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Music therapy for premature infants and their parents: an integrative review*

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Music therapy in the Neonatal Intensive Care Unit (NICU) is a young but globally expanding field of interdisciplinary interest. This integrative review provides a comprehensive as well as method-overriding, interdisciplinary critical overview of empirical results on music therapy with premature infants and their parents in neonatal care covering evidence from 43 articles between 1970 and 2010. The research outcomes illustrate that music therapy seems to be beneficial for premature infants, especially in terms of pacification and stabilization. It also emphasizes that the premature infants' perceptive faculties and capabilities are *actively* engaged in music therapy to a greater extent than has been recognized in the literature thus far. However, some authors caution against the potential danger of over stimulating the premature infant and therefore recommend professional use of music therapy and general awareness in this sensible field. So far, research has predominantly focused on the short-term influence of recorded stimulations on the premature infant with quantitative designs. Future research should include active music therapy approaches, an in-depth analysis of the therapeutic process, the parents' perspective, as well as qualitative, mixed-methods, multi-center, and longitudinal designs to gain a deeper understanding of the advantages and limitations of music therapy in the NICU.

Keywords: music therapy; premature infants; parents; NICU; integrative review

Introduction

Premature infants are a constantly growing group in pediatric care. An increasing number of premature infants survive due to advances in neonatal care (European Foundation for the Care of Newborn Infants (EFCNI), 2009/2010). However, their increased survival rate cannot be implicitly equated with an improved quality of life. The youngest, especially, face tremendous challenges since the less mature an infant is at birth and the less

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developed his or her organs are, then the more invasive and complex the interventions need to be to ensure the infant's survival (Markestad et al., 2005). Many premature infants have to cope with the potential sensory tensions of overstimulation and deprivation in neonatal care. A stressful intensive care environment replaces the intrauterine nurturing world that usually is perfect for fetal growth and maturation with regard to type, extent, and duration of stimuli as it is a world of low-frequency sounds providing protection and steady rhythm characterized by the swooshing sound of intrauterine environment as well as the mother's steady heartbeat and voice (Fischer & Als, 2003). The infant's parents are also confronted with numerous problems and concerns. The sudden end of the pregnancy, the trauma of the premature birth, and the uncertainty of the infant's survival can evoke feelings of fear, guilt, loss, and grief. These reactions may increase parental stress and may have a negative impact on their attachment process (Bialoskurski, Cox & Hayes, 1999; Brisch, 1996; Bruns-Neumann, 2006; Jotzo & Poets, 2005).

In the last decades, various interventions have emerged in order to improve the quality of life for premature infants and their parents as well as to support their bonding process in this traumatic event. One of these interventions is music therapy. Its overall objective is to reduce and prevent sensory overstimulation as well as to minimize sensory deprivation and particularly to support the attachment process between parents and infant. Worldwide, diverse music therapy approaches have been developed and implemented (e.g. Pratt, 1999; Shoemark, 1999; Standley, 2003b; Hanson-Abromeit et al., 2008; Loewy, 2000; Nöcker-Ribaupierre, 2003b; Haslbeck, 2004).¹ Active and receptive approaches with live or recorded music can be directed toward the premature infant (with or without involvement of the mother or father), toward the parents, toward an entire family, or even toward the in-patient environment.

Research in the expanding field of music therapy in neonatal care has been conducted by a variety of disciplines with various methods and intervention techniques. The growing evidence-base has been recently synthesized with a vast array of priorities since these reviews were conducted by various disciplines (Standley, 2002; Hartling et al., 2009; Neal & Lindeke, 2008; Krueger, 2010; Hodges & Wilson, 2010). However, the majority of these reviews focus on the effects on the premature infant itself and only include specific studies such as those on evaluating the exposure to the maternal voice (Krueger, 2010) or those predominantly published in one discipline (Standley, 2002). Other aspects that are essential for providing a more comprehensive understanding of the phenomenon under investigation are hardly addressed or discussed; for instance, a more integrative

¹Find list of hospitals with NICU music therapy service form around the world at: <http://www.currentsinmusic.com/2010/02/35-hospitals-with-nicu-music-therapy-programs-around-the-world/>

perspective, the premature parents' perspective or the impact of how, and with which method music therapy is conducted. Therefore, the overall objective of this article is to provide both a more comprehensive as well as interdisciplinary overview of empirical results on music therapy in the Neonatal Intensive Care Unit (NICU). Particular attention is given to studies that also involve the parents; commonalities and differences as well as actual trends and implications for future research will also be identified.

