the sensitive caregiver and infant through mutually contingent gestures, expression, and timing, which in turn enhance the infant's ability to modulate feeling states (Isabella & Belsky, 1991; Weinberg & Tronick, 1994), and to express a range of emotions (Tronick, 1989). Caregiver and infant share emotional experiences by matching the intensity, rhythm, shape, and duration of the other's expression in what has been called 'affect attunement' (Stern, Hofer, Haft, & Dore, 1985). The critical importance of contingent, sensitive, parent–infant interactions on infant social, emotional, and cognitive development has been well-documented (Bowlby, 1979; Dunham & Dunham, 1990; Field, Healy, Goldstein, Perry, & Kuhn, 1988; Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001; Murray & Trevarthen, 1985; Watson, 1985).

Sometimes contingent, well-timed gestures and expression between adult caregiver and infant are compromised. In cases of maternal postnatal depression, and even maternal emigration to a new culture, mothers may become less sensitively attuned to their infants (Marwick & Murray, 2009; Murray, Fiori-Cowley, Hooper, & Cooper, 1996; Gratier, 2003), which can lead to later impairment in the child's social and emotional development (Dietz, Jennings, & Abrew, 2005; Murray et al., 1999). Infants who are exposed to sustained noncontingent interactions may develop a stable pattern of social withdrawal analogous to a depressed state, with consequent negative effects on development (Field, 1995; Guedeney, 2000).

HOSPITALIZED NEWBORN INFANTS

The highly technical, noisy, and interventionist context of an NICU can affect adult–infant interactions. The infant is subjected to a range of care dictated by medical necessity, with little consideration for individual temperament and emotional need. This medical regimen maximizes chances of the infant's physical survival, but can limit the opportunity for the family and NICU staff to create a sympathetic, contingent, and emotionally rich adult–infant relationship. The infant suffers pain and discomfort, is often physically restricted by medical equipment, and thus cannot engage in a normal physical relationship with an adult.

In addition, the parents may feel that their medically fragile infant is unavailable to them (Sim, 2000), and may avoid or limit a close relationship with their infant as they anticipate a poor outcome or death (Wereszczak, Miles, & Holditch-Davis, 1997). These factors work against the establishment of a sympathetic adult–infant relationship.

In addressing the social needs of hospitalized infants, research has focused primarily on interventions aimed at improving "development" (not specifically "social or emotional development") in the preterm population. Kangaroo care (skin-to-skin contact between infant and parent; Feldman & Eidelman, 2003), the nursing system known as "developmental care" (Als, Butler, Kosta, & McAnulty, 2005), and touch, stroking, and massage (Field, Hernandez-Reif, Feijo, & Freedman, 2006; L. Harrison, 2001) have been extensively studied. All seem to confer some short-term benefits, although infants' social needs and social outcomes have not been the focus of outcome assessments. In contrast, using a modified Mother–Infant Transaction Program with mothers of preterm infants, Newnham, Milgrom, and Skouteris (2009) found improved mother–infant interactions at 3 and 6 months (corrected age) compared with those receiving standard care.

A small number of NICUs employ infant psychotherapists, who typically work within a psychoanalytic framework to assist family and staff to understand the experiences of the infant (Kraemer, 2006; Mendelsohn & Philips, 2005; Steinberg, 2006). While this work gives valuable primacy to the experience of the parent and carer, it still does not directly address the social needs of the infant. There is a dearth of research that has examined strategies that might promote a socially rich, contingent interplay between adult and infant. The shared experience of music could serve as such a strategy to enhance the development of infants at risk.

MUSIC FOR HOSPITALIZED INFANTS

Music can have a substantial effect in the modulating of affective states (e.g., Juslin & Sloboda, 2001), and, as with healthy children (Hallam, Price, & Katsarou, 2002), studies have examined the effectiveness of recorded music in modulating affective states in hospitalized premature infants. Better described as "music medicine" (Dileo & Bradt, 2005), these studies have researched the use of intrauterine maternal pulses with synthesized female vocals (Burke, Walsh, Oehler, & Gingras, 1995; Collins & Kuck, 1991;

Marchette, Main, Redick, & Shapiro, 1992), intrauterine sounds (Moore, Gladstone, & Standley, 1994), lullabies (Caine, 1991; Cassidy & Standley, 1995; Moore et al., 1994; Standley, 2003; Standley & Moore, 1995), children's music (Caine, 1991), and classical music (Kaminski & Hall, 1996; Lorch, Lorch, Diefendorf, & Earl, 1994; Marchette et al., 1992). The effects of these stimuli have been examined with infants ranging in age from 24 weeks' gestational age to healthy, full-term newborns. Results have indicated that a "quiet alert" state can be encouraged in premature infants through the use of soothing recorded music, which encourages the infant's heart rate to move within the normal range and reduces energy expenditure (White-Traut & Hutchens Pate, 1987). Use of recorded music in this manner also can decrease a hospitalized premature infant's stress response and increase blood oxygen saturation (Collins & Kuck, 1991; Caine, 1991; Keith, Russell, & Weaver, 2009), accelerate weight gain (Coleman, Pratt, Stoddard, Gerstmann, & Abel, 1998; Caine, 1991), shorten length of hospital stay (Caine, 1991; Coleman et al., 1998), and decrease the incidence of medical complications (Schwartz & Ritchie, 1999). While recorded music helps premature infants to maintain homeostasis, it does not provide the infant with contingent interactions with a sensitive other. The music is "dosed" to the infant in a manner similar to medication.

Trevarthen and Malloch (2000) supported the translation of communicative musicality as a therapeutic application for clients who are unable to express themselves in language. Thus, a therapeutic intervention for infants in the NICU and special care nursery (SCN) that combines the infant's need for companionable infant–adult interactions with the demonstrated affective and physiological regulating qualities of music appears highly indicated—and such an approach is available in sympathetic improvisational music therapy (MT).

Shoemark (2011) noted that there is meaning in the melody of singing (Papoušek & Papoušek, 1991; Trehub, Unyk & Trainor, 1993) and predictability in song as a consistent framework (Nakata & Trehub, 2004; Trainor & Heinmiller, 1998), thus meeting the infant's pattern of expectation about the world (Beebe & Lachmann, 1994). Drawing on the principles of communicative musicality (Malloch, 1999; Malloch & Trevarthen, 2009a, 2009b), the music therapist consciously applies the musicality evident in the supportive interplay of attuned adults and infants. In this model, the "personhood" of the therapist is inextricably part of the therapeutic process and its outcome:

> . . . music is therapeutic because it attunes [through the sympathetic sensitivity of the therapist] to the essential efforts that the mind makes to regulate the body, both in its inner neurochemical, hormonal and metabolic processes and in its purposeful engagement with the objects of the world and with other people. (Trevarthen & Malloch, 2000, p. 11)

The few studies that have reported on singing to infants in the NICU, as with the studies that have investigated the effectiveness of music medicine, have focused on premature infants (Coleman et al., 1998; Standley, 1998, 2000, 2002; Standley & Moore, 1995, Whipple, 2005). While premature infants form the majority of infants admitted to an NICU, 38% of NICU infants in Australia are born at more than 34 weeks' gestation (Laws, Abeywardana, Walker, & Sullivan, 2007). These late preterm and full-term infants are more socially mature, with correspondingly more demanding social needs than premature infants (Raju, Higgins, Stark, & Leveno, 2006). Combined with evidence that has supported the efficacy of live infant-contingent singing for development of positive therapist–infant interactions (Shoemark, 1999), this strongly suggests that improvised infant-contingent singing, based on such infant-inclusive singing styles as lullaby and playsong[1] (Nakata & Trehub, 2004; O'Gorman, 2006; Shoemark, 1999, 2006), is highly appropriate and could be very beneficial for this population because it attends to the infants' social needs in ways that music medicine cannot. The therapist's live singing with an infant client is a mutually determined experience in which the therapist's musical creation authentically represents the infant while maintaining an intention to both support and encourage the safe exploration of new experience (Shoemark, 2006).

To summarize, MT appears to hold promise as a supportive sensory experience for the medically fragile newborn infant (Butt & Kisilevsky, 2000; Caine 1991; Cassidy & Ditty, 1998; Kaminski & Hall, 1996; Standley & Moore, 1995), and a range of positive sensory experiences such as contingent singing is necessary for healthy infant neurological development (Beebe et al., 2000; Cyander & Frost, 1999; Papoušek & Papoušek, 1997; Sameroff, Bartko, Baldwin, Baldwin, & Seifer, 1998). We propose that live vocal music may promote the social and neurological development of medically fragile newborn infants. Specifically, in the socially diminished environment of the NICU and the SCN, sympathetic improvisational MT with the infant serves as a contingent relationship (in this case, with the music therapist) and thus makes the infant more available for other potentially contingent relationships (e.g., with parents). In this regard, MT combines elements of infant-led psychotherapies (Cohen et al., 1999; Thomson-Salo & Paul, 2004) and music medicine.

We report on a study investigating the effectiveness of contingent, improvisational MT with full-term and late-preterm hospitalized infants. The hypothesis was that the use of an MT intervention with infants in the NICU and the SCN would support and encourage an infant's abilities to participate in a social relationship, thus facilitating the medically fragile infant's social and neurological development. Specifically, we hypothesized that infants receiving the intervention compared with infants in a control group would exhibit more socially interactive behaviors and fewer socially withdrawn behaviors.

[1]We regard the term *infant-directed*, usually used in this context, to be a misnomer that does not acknowledge the cooperative and shared nature of the interaction. We use *infant-inclusive* to refer to the style of speech and singing that spontaneously occur between caregiver and infant, and *infant-contingent* to refer to the style of interaction consciously cultivated by the music therapist when working with an infant.

TABLE 1. *Group Demographic Characteristics*

	NICU-MT ($n = 10$)	NICU-noMT ($n = 10$)	Healthy Control ($n = 19$)
M Gestational Age (weeks)	38.3	38	38.6
(*SD*)	(1.8)	(1.5)	(1.8)
M Postnatal Age at Preassessment (days)	38.4	37.2	39.7
(*SD*)	(19.8)	(22.1)	(20.4)
M Postnatal Age at Preassessment (days)	66	58.5	65.2
(*SD*)	(22.5)	(24.8)	(22.6)
Sex	6 males, 4 females	5 males, 5 females	11 males, 8 females
M Severity of Illness Rating	7.2	8.5	n.a.
	(3.7)	(4.7)	
Primary Diagnosis	Pierre Robin Syndrome: 4 (40%)	Pierre Robin Syndrome: 4 (40%)	n.a.
	Esophageal atresia: 3 (30%)	Esophageal atresia: 1 (10%)	
	Bowel obstructions: 3 (30%)	Other[a]: 5 (50%)	
M Socioeconomic Status[b]	3.6	4.1	3.9
(*SD*)	(1.6)	(1.3)	(1.1)
M No. of Parental Visits per Week	3.5	3.2	n.a.
(*SD*)	(2.2)	(1.3)	
M No. of Music Therapy Sessions	7.9	n.a.	n.a.
(*SD*)	(3.8)		

[a]Included bladder extrophy, ascites, laryngeal/tracheal stenosis, left diaphragmatic hernia, and arteriovenous malformation/seizures.
[b]Following the method of Daniel (1983), socioeconomic status was calculated by converting the level of education attained by the infant's mother into an ordinal scale (range = 0–6) and taking the mean.

METHOD

Design

A pre/post between-subjects experimental design was employed. Thirty-nine full-term infants were recruited into three groups, comprising one experimental group and two control groups as follows:

- NICU-music therapy group (NICU-MT): NICU infants who received music therapy ($n = 10$)
- NICU-no music therapy group (NICU-noMT): NICU infants who did not receive music therapy ($n = 10$)
- Healthy-no music therapy group (Healthy): nonhospitalized healthy infants who did not receive music therapy ($n = 19$).