Method

An integrative review approach was chosen rather than a systematic review. While a systematic review is highly selective with a focus on particular interventions, an integrative review promotes a more comprehensive approach. It is appropriate for reviewing multiple interdisciplinary perspectives and types of literature (Whittemore, 2007; Whittemore & Knafl, 2005), which were needed to synthesize the existing evidence-base of music therapy in neonatal care. Therefore, a broad definition of music therapy was used: Music therapy as an intervention based on music and auditory stimulation that incorporates musical elements such as rhythm and melody or sounds based on the acoustic intrauterine environment like recorded womb sounds, the recorded mother's voice and breathing sounds and heartbeats, used by either music therapists or other healthcare professions in neonatal care.²

Search strategy

Studies were selected primarily by searching health-related databases, combined with an extensive hand search. The search was undertaken from 2008 to 2009 and was updated in December 2010. Attention was given to Medline, CINAHL, PsycINFO, Scopus, AMED, and Music Therapy World using the search interfaces EBSCO, Orbis, OVID, and Scopus. The database search was enhanced with diverse hand search techniques. A web-based search in book contents was conducted via Google Books[®] to identify published research findings, which are not listed in databases. Reference mining was done with search tools in databases or journals (e.g. "related articles" or "cited by" features) as well as by checking reference lists from retrieved articles and books. In addition, contacts to music therapy experts were used to identify potentially relevant studies that were not (yet) published (Evans, 2007). In a preliminary limited search, basic search terms were identified; "music therapy", "premature infants", and "NICU". They were used to search for relevant literature by developing concept tables with medical subject headings

²Compare definition of the World Federation of Music Therapy at: http://musictherapyworld.net/WFMT/President_presents..._files/President%20presents...5-2011.pdf last accessed February 14th, 2012

and keywords. Two search sets were created for each particular database (Appendix 1) focusing on (1) the premature infant in the neonatal care setting and (2) any kind of music therapy (Gilbertson & Aldridge, 2003).

Study selection

In total 2278 articles were found. Studies were included if they focused on music therapy, defined as above, with premature infants (*and* their parents) in the NICU, were published either in English or German, if they were empirical primary research reports which embraced a clear methodological stance and were high-quality studies. Following the review strategies of Nicholls and Webb (2007), anecdotal papers, discussion papers, and reviews were excluded. In order to achieve rigor in the review process, unpublished grey literature (e.g. theses and dissertations) was not included (Whittemore, 2007).

After an evaluation according to the inclusion criteria and a check for duplicates, 56 references were identified as potentially relevant articles and used for in-depth reviewing. Studies were re-checked to ensure that they matched the inclusion criteria and to determine their relevance for the review (Evans, 2002). A generic quality index was used to appraise potentially relevant records (Beck, 1995; Polit & Beck, 2004). It included diverse issues using a numerical score to evaluate a particular study's sampling strategy, sample size, research design, instrument reliability and validity, or first author's expertise. The total possible score was 23 points (see Appendix 2). The author evaluated records for quality and nine studies were excluded because they scored less than 10 points. In total, 43 studies met all inclusion criteria and were included in the review. Retained studies were carefully analyzed and their evidence was extracted by narrative summary and tabulation (Evans, 2007) (see Appendix 3; Tables 1 & 2).

Results

Description of included studies

Starting in the 1970s, studies were conducted in Anglo-American countries, and their number increased over the following decades. A rapid growth has taken place since the millennium. Included studies were mainly from the USA ($n = 30$) and Canada ($n = 5$), some were from China ($n = 3$), Germany ($n = 2$), Israel ($n = 2$), Iran ($n = 1$), and Australia ($n = 1$). Although the focus of this review is on music therapy interventions, the studies included were carried out by the various disciplines: music therapy ($n = 19$), nursing ($n = 16$), medicine ($n = 5$), and behavioral science ($n = 3$).

The study population in the included articles also varied. For the most part, study participants were premature infants, predominantly older than 32 weeks gestational age (GA), defined as mild premature infants. Although there is a strong call to also focus on the parents of the premature infant

since their involvement can influence the bonding process and their own wellbeing (e.g. Loewy, 2000; Shoemark, 2008; Whipple, 2000; Nöcker-Ribaupierre, 2003a), parents were hardly actively included in the therapeutic process with their infant.