Participants

The NICU-MT and the NICU-noMT groups were recruited from The Royal Children's Hospital, Melbourne, and the healthy control group from the Mercy Hospital for Women (both hospitals are in metropolitan Melbourne.) Criteria for inclusion in the NICU-MT and NICU-noMT groups were as follows: (a) born at >36 weeks' gestational age, (b) anticipated admission of at least 4 weeks, (c) medically stable, and (d) English as first language for parents.

A total of 28 families were approached in the NICU for recruitment into the study. Of these, 1 family declined to be involved; 2 infants were withdrawn from the study because they became too ill to continue; and another 5 infants recruited into the study were discharged from hospital before data were collected—leaving 20 NICU infants. A total of 22 families were approached in the Mercy Hospital for Women. Of these, 20 infants were enrolled into the healthy group, and full data were collected for 19 infants.

NICU infants were randomly assigned to the MT or noMT groups with the restriction that all groups were matched for gestational age at birth, sex, and age at initial assessment and that the NICU-MT and NICU-noMT groups were matched for severity of illness (discussed later). Group demographic information is presented in Table 1. There were no significant differences between groups on any of the variables shown, except primary diagnosis.

It is difficult to accurately measure the medical status of infants with one condition compared with infants with another condition; however, it is possible to measure the level of interventions used in the care of the infant (Gray, McCormick, Richardson, & Ringer, 1996). Most of these tests are aimed at scoring medical interventions for premature infants and are administered soon after birth, relying heavily on physiological information gained from laboratory tests. As infants in this study were not enrolled until medically stable, this could fall outside the time range for these tests. Accordingly, severity of illness was measured using a version of the Neonatal Therapeutic Intervention Scoring System (NTISS) adapted for a study of infant pain with this same population (NTISS-Adapted: D. Harrison, Johnston, & Loughnan, 2003). This consists of 64 items rating therapeutic intensity and complexity, grouped into eight categories: respiratory, cardiovascular, drug therapy, monitoring, metabolic/nutrition, transfusions, procedural, and vascular access (Gray, Richardson, McCormick, Workman-Daniels, & Goldmann, 1992). The NTISS-Adapted (D. Harrison et al., 2003), which includes additional questions specific to infants who undergo major surgery at or near birth, was completed by one of two highly skilled neonatal nurses (both trained in

administration of the instrument) who were otherwise involved in collecting daily data from patient records. NICU groups were not significantly different from one another in the severity of illness.

The Intervention

The MT protocol was presented by the same qualified and experienced music therapist throughout (the second author). Guided by the stable parameters of lullabies and playsongs, the therapist consciously manipulated melody, register, dynamics, tempo, timbre, attack, and silence to provide the infant with contingent interaction and a balance between stimulation and support in the moment. The therapist's intention was to provide attuned interaction which would bring the infant to a quiet alert state or a sleep state as needed.

The practical framework for the therapeutic intervention was based on the Audio Tactile Visual Vestibular Stimulation protocol (ATVV; Burns, Cunningham, White-Traut, Silvestri, & Nelson, 1994).[2] The auditory modality of the original ATVV was talking; however, hospitalized infants prefer the stimulus of sung voice over spoken voice, as evidenced by lower infant heart rate, higher oxygen saturation, and reduced distress behaviors (Coleman et al., 1998) and greater caloric intake and weight gain (Standley & Moore, 1995) in singing over talking contexts. Further, it has been demonstrated with healthy infants that singing holds infant attention and modulates infant arousal levels better than does talking (Nakata & Trehub, 2003; Shenfield, Trehub, & Nakata, 2004). Thus, Standley (1998) changed the modality of the ATVV to humming (using Brahms's Lullaby as the invariant form) and, in turn, Shoemark (1999) suggested that *improvised* infant-contingent singing more successfully supports the full-term infant's vocal explorations and development than does the use of an invariant form, and is successful in developing positive therapist–infant vocal interactions.

Two of the modalities of the ATVV protocol were not used in this study: the vestibular and touch modalities. The vestibular modality would have necessitated physically removing the infant from bed, something that was not possible due to the strong possibility that infants in this study would be too sick to be handled in this way, would be attached to medical equipment (e.g., a ventilator), or both. In early pilot sessions, touch was often repelled by infants who had undergone significant tactile trauma from surgery, invasive treatment, and monitoring. The therapist therefore reduced touch to a discretionary addition as tolerated by the infants. Thus, the protocol remained centered in the auditory and visual domains. This adaptation worked well with this age group because it gave primacy to the emerging social capabilities of the infants.

Unlike usual clinical practice, for the current purposes, the intervention was completed while family members were not present (but with their approval) to obviate any influence on their interaction style with the infant in the short-term which could influence the experimental results. All sessions were video- and audio- taped using fixed cameras and clip-on microphones, and were conducted on the infant's ward. Sessions were scheduled three times per week and conducted in the early morning before daily medical routines began and parents arrived. The length of sessions was determined by the infant's state and availability for interplay and thus varied, with an average session length of 52 min (range = 15–100 min; $SD = \pm 24.2$ min).

Example of an Interaction

The following vignette describes the intervention with an infant, "John," born at 38 weeks' gestation with gastroschisis (bowel outside his body). He had surgery on Day 9 of life to reinsert his bowel. During his recovery, he battled with extended periods of painful straining in attempts to pass bowel motions. This vignette comes from the third session when he is just over 6 weeks old:

> At the outset I speak to John in a gentle breathy tone, with an upward inflection to entice his attention. Initially he startles, with widened eyes and a burst of jerky movement, but then he smiles and offers a small vocalization, immediately followed by hiccups. This leap between behaviors of engagement and disengagement continues throughout our interplay, suggesting he is at the threshold for stimulation. John strains to pass a bowel motion, and cries as if in pain. I reduce my stimulation from the "bright" engaging behaviors to supportive, that is, a less animated face and a more soothing vocal tone. I let my face briefly reflect his pain. Once he makes eye contact with me, I relax my face and nod reassuringly. I offer active support by patting his bottom firmly and chanting the rhythmic and strong nonsense sound "Tschu-tshu-tshu" which momentarily satisfies him and he stills, relaxing his face and abdominal muscles. As he recommences straining, I jiggle his bottom and reflect his effort with a repeated short "oh-oh-oh." I introduce a small melodic motif with the improvised lyric "We give some vibration to his bottom" to match the jiggling. John relaxes and listens to three verses of singing. I anticipate the next wave of pain and take responsibility for meeting it by increasing the volume and making the timbre of my voice "stronger." He eases again. He vocalizes to me using intonation which expresses his plight. He now looks disquieted by the jiggling, so I discontinue and select a favored position. I lift his upper half out of bed in a semi-cuddle position. He is instantly more relaxed and engaged with his brow raised and looking "deep into" my eyes. "What you say?" I ask and as I sing "Something . . . yeah . . . yeah," he passes a bowel motion. He sneezes, and smiling at him I change the lyric to "Some tissues, that's what we need. . . ." He smiles.

The painful episodes of bowel spasms cannot be eliminated, but the subtle moment-by-moment variation in multimodal stimulation of the musical interplay offered John both interpersonal and rhythmic support for the muscular action needed and the opportunity for him to know that he was supported through a painful experience until it resolved.

[2]The ATVV systematically introduces or removes (depending on the infant's response) stimulation of each sense (auditory, tactile, visual, and vestibular) in response to the infant's cues of engagement or disengagement. A decision tree evaluation mechanism is used to indicate how the therapist will respond to adverse physiologic changes (measured by heart rate, respiratory rate, and oxygen saturation) and cues of disengagement (hiccups, grimace, clinched eyes, eyes averted, tongue protrusion, finger splay, struggling movements). If no adverse response is encountered, further modalities are included. If an adverse cue becomes more potent (crying, whining, fussing, spitting/vomiting, or hand in halt position) or a physiologic measure moves outside the safe range, each stimulus is withdrawn in sequence.

The vignette offers illustration of the presence of the three characteristics of *communicative musicality*: pulse (the infant's engagement with rhythmic repetition from the therapist), quality (the therapist's multimodal matching of the affective qualities of the infant's behaviors), and narrative (the overall "dramatic contour" of the therapist–infant engagement) (Malloch, 1999; also see Stern et al., 1985). Pulse, quality, and narrative are outcomes of coherent mind time in interpersonal communication. Regularities of brain time can be seen across time scales from milliseconds to several minutes (Trevarthen, 1999). It is with these brain times, with an emotionally, intersubjectively motivated infant, that the mind and body of the music therapist engages.

Measures of Infant Socioemotional and Neurobehavioral Development

Two scales that employ clinician–infant interactions were used to determine the infant's socioemotional and developmental status: the Alarme Détresse du Bébé scale (Alarm Distress Baby Scale), a measure of infant social withdrawal (ADBB: Guedeney & Fermanian, 2001), and the Neurobehavioral Assessment of the Preterm Infant (NAPI: Korner & Thom, 1990).

The ADBB was used to detect features of social withdrawal as an early indicator of infant mental health problems. The ADBB is an eight-item measure designed to assess infant socioemotional difficulties in research and clinical settings (Guedeney & Fermanian, 2001) and to be used during a clinician's routine assessment. Each item is scored along a scale of 0 to 4, where 0 is "no unusual behavior" and 4 is "severe unusual behavior". A total score is derived by adding item scores, and a high score indicates greater social withdrawal. Guedeney and Fermanian (2001) showed the ADBB scale to have good psychometric properties on a sample of 60 infants between 2 to 24 months in France. The ADBB subsequently has been further validated in a number of other countries and clinical contexts (e.g., Lopes, 2008; Mäntymaa, Puura, Luoma, & Kaukonen, 2008). The scale's first author suggested that the ADBB could be applied to use with infants >2 months, with the caveat that interrater reliability would need to be demonstrated and that the cutoff point documented in the literature that suggests withdrawal (a score >5) should not be utilized (Guedeny, personal communication with fifth author, July 2009). Thus, two ADBB raters, both very familiar with infant behavior, rated a video of behavior during the administration of the NAPI.

The primary aim of the NAPI (Korner & Thom, 1990) is to test the infant's neurological and behavioral functioning. It was particularly suited to our needs because it allows assessment of very young infants, both preterm and full-term (Hyman, Snider, Majnemer, & Mazer, 2005). The NAPI items are similar to those in other neonatal neurobehavioral assessments, but have the following advantages: (a) Items are given in an invariant sequence, which takes infants through a series of helpful states (reducing the effect of state on infant responses and helping to standardize each assessment); (b) no aversive items are included, which can dysregulate and stress an infant; and (c) all the items and clusters have excellent psychometric properties. Individual NAPI items are combined to form summary, or category, scores. Our intention was to use these behavioral and autonomic category scores to assess the infant's ability to relax, trust, and enjoy (as opposed to withdraw, become stressed, and become dysregulated) during the standardized gentle social and handling attention by the assessor.

Nine NAPI category scores were considered in the analyses: (a) motor development and vigor, (b) alertness and orientation, (c) irritability, (d) crying extent, (e) alertness, (f) vigor, (g) quality of movement, (h) behavioral response to handling and stimulation, and (i) physical response to handling and stimulation. The category "number of states" was excluded due to ambiguity regarding the interpretation of scores. In addition, a total NAPI score (the mean of the scores on the nine scales) was calculated to provide an indication of overall developmental status. One person (fourth author), trained in the use of the scale, carried out the NAPI and scored in vivo. NAPI interactions were filmed for later rating using the ADBB.

Other Measures

Weight was recorded from the infant's medical record. In addition, physiological data consisting of heart rate, respiration rate, and blood oxygenation were recorded as part of the routine monitoring of the infant, but were not analyzed due to limitations of time and budget.