Notably, all included articles were intervention studies using various stimulation techniques. For the most part, a recorded receptive stimulus was used and in some studies auditory stimulation was combined with other interventions, such as kinesthetic stimulation (either a rocker-bed that allows back and forth movement of the tray and mattress in the isolette, or a somatron mattress specified for an infant's crib through which the music is played), or kangaroo care (the premature infants are held skin-to-skin on their parents' chest in order to provide physiological and psychological warmth and bonding). Receptive auditory stimulation used here was based on recordings of sung or instrumental lullabies, children's music, and classical tunes. The mother's recorded voice, womb sounds, heartbeat sounds, or a breathing bear were also used in trials. The latter consists of a stuffed bear placed in the isolette to *breathe* at the same breathing rate of each individual infant during quiet sleep; it is adjusted once a week, and this method of stimulation allows the child to self-regulate the intervention by making or breaking contact with the bear (Thoman & Graham, 1986). However, four of the studies evaluated more active music therapy approaches using live music or live singing.

A distinctive feature of the studies included in this review is their objective to examine the effects of music therapy on premature infants. The focus was mainly on physiological ($n=22$) and behavioral ($n=19$) parameters. Six studies investigated the influence of music therapy on the wellbeing of the mothers and 13 studies investigated the difference between various techniques of music therapy. It is worth mentioning that no study could be identified, which evaluated the quality of the therapeutic process itself. In terms of methodological quality, only eight out of 43 studies explicitly mentioned the approval of an ethics committee. In some trials the concealment of allocation was unclear and a lack of double blinding and randomization became apparent.

The research outcomes predominantly illustrate various positive effects of music therapy in the NICU. However, some authors warn against the potential danger of the premature infant's overstimulation and recommend a highly professional use of music therapy and general awareness of to whom, when, what kind of, and for how long stimulation is provided (e.g. Shoemark, 1999; Standley, 1998; Standley, 2003b; Standley et al., 2010). Yet, it has to be emphasized that five studies showed inconclusive results, which, according to the authors, might be related to a small or skewed sample size (Blumenfeld & Eisenfeld, 2006; Calabro, Wolfe, & Shoemark, 2003; Johnston et al., 2009), uncontrolled variables (Blumenfeld & Eisenfeld, 2006; Chapman, 1984), or a short timeframe of investigation or intervention (Blumenfeld & Eisenfeld, 2006; Calabro et al., 2003; Cassidy,

2009; Chapman, 1984). All other studies ($n=38$) demonstrated positive trends of various effects of music therapy in the NICU.

Positive effects of music therapy on premature infants

A majority of studies reinforce that music therapy has positive effects on the premature infants' behavioral parameters, for instance that the infants can calm down and relax. As a result of this pacification, many other positive effects on the premature infant are demonstrated. However, older premature infants show not only a relaxing effect but also a stimulating tendency; in some trials, these infants were highly motivated to reinforce the stimulation by themselves.

As listed in Table 1, many studies showed that music therapy is beneficial for premature infants in terms of *behavioral states* ($n=18$ from 19 assessing studies) (e.g. Burke, Walsh, Oehler, & Gingras, 1995; Caine, 1991; Whipple, 2008). The stress level of premature infants was decreased and they calmed down. They were able to absorb and consume more oxygen, and to respire more regularly. Therefore, various studies reported more stable *physiologic measures* results (e.g. Bo & Callaghan, 2000; Farhat et al., 2010; Nöcker-Ribaupierre, 1995). Mainly, an increase in oxygen saturation levels ($n=12$) as well as regularity in heart rate ($n=10$) are mentioned; the premature infants also became more self-balanced and had more energy left to grow (e.g. Collins & Kuck, 1991; Coleman, Pratt, Stoddard, Gerstmann, & Abel, 1997). One study explicitly evaluated the premature infants' *resting energy expenditure* (Lubetzky et al., 2010). This aspect is supported by study results indicating that those premature infants who received music therapy had an increase in *sleep quantity and quality* (e.g. Arnon et al., 2006; Lai et al., 2006) and showed increased *weight gain* (e.g. Standley, 1998; Whipple, 2000) or *caloric intake* (e.g. Caine, 1991).

The Pacifier-Activated-Lullaby (PAL) method developed by Standley (2003a) especially helps to increase the non-nutritive *sucking rates* of infants, and therefore supports their subsequent *feeding ability*. PAL is used to teach mild premature infants the suck-swallow-breath reflex using music as a contingency. The infants' suck of predetermined strength activates an electrical signal to a cassette player and music is only playing when an infant sucks, and the more it sucks the more the music will be provided (Standley, 1999; Standley, 2000a, 2003a; Standley et al., 2010). The studies also showed that premature infants from an age of 34 GA were able to *self-regulate* their stimulation, and to *establish a cause and effect relationship* (Standley et al., 2010). This ability of self-regulation in older, stable premature infants also became apparent in the study outcomes of Thoman and Graham (1986). The infants that were offered a breathing bear as a self-regulating source of rhythmic stimulation showed more *seeking contact* with the bear than the control group.