RESULTS

Equivalence of Experimental Groups

Kruskal–Wallis tests indicated that the three experimental groups did not differ significantly in terms of infant gestational age, postnatal age, or socioeconomic status at either the pre- or postassessment, ps > .05. Two-way chi-squared analysis revealed that infant sex was evenly distributed across groups, $\chi^2(2, N = 39) = .24$, $p = .89$.[3]

For the two NICU groups, Mann–Whitney U tests indicated no significant differences in terms of infant illness severity (measured using the NTISS-Adapted) or the mean number of parental visits per week, ps > .05. Four categories were used to describe infant medical condition: (a) bowel obstructions, (b) esophageal conditions, (c) facial abnormalities, and (d) other conditions (see Table 1). Two-way chi-squared analysis suggested that diagnostic category differed between groups, $\chi^2(3, n = 20) = 9.00$, $p = .03$; all infants suffering bowel obstructions were located in the NICU-MT group ($n = 3$), and all of the "other" classifications were represented in the NICU-noMT group ($n = 5$). Since omnibus severity of illness scores were comparable between groups, this difference was of limited concern.

[3]Note that this chi-square analysis contains expected frequencies of less than 5. Expected frequencies of this magnitude are acceptable, but may reduce power (Delucchi, 1983).

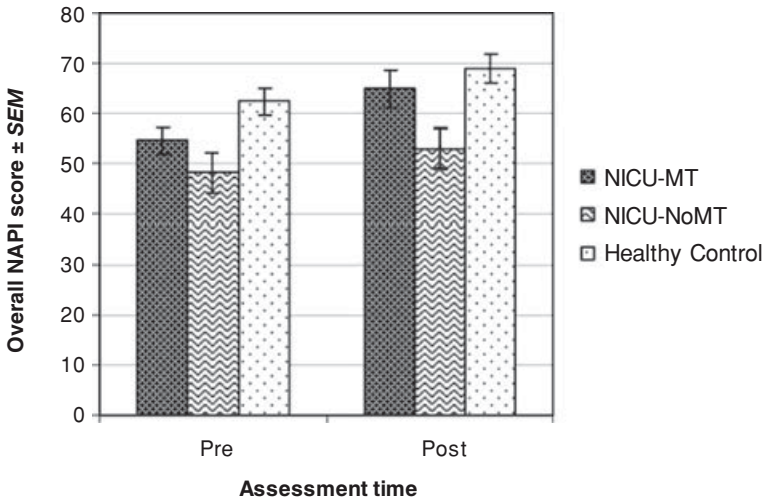

FIGURE 1. Mean overall NAPI scores for each group at pre- and postassessment.

TABLE 2. *Correlations Between Infant Gestational Age and Severity of Illness, and NAPI and ADBB Scores at Pre- And Postassessment*

	Gestational Age	Severity of Illness
ADBB Preassessment	−.49**	−.05
ADBB Postassessment	−.49**	−.34
Overall NAPI Preassessment	.34*	.12
Overall NAPI Postassessment	.51**	.18

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

Interrater Reliability and Validity of Assessments

All NAPI assessments were scored in vivo by a single trained and experienced clinician (the fourth author) who was blind to group allocation. For the ADBB, two raters who were both trained and skilled in the use of the scale independently rated a representative sample of 19 of the study clips (49% of the total). These clips were of the NAPI assessment and a subsequent period of play. Interrater reliability for the ADBB total score was high (Pearson's $r = .82$). Correlations between overall NAPI and ADBB scores and gestational age and severity of illness ratings are presented in Table 2. Scores on both instruments were significantly correlated with gestational age, such that older infants exhibited superior neurobehavioral status and less social withdrawal. Note that neither the ADBB nor the NAPI correlated significantly with infant severity of illness. This suggests that they were valid tools to apply in the NICU context in that they were not simply providing an index of the severity of the infant's illness.

Analyses

Small and uneven group sizes and occasional nonnormal distribution of variables necessitated the use of nonparametric statistical approaches with pairwise comparisons. Alpha was set at .05 for all comparisons, following recommendations by Saville (1990), who argued for this per-comparison level rather than a family-wise approach when conducting research in novel areas. Descriptive information regarding overall NAPI scores are presented in Figure 1, with ADBB scores presented in Figure 2. The nine-category NAPI scores for each experimental group are displayed in Figures 3a and 3b for pre- and posttreatment, respectively.

NICU-MT and NICU-noMT

Mann–Whitney U tests were used to compare the NICU-MT and NICU-noMT groups on NAPI and ADBB scores at each assessment point. This analysis was designed to examine whether MT aids the rehabilitation of hospitalized infants.

NAPI. With regard to the overall NAPI score, the difference between the groups was not significant at the preassessment, $z = -1.51$, $p = .13$; however, the NICU-MT group showed a significantly higher overall score at postassessment, $z = -1.96$, $p = .05$. Examination of the nine NAPI category scores revealed that the two groups did not differ significantly on any of the categories at preassessment. By postassessment, however, the NICU-MT group scored significantly higher (i.e., better) on irritability, $z = -3.18$, $p = .001$, and crying extent, $z = -2.51$, $p = .01$.

ADBB. No significant differences were observed between the NICU groups at either the preassessment, $z = -.83$, $p = .40$, or postassessment, $z = -.49$, $p = .62$.

NICU-MT and Matched Healthy Controls

NICU-MT and healthy controls were compared in an analysis designed to explore whether improvements recorded by the hospitalized infants receiving MT brought them to a level

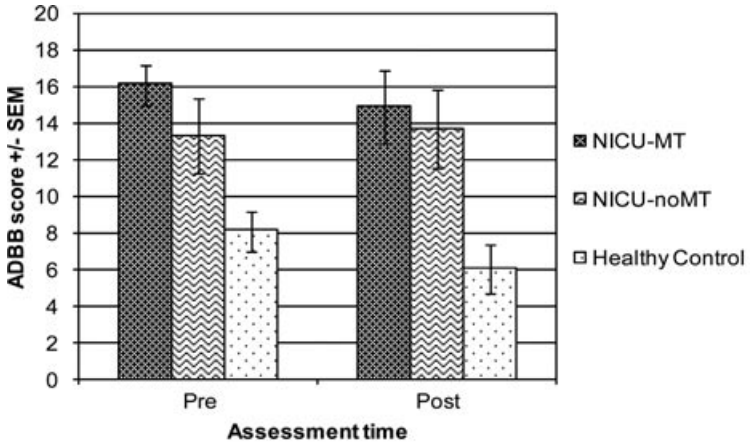

FIGURE 2. Mean ADBB scores for each group at pre- and postassessment. Mann–Whitney U tests indicate that at preassessment, the NICU-MT versus the NICU-noMT difference is not significant while the healthy control group scored significantly lower (i.e., was less withdrawn) than did the two NICU groups ($ps < .05$). The same pattern is evident postintervention. The largest effect size from pre- to postassessment was observed in the healthy control group ($d = .40$, which is small). A small effect also was observed in the NICU-MT group ($d = .23$) while a negligible effect was evident in the NICU-noMT group ($d = -.06$).

comparable to those of matched healthy infants during normal development.