Table 1. Number of studies showing positive effects on premature infants and their parents.

Positive effects on premature infants	Number of studies	Authors
Behavioral states	18 (of 19 AS ¹)	Arnon et al. (2006); Barnard (1973); Barnard & Bee (1983); Bozette (2008); Burke et al. (1995); Butt & Kisilevsky (2000); Caine (1991); Chapman (1978); Coleman et al. (1997); Collins & Kuck (1991); Katz (1971); Keller (2008); Lai et al. (2006); Nöcker-Ribaupierre (1995); Segall (1972); Standley (1998); Whipple (2000); Whipple (2008)
Oxygen saturation	12 (of 15 AS)	Arnon et al. (2006); Bo & Callaghan (2000); Burke et al. (1995); Cassidy & Standley (1995); Chou et al. (2003); Coleman et al. (1997); Collins & Kuck (1991); Farhat et al. (2010); Johnston et al. (2007); Keith et al. (2009); Nöcker-Ribaupierre (1995); Standley & Moore (1995)
Heart rate	10 (of 16 AS)	Arnon et al. (2006); Bo & Callaghan (2000); Burke et al. (1995); Butt & Kisilevsky (2000); Cassidy & Standley (1995); Cassidy (2009); Coleman et al. (1997); Keith et al. (2009); Lorch et al. (1994); Segall (1972)
Respiratory rate	5 (of 10 AS)	Cassidy & Standley (1995); Farhat et al. (2010); Ingersoll & Thoman (1994); Keith et al. (2009); Lorch et al. (1994)
Hospitalization time	9 (of 9 AS)	Caine (1991); Cevasco (2008); Malloy (1979); Schwartz et al. (1999); Standley (1998); Standley et al. (2010); Thoman et al. (1991); Whipple (2002); Standley et al. (2010)
Weight gain	6 (of 9 AS)	Barnard (1973); Caine (1991); Cevasco & Grant (2005); Malloy (1979); Standley (1998); Whipple (2000)
Sleep quantity and quality	6 (of 6 AS)	Arnon et al. (2006); Barnard (1973); Ingersoll & Thoman (1994); Lai et al. (2006); Thoman & Graham (1986); Thoman et al. (1991)
Long-term effects	5 (of 6 AS)	Barnard & Bee (1983); Ingersoll & Thoman (1994); Katz (1971); Nöcker-Ribaupierre (1995); Thoman et al. (1991)
Pain reduction	5 (of 5 AS)	Bo & Callaghan (2000); Butt & Kisilevsky (2000); Chou et al. (2003); Whipple (2008)
Caloric intake	2 (of 2 AS)	Caine (1991); Coleman et al. (1997)
Sucking rates	3 (of 3 AS)	Cevasco & Grant (2005); Standley (2000b); Standley (2003a)
Feeding ability	2 (of 2 AS)	Standley (2003a); Standley et al. (2010)
Seeking contact	2 (of 2AS)	Thoman & Graham (1986); Thoman et al. (1991)

(continued)

Table 1. (Continued).

Positive effects on premature infants	Number of studies	Authors
Energy expenditure	1 (of 1AS)	Lubetzky et al. (2010)
Inconsolable crying	1 (of 1AS)	Keith et al. (2009)
Positive influence on parents		
Coping/Well-being	4 (of 4 AS)	Cevasco (2008); Nöcker-Ribaupierre (1995); Whipple (2000); Blumenfeld & Eisenfeld (2006)
Bonding	2 (of 2 AS)	Nöcker-Ribaupierre (1995); Whipple (2000)
Maternal anxiety	1 (of 2 AS)	Lai (2006)

¹AS = Assessing studies.

According to Standley (1998), the Multimodal Stimulation (MMS) in particular may *facilitate homeostasis* and support additional *tolerance to progressive stimulation*. MMS is a music therapy method with a specific stimulation sequence based on the neurological development of premature infants from the age of 30–32 GA. If there are no signs of overstimulation, auditory (live sung lullabies with or without guitar accompaniment), tactile (massage), vestibular (rocking), and visual (eye-to-eye-contact) stimulation is offered methodically by a music therapist to support infants in tolerating stimulation and to encourage their homeostasis (Standley, 1998). Finally, the positive effects of music therapy listed here may influence the *period of hospitalization*; several studies ($n=9$ from 9 assessing studies) (e.g. Caine, 1991; Schwartz, Ritchie, Sacks & Phillips, 1999; Standley et al., 2010) were able to demonstrate an earlier discharge for premature infants stimulated with music therapy in comparison to the control group (Table 1).

Positive effects of music therapy during or after stressful procedures or events

In the last decade, some researchers started to evaluate the effect of music therapy on premature infants, not only on a proactive basis, but also as a response to an acute behavioral state, such as stressful procedures or episodes in the NICU. Findings from such studies showed a positive trend in pain reduction due to music therapy during or after painful medical interventions in terms of better oxygen saturation, lower stress levels and less time spent in undesirable behavioral states (e.g. Butt & Kisilevsky, 2000, Chou, Wang, Chen, & Pai, 2003). Premature infants in an extremely agitated state calmed down faster with music therapy than those without (Collins & Kuck, 1991; Keith, Russel, & Weaver, 2009) (Table 1).

Long-term effects

There is also some evidence supporting the positive long-term effects of music therapy on premature infants. Infants receiving music therapy during their initial hospital stay showed improved sleeping patterns at five weeks post-term (Ingersoll & Thoman, 1994; Thoman, Ingersoll, & Acebo, 1991), advanced motor development at five and eight months after birth (Katz, 1971; Nöcker-Ribaupierre, 1995), advanced verbal development at five months and six years (Nöcker-Ribaupierre, 1995), and higher scores in mental development in a 24-month period in comparison to the control groups without music therapy (Barnard & Bee, 1983). Barnard & Bee (1983) also reported a better orienting response at the age of two years.

Positive influence of music therapy on premature mothers and parents

Not only did premature infants seem to benefit from music therapy, but some trials also show that it is beneficial for their *premature mothers*, a term adapted from Zimmer (2003, p. 170). A vast array of interventions were used: recorded heartbeat combined with kinesthetic stimuli, music listening for mother and infant during kangarooing, recorded mother's voice stimulation, or mother's live singing for their babies. The trials showed a positive influence on the mothers' or in one case the parents' wellbeing, their coping behavior, and on mother-child interaction patterns. Nöcker-Ribaupierre (1995) reported an increase in quantity and quality of mothers' breast-feeding, which was interpreted as a sign of intensified bonding. Five months after discharge, the mothers appeared physically and psychologically more stable than the control group without music therapy. In addition, a decrease in maternal anxiety as an effect of music listening during kangaroo care has been reported (Lai et al., 2006). Furthermore, positive trends were observed in terms of wellbeing, coping, and the mothers' motivation to sing for their infant both in the NICU and later at home (Blumenfeld & Eisenfeld, 2006; Cevasco, 2008). Finally, Whipple (2000) demonstrates the positive effects of parent training in Multimodal Stimulation on the appropriateness of parent-infant interaction (Table 1).

Impact of different music therapy approaches

Apart from evaluating the effects of music therapy on premature infants and their parents, some studies also compared *different techniques* of music therapy indicating that the way in which music therapy is offered may be of importance, too.

Lorch, Lorch, Diefendorf, & Earl (1994) demonstrate that sedative music had more positive effects on premature infants than stimulating music and Coleman et al. (1997) concluded that premature infants were more affected by sung rather than spoken lullabies. However, according to

Coleman (1997), it made no difference whether the auditory stimulation was provided with a sung male or female voice. Yet, there is evidence that not only the style of the auditory stimulation, but also *the way* the stimulation is used in the therapeutic process may have an impact on premature infants. For instance, when mild premature infants had the opportunity to self-regulate the stimulation, e.g. with the breathing bear, they showed more beneficial effects than without an opportunity of self-regulation (Thoman & Graham, 1986). Similarly, Barnard and Bee (1983) observed that the quasi-self-activating group, which, for instance, could turn the rocking bed or heart-beat stimulation on or off by their own behavior, resulted in better orientation patterns later on than the group that was stimulated with a fixed intervention. The authors concluded that this is an outcome of an additional increasing learning experience of premature infants who had the chance to self-activate an auditory stimulation. Last but not least, the live version of music, specifically female humming with simple instrumental accompaniment, was more beneficial to the premature infants than the recorded version of the same music. The live version also provided a more sustainable outcome (Arnon et al., 2006). In addition, both premature parents and the NICU staff preferred live music over recorded versions (Arnon et al., 2006) (Table 2).