NAPI. Analysis revealed that the healthy control infants recorded significantly higher overall NAPI scores at preassessment, $z = 2.02$, $p = .04$. However, at postassessment, the gap between the groups closed, $z = .96$, $p = .34$. With regard to the NAPI categories, at preassessment, healthy control infants scored significantly higher in physical response to handling/stimulation, $z = 2.38$, $p = .02$, and developed an advantage in both motor development and vigor, $z = 2.11$, $p = .04$, and by postassessment, alertness and orientation, $z = 2.00$, $p = .05$.

ADBB. The healthy control group scored significantly lower (i.e., better) than did the NICU-MT group at both the preassessment, $z = -3.8$, $p < .0001$, and postassessment, $z = -3.0$, $p = .002$.

NICU-noMT and Matched Healthy Controls

The NICU-noMT and healthy controls were compared to explore the effects of being hospitalized, but not receiving an MT intervention.

NAPI. Analysis indicated that the NICU-noMT group produced significantly lower overall NAPI scores at both the preassessment, $z = -2.86$, $p = .003$, and postassessment, $z = -2.34$, $p = .019$. Examination of the component NAPI categories revealed that the healthy control group demonstrated an advantage on several NAPI scores at each assessment point; namely, at preassessment, alertness and orientation, $z = 3.35$, $p = .001$, alertness, $z = 2.54$, $p = .01$, quality of movement, $z = 2.06$, $p = .04$, and physical response to handling/stimulation, $z = 3.27$, $p = .001$; and at postassessment, physical response to handling/stimulation, $z = 2.59$, $p = .01$, irritability, $z = 2.40$, $p = .02$, and crying extent, $z = 2.23$, $p = .03$.

ADBB. The healthy control group had significantly lower ADBB scores than did the NICU-noMT group at both preassessment, $z = -2.1$, $p < .03$ and postassessment, $z = -2.6$, $p = .009$.

Infant Weight Gain

A supplementary analysis focused on infant weight gain during the study. Due to the disparate amounts of time between initial and final weighing, weight gain from recordings taken closest to the beginning and the end of the 4-week period were divided by the number of days between measurement to give the number of grams gained per day. A Kruskal–Wallis test performed on this variable indicated no significant difference among the mean ranks of weight gain for the NICU-MT ($M = 35.74$, $SD = 18.25$), NICU-noMT ($M = 27.44$, $SD = 12.63$), and healthy ($M = 45.75$, $SD = 18.25$) groups, $\chi^2(2, n = 31) = 1.40$, $p = .50$. The difference between the NICU-MT and NICU-noMT groups is equivalent to a Cohen's d of .53, which represents a medium effect size.

DISCUSSION

There is overwhelming evidence that contingent and emotionally sensitive interaction with an infant is vital to the infant's well-being. Where this interaction is lacking, for example, in cases of maternal postnatal depression, there is evidence that the later interaction styles of the children can be compromised (Halligan, Murray, Martins, & Cooper, 2007). While there is much evidence for prerecorded music supporting a quiet alert state in premature infants, this is the first study to examine the effectiveness of a live, improvised MT intervention with the intention of providing a highly social, contingent interaction with full-term and

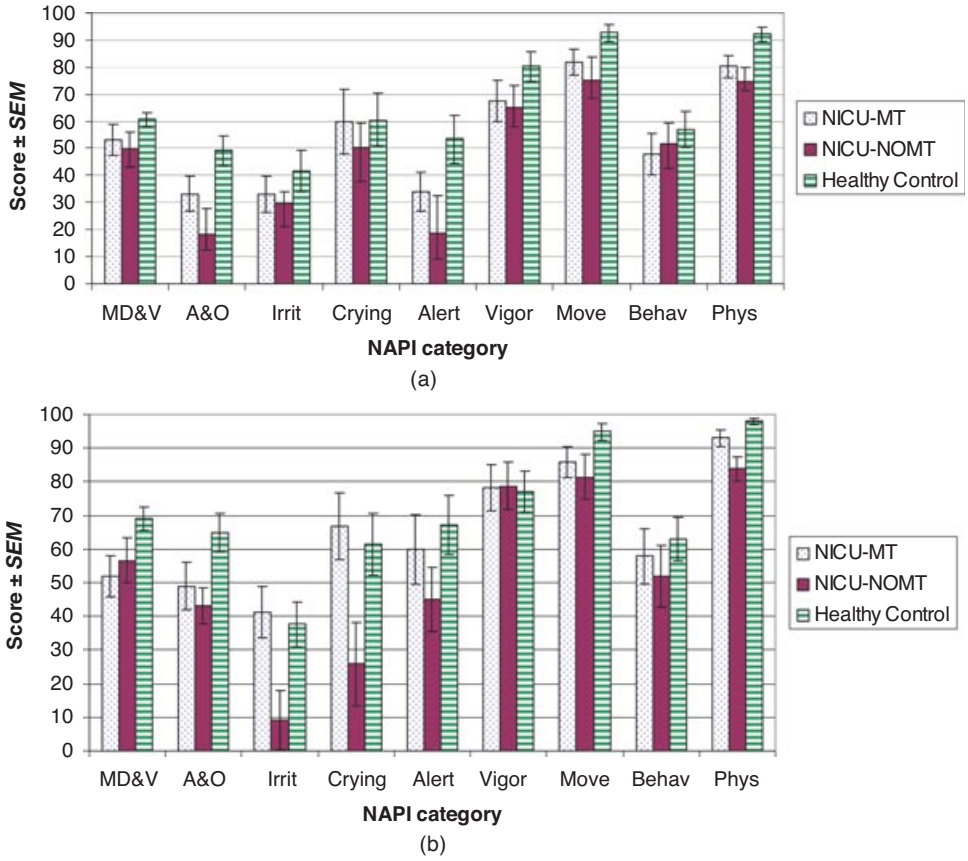

FIGURE 3. Mean NAPI scores for each experimental group across the nine NAPI categories at preassessment (a). Mean NAPI scores for each experimental group across the nine NAPI categories at postassessment (b).