Inconclusive findings

The included studies also reported inconclusive findings due to different stimulation methods, the influence of age and gender, as well as the ideal timing of music therapy.

On the one hand, studies show better outcomes *post-treatment* for the mother's recorded spoken voice versus recorded lullabies (Djordjevic, Linderkamp, Brussau, & Cierpka, 2007; Standley & Moore, 1995). On the other hand, a more positive influence of recorded lullabies in comparison with a spoken maternal voice on premature infants *during* stimulation was evident (Malloy, 1979; Standley & Moore, 1995; Chapman, 1978). These results indicate a differential response to the two different auditory stimuli over time (Standley & Moore, 1995). The aspects of optimal timing, length of music therapy interventions, as well as possible age recommendations are discussed heterogeneously, as well as different reactions to music therapy due to gender (e.g. Butt & Kisilevsky, 2000; Cassidy & Standley, 1995; Cassidy, 2009; Standley, 2003b; Standley et al., 2010; Whipple, 2008; Cevasco & Grant, 2005) (Table 2).

Discussion

The evidence synthesized in this review illustrates that research on music therapy with premature infants, as well as their parents, is a young but

Table 2. Number of studies showing impact of various music therapy approaches as well as inconclusive findings.

Impact of various music therapy approaches	n	Authors	Inconclusive findings	n	Authors
Sedative > stimulating music	1 (of 1AS)	Lorch et al. (1994)	Spoken mother's voice vs. recorded lullabies	4	Djordjevic et al. (2007); Standley & Moore (1995); Malloy (1979); Chapman (1978)
Sung > spoken lullabies	1 (of 1AS)	Coleman et al. (1997)	Premature infant's age	3	Butt & Kisilevsky (2000); Standley et al. (2010); Cassidy and Standley (1995)
Sung male equals sung female voices	1 (of 1AS)	Coleman et al. (1997)	Premature infants gender	4	Standley (1991); Standley (1998); Standley et al. (2010); Cassidy (2009)
Live music > recorded music	1 (of 1AS)	Arnon et al. (2006)	Timing of music therapy intervention	5	Cassidy (2009); Standley (2003b); Standley et al. (2010); Whipple (2008); Cevasco and Grant (2005)
Preference of parents and stuff: live music > recorded music	1 (of 1AS)	Arnon et al. (2006)			
Self-regulated > predetermined stimulation	2 (of 2 AS)	Thoman and Graham (1986); Barnard & Bee (1983)			

globally expanding field of interest. The findings demonstrate that music therapy in the NICU may have beneficial effects among stable premature infants, even though various stimulation methods were used in trials conducted in various disciplines (comp. Standley, 2002; Hodges & Wilson, 2010; Hartling et al., 2009). Interestingly, although an array of music therapy approaches in the NICU exists throughout the world (e.g. Haslbeck, 2004; Loewy, 2000; Nöcker-Ribaupierre, 2003b; Shoemark, 2006; Stewart, 2009; Teckenberg-Jansson, Huutilainen, & Pölkki, 2011) studies included in this review primarily focus on recorded stimulation; evaluating the effects of music therapy on the premature infant itself with quantitative designs. The review findings indicate that music therapy may be especially beneficial for the behavioral and physiological parameters of premature infants. It also emphasizes that the premature infants' perceptive faculties and capabilities to be *actively* engaged in music therapy may be greater and of more value than it has been recognized in the literature so far. In addition, few studies included parents and their perspective, live music or even interactive music therapy interventions. However, there is a trend towards more active, respectively interactive, approaches as well as to involve mothers in the therapeutic process of music therapy in the NICU (e.g. Arnon et al., 2006; Whipple, 2000; Teckenberg-Jansson et al., 2011).

As music therapy can be hypothesized to be a beneficial intervention for stable premature infants and their parents those review findings shall be explored in further detail, which, if at all, have hardly been in the center of the scientific debate on music therapy in neonatal care.

First of all, auditory stimulation with rhythmic as well as self-regulating components for premature infants is of interest. So far, the breathing bear findings (Ingersoll & Thoman, 1994; Thoman & Graham, 1986; Thoman, Ingersoll, Acebo, 1991) have not been discussed in the literature on music therapy in the NICU. Even if that is not *real* music therapy (comp. see note 2), these studies add important results to the knowledge base by showing that mild stable premature infants were actively seeking contact with the breathing bear, were capable of self-regulating the stimulation, and established a cause and effect relationship. These findings demonstrate that stable premature infants with an age from 33 GA may already be capable of organizing their motor movements in a directed fashion. This indicates that their central nervous systems' integration may be greater than has been anticipated. In addition, these infants may be able to *interact* with their environment and to actively participate in *interactions*, which may last more than two hours (Thoman & Graham, 1986). The duration of interaction is significant as it shows that the offered stimulation is highly interesting for premature infants. The level and quality of stimulation may have fit their level of alertness and attentiveness (comp. Stern, 1997).

Thus, a particular advantage and quality of stimulating premature infants with a breathing bear is its capability to reflect on the premature

infants' individual breathing rhythms and this may be a primary source for their high motivation. In this context, it can be hypothesized that mild premature infants may be empowered to orientate by being synchronized with their individual biorhythm. Furthermore it can be hypothesized that by improving the interaction with a responsive human therapist or caregiver, premature infants may be engaged in an intentional action (Newman, 1981), motivated by synrhythmic (Trevarthen, 2008) and interactional synchrony (Aldridge, 1996). At a fundamental level, human activity is organized as a hierarchy of rhythmic entrainment; within the individual as self-synchrony, and within relationships as interactional synchrony (Aldridge, 1996). This is in line with preliminary findings from creative music therapy with premature infants and their parents (Haslbeck, 2004, 2009a). Its infant-directed singing is based on an infant's breathing rhythm, facial expression, and gesticulation and it offers synchronization, entrainment and orientation up to first interaction and communication. According to this, music therapy in neonatal care may benefit from entraining auditory stimulation to the rhythms and expressions of premature infants as well as from giving them more opportunities to self-regulate a particular stimulation.

Second, the review findings draw attention to a possible positive influence of music therapy on the premature mothers' wellbeing and on mother-infant-bonding. There is a call for creating relationships that help to build bridges from the intrauterine life, through the time in the NICU, to life at home as a decisive basis for the bonding process (Nöcker-Ribaupierre, 1998). An effective way to help a mother suffering from feelings of guilt, fear, and a loss of self-esteem may be to give her the opportunity to be active and to talk or sing to her baby, which, of course, may also be of relevance for their partners. Training parents in singing may offer an opportunity for music to be a continued stabilizing factor and could also result in long-term developmental and social benefits, as well as increased amounts of appropriate parent-infant interactions and secure attachments (Whipple, 2000). Live singing for one's own infant appears to be crucial. It creates an opportunity to be engaged in an enjoyable activity that may initiate the motherhood constellation, which is the basis for a healthy mother-infant-relationship (Stern, 1997). For that reason, further research is needed on live, as well as interactive music, for premature infants and their parents (Blumenfeld & Eisenfeld, 2006) since there are also signs that premature infants may prefer their mothers' live voice to a recorded one (Johnston, Filion, & Nuyt, 2007).

Third, the aspect of live music therapy in neonatal care is of importance. The review findings summarize early evidence on the benefits of live music, since it appears to be more beneficial for premature infants than recorded versions (Arnon et al., 2006). Interestingly, this difference was particularly observed post-treatment. This raises the question as to whether live music might be more sustainable than recorded music, the latter being regarded as

having no long lasting effects (Lubetzky et al., 2010). However, more research is needed to further strengthen these outcomes.

There is also a call for providing live music interventions in neonatal care primarily through trained professionals. To maximize the benefits of live music, trained professionals are needed in order to respond immediately to changes in an infants' behavior. By continuously *reading* the premature infant, overstimulation of these vulnerable patients can be avoided and the therapeutic process can be sustainably attuned to the infants' and parents' needs, because live active music therapy is characterized by its unique properties to be flexible, creative, interactive, individual, and communicative (Aldridge, 1999; Keith et al., 2009; Nordoff & Robbins, 1977). In this context, live music therapy with parents appears to be crucial since parents who sang directly to their infants, even those who were not born prematurely, were emotionally more engaged, sang in a higher pitch level and slower tempo, and the infants prefer the infant-directed singing (Trehub, Hills, & Kamenetsky, 1997; Trainor, 1996). In this regard, it has also been observed that parents may sing in response to the vitality signs of their baby and, in an inter subjective consciousness, are sharing an affective experience of vitality affects (Stern, 1997). In particular, infant-directed singing has a quality of a *loving tone* and may encourage a reciprocal relationship (Abromeit, 2003; Shoemark, 1999; Trainor, 1996). It is able to offer interactional synchronization, for instance the *I-Thou* responsibilities, and it is capable of transporting reciprocal emotional attachment (Aldridge, 1999; Buber, 1999; Hanson-Abromeit et al., 2008; Loewy, 2003). With this in mind, auditory stimulation, e.g. with mothers' recorded voices, may be extended by motivating and supporting mothers, as well as parents, to sing live and directly to their premature infant. This should be guided and coached by trained professionals because *reading* a premature infant could be much more challenging than understanding a healthy baby.