Note, figure 3a. MD&V = motor development and vigor; A&O = alertness and orientation; Irrit = irritability; Crying = crying extent; Alert = alertness; Move = quality of movement; Behav = behavioral response to handling and stimulation; Phys = physical response to handling and stimulation. Mann–Whitney *U* tests indicate no differences between the NICU-MT and the NICU-noMT groups. The healthy control group scored significantly higher on physical response to handling and stimulation than did both NICU groups, and significantly higher on alertness and orientation, alertness, and quality of movement relative to the NICU-noMT group ($ps < .05$).
Note, figure 3b. MD&V = motor development and vigor; A&O = alertness and orientation; Irrit = irritability; Crying = crying extent; Alert = alertness; Move = quality of movement; Behav = behavioral response to handling and stimulation; Phys = physical response to handling and stimulation. Mann–Whitney *U* tests indicate that the NICU-MT group scored significantly higher on irritability and crying extent as compared to the NICU-noMT group. The healthy control group scored significantly higher on motor development and vigor, and alertness and orientation, relative to the NICU-MT group; and on physical response to handling and stimulation, irritability, and crying extent relative to the NICU-noMT group ($ps < .05$).

late-preterm hospitalized infants. The application of the ATVV framework (Burns et al., 1994) brought to the therapist's awareness the more pertinent application of auditory and visual stimuli than the modalities of tactile and vestibular stimulation, which were not suited to medically fragile newborn infants.

The results support the proposition that an MT intervention can facilitate the neurobehavioral development of the medically fragile newborn infant in the often socially unsympathetic, noncontingent context of the NICU. This conclusion is supported by the three comparisons between groups on the NAPI. First, the overall NAPI score for the NICU-MT group was significantly poorer when compared with that of the healthy controls before intervention, but there was no significant difference after the intervention. Second, the overall NAPI score for the NICU no-MT group was significantly poorer than that of the healthy control group at both pre- and postintervention. Third, the overall pre-intervention NAPI scores for the two NICU groups showed no significant difference, but postintervention, the group receiving MT obtained a significantly higher score. Moreover, the effect size observed in overall NAPI score from pre- to postintervention was large for the NICU-MT group, but small for the NICU-noMT group, supporting the conclusion that MT aids neurobehavioral development as measured by this instrument.

In contrast to the measure of neurobehavioral change, a measure of infant social withdrawal (ADBB) showed no significant change in the NICU-MT group after the intervention. At first, this seems contradictory; however, there are a number of possible reasons for this.

First, the lack of significance may be due to low numbers and the consequent low power. While results do not approach statistical

significance, inspection of both the mean and median numbers for the pre- and post-ADBB scores and measures of effect size (Figure 2) indicate a small effect for the group receiving MT, showing an improvement in withdrawal behavior (as do the healthy controls, this likely being a function of age), while the group not receiving MT shows a negligible-sized change. Replication with a larger sample would help to resolve this issue. Second, and possibly more likely given the fact that there were significant differences in NAPI scores, it is conceivable that the ADBB is not sensitive to subtle changes in social behavior in very young infants; perhaps these changes are observable later as social behaviors increasingly mature. Suitable age adaptations of rating systems that incorporate more fine-grained videotape ratings of infant social behavior may have produced different results, such as the Global Rating Scale (Murray et al., 1996), the CARE Index (Crittenden, 1988), and the Emotional Availability Scales (Biringen, Robinson, & Emde, 1998). Third, it is instructive to examine the NAPI categories that carry the overall change in the NAPI score in this study, and to consider how these categories compare with the behaviors that are assessed in the ADBB, as set out later.

When the two NICU groups are compared, it is the NAPI categories of irritability and crying extent that are significantly changed for the better. When the NICU-MT group is compared with the healthy control group, physical response to handling/stimulation is significantly poorer in the NICU group, but is no longer significantly different by postintervention. In contrast, when the NICU no-MT group is compared with the healthy control group at postintervention, the NAPI categories of physical response to handling/stimulation, irritability, and crying extent are all significantly lower in the NICU-noMT group. This cluster of results suggests that the infants who receive the MT intervention are better able to maintain self-regulation during social interaction with an adult: They are less irritable, cry less, and are more positive in their response to adult handling. In other words, they protest less when an adult interacts with them. These results, combined with the result from the ADBB showing no change postintervention, suggest that what we may be seeing is a *first step* over this 4-week period of intervention toward greater infant social interaction—a first step that, as yet, does not register on the measure of infant social withdrawal.

It may be that through the MT intervention the infants became less negatively reactive to adult contact, which up until the intervention may have been often painful, noncontingent, and nonsocial. In a longitudinal study, in which periods of intervention and observation were longer, infants may be observed to take further steps toward reestablishing their inherent ability for active participation in social interaction with adult caregivers. This would be an important area for further study, as both NICU groups in this study showed high levels of social withdrawal, significantly higher than that of the healthy control group.

Furthermore, the NAPI measures in which we found group differences were of infant regulation. That is, the MT infants were more able to cope with a standardized series of handling and orientation items without becoming physiologically or psychologically dysregulated (e.g., autonomic nervous system changes, irritability). Infants are unable to maintain engagement or become involved in interactions with another person if their body or emotions are overwhelmed (Fogel, 2009; Tronick, 1989). Thus, we suggest that the ability to remain physiologically and psychologically regulated during the NAPI sequence may later support interaction with a social partner. The ability to stay regulated is a first, but necessary, step or precursor for social interaction.