Fourth, economic and professional aspects of music therapy in neonatal care have to be considered. The review findings re-emphasize a reduced hospitalization time for some premature infants, which is of relevance in times of growing economic pressure in healthcare. A decreased length of stay in the hospital by one day may save costs of up to US\$ 2000 (Schwartz et al., 1999; Standley et al., 2010). As both clinicians and administrators are becoming more aware of the cost-saving benefit of music therapy in the NICU, programs are starting to receive increased attention by decision-makers and reimbursement possibilities for music therapy services have been reported in the USA (Robertson, 2010).

Last, the review findings outline the importance of addressing methodological questions as well as challenges and future directions for research on music therapy in neonatal care. Some studies included in this review both show and report various limitations and some findings also appear to be inconclusive or under-powered. This may be related to an

aspect that is paramount in neonatal care and research in this area: the vulnerability of premature infants, and their parents, meaning their susceptibility in healthcare and being at risk for health problems (comp. de Chesnay, 2005). Globally, there is an interdisciplinary call that not only premature infants, but also their parents, are highly vulnerable and that they have to be treated as an inseparable unit (Nöcker-Ribaupierre, 1998; Hanson-Abromeit et al., 2008; Als et al., 1994; Bundesverband "Das frühgeborene Kind" e.V., 2006). Bearing the topic of vulnerability in mind, it is of interest that several studies included in this review did not explicitly report of ethics committee's approval, parents' informed consent as well as involvement of the premature infant's parents or leastwise the reason why parents have not been involved (e.g. Cevasco & Grant, 2005; Standley, 1998).

These aspects have to be considered very carefully since there are reports that mothers opted out of studies due to excessive anxiousness, stress, shyness, and inhibition towards singing when asked to speak or sing to their child without any professional support (Blumenfeld & Eisenfeld, 2006; Johnston et al., 2007; Johnston et al., 2009). The lack of parental involvement and professional support has to be addressed as there is evidence that parents supported by a music therapist demonstrated greater parental motivation (Cevasco, 2008; Nöcker-Ribaupierre, 1995; Standley & Moore, 1995). In addition, the potential danger to the premature infant being overwhelmed by stimulation has to be taken into account (e.g. Standley, 1998; Standley et al., 2010). Thus, the methodological quality in research on music therapy in the NICU may be enhanced by being more considerate of the premature infants' and their parents' vulnerability and fragility as well as growing need for specially trained professionals.

Considering the research designs of studies included in this review the question arises as to whether the so far exclusive use of quantitative research methods may be suitable and sufficient to solely evaluate the impact of music therapy on premature infants, their parents, and the NICU in general. Some study results on physiological parameters are inconclusive and they are raising questions about whether they are suitable as sole outcome measures of therapeutic effectiveness. For instance, older premature infants may demonstrate an increase in heart rate during music therapy because they are more alert and active but not implicitly more stressed (Whipple, 2008). In addition, some researchers (e.g. Cassidy, 2009; Whipple, 2008) hypothesized that the precision of a monitor's measurement of a child's respiration rate is lacking reliability for research purposes (Whipple, 2008). Thus, optimal age-related tools for measuring the impact of music therapy on the well being of a premature infant must be considered. Furthermore, the use of exclusively quantitative methods, particularly with regard to evaluating the characteristics of the therapeutic process, the parents' perspective and the quality of the infant-parent-bonding has to be reconsidered (e.g. Cevasco, 2008).

As an aside, several studies with a high quality score were conducted in nursing. This discipline initiated and dominated research on music therapy in the NICU in the 1970s and 1980s (e.g. Barnard, 1973; Chapman, 1984). Moreover, almost as many studies on the subject were conducted in nursing alone as in music therapy. This may indicate that the discipline of music therapy, being a relatively young discipline in healthcare, still can improve and expand its research activities, research methods, and its methodological skills. In addition, more interdisciplinary research and collaboration is warranted to cross-pollinate on-going research activities and to improve the quality of care, as well as to enhance the quality of research in each discipline working on the subject. The latter appears paramount as many studies included in this review did not mention or were not aware of findings from other disciplines, which could have enriched their research approach, activities, and outcomes.

Ultimately, this review's limitations have to be addressed. Even though the literature search was conducted in collaboration with public health and nurse researchers, available resources