The significance of less protesting behavior during interaction with adults bodes well for parents of infants receiving MT intervention. Our results suggest that following MT, infants may be more regulated in interactions with an adult partner, creating less stress for both the infants themselves and their caregivers.

Our results also may indicate overall less energy expenditure in negative mood states during hospitalization in MT infants from pre- to postintervention, an important change given the precarious medical condition of these infants. It was expected that the data on weight gain would support this. While results were not statistically significant, the data indicate a trend that suggests that the NICU infants who received the MT intervention gained weight faster. Indeed, the difference between the NICU-MT and NICU-noMT groups (8.3 g per day) was reflective of a medium effect size ($d = .53$). This equates to a clinically meaningful difference of around $\frac{1}{4}$-kg extra weight over a 1-month admission. Weight gain is one of the most important factors in hospital discharge of neonates. These results, if confirmed in a larger study, would further support the importance of MT interventions in all NICUs in terms of supporting the normal development of social behaviors and physical recovery.

Limitations

A limitation of this study is the relatively small number of participants, the short duration of observation, and, potentially, the number of interventions. During the course of recruiting, we found that the unpredictable medical pathway of this population makes it particularly difficult to recruit. Of the NICU infants recruited, 7 of the 27 (25%) infants left the study prior to a dataset being collected either because their condition became too severe or they were transferred to another hospital. Indeed, if the period of observation had been longer, the dropout rate may have been higher. In addition, the scheduling of sessions three times per week reflected the real-world clinical application of MT at the Royal Children's Hospital. A more frequent application of the intervention (e.g., each day) may have intensified the impact of the MT intervention.

A larger study of this type would necessitate either a longer period of recruitment or the use of multiple recruitment sites, most probably with the added methodological difficulty of more than one therapist supplying the intervention and opening the study to the challenges of controlling for differences in presentation of the intervention. The study employed a typical design for intervention studies; namely, comparison of treatment versus no-treatment conditions. One could conjecture that the improvements observed in the NICU-MT group reflect a Hawthorne effect (Gillespie, 1991);

that is, the attention of any sympathetic adult may have made a significant positive difference for the infants. However, as both NICU groups experienced normal access to parental visits and other interactions, and given that the addition of the musical interplay was the only overridingly significant departure from regular interaction, the likelihood of the findings being caused by a Hawthorne effect are negligible.

Two methodological issues of this study are that interrater reliability was not established for the NAPI and that the intervention was completed by one experienced therapist, both leading to implications for replication. The person who undertook the NAPI was highly trained and experienced. Another person with similar training was not available for this study. Establishing interrater reliability for the NAPI would have been preferable. That the MT intervention was carried out by a single therapist can be seen as both representative of the nature of the intervention and a limitation. The highly intimate nature of the therapeutic intervention means that the personhood of the therapist is an integral aspect of the intervention—the therapy is inextricably linked to the subtle, moment-by-moment interactions of two unique persons. A different therapist, while trained in the intervention to the same degree, will not conduct the intervention in exactly the same manner. To attempt to achieve this would work counter to the process nature of the intervention. However, this of course is not to say that the manner of carrying out the process cannot be learned.

The use of song and musical activities with infants need not, and indeed should not, be confined to the music therapist. While parents were asked not to be present during the study intervention to avoid possible changes in the parents' behavior during the course of the study, in normal clinical practice, the music therapist works in conjunction with parents to encourage their use of voice, gesture, and facial expression in interplay with their infant. This is a strength of this intervention—it can influence the infant and also encourage more infant-sympathetic behaviors in parents and other caregivers. Shoemark and Grocke's (2010) companion research has elucidated the progression and scope of interplay within the sessions, offering categorization of the infant's availability for interplay and therapist's behaviors in response. This may guide nursing staff and family as well as other therapists and researchers to understand more about the infant's behaviors and how others might support the infant to expand or contain interactions.

Implications for Practice and Future Research

Western medicine is now beginning to engage with the "humanity of care" (Shoemark, 2009), embracing the patient and family as key partners in creating the best outcomes. As the medical team treats the infant as a patient, it is vital that this occurs in the context of the infant as a social being in the context of the family. The enticing value of the findings from this small study is that contingent singing, drawn from the naturally occurring patterns of successful mother–infant communication which support the infant to be heard, seen, and nurtured, may be extrapolated back into the mother–infant relationship in the NICU. A larger study may help to consolidate this finding. Indeed, future research may investigate the transformation of the protocol into a supportive education program for parents, and particularly for mothers who remain the primary carers in hospital. Given that the mother's voice is familiar and preferred by the infant based on in utero experiences (Moon & Fifer, 2000) and conveys a rich range of support and nurturing to the infant (Nakata & Trehub, 2004; Shenfield, Trehub, & Nakata, 2003), education and support may help those mothers who lack self-efficacy, and provide opportunities in which to develop it (Črnčec, Barnett, & Matthey, 2008; Teti et al., 2009).

Shared music-making is a nuanced and keenly interpersonal process which is difficult to research in its entirety. However, there is potential for research teams, consisting of such disciplines as neurology, developmental psychology, infant mental health, and music, to tease out the quality of interplay during this shared musical creativity and to track its short- and long-term impacts. In the future, the intervention may be further refined to determine thresholds for infants of increasing prematurity, ensuring that the infant is supported without traversing thresholds for stimulation. The determination of the differential impact of humming, chant, and singing would enable parents to offer nuanced, but predictable, stimulation to nurture their infant. Given the heightened experience of attunement, MT might be examined as a process to support those infants who are clearly more vulnerable or who have parents who are physically or emotionally unavailable.

Conclusion

This study shows that MT appears to exert benefits to infant neurological development, but not to infant social withdrawal or weight gain (although larger samples, or an extended timescale, may lead to positive findings on both aspects). Less irritability and less crying were observed in those NICU infants who received the intervention—factors that suggest that the infant group who received MT were better "organized" and expended energy on the "right" things. A larger study is called for to further explore these findings.

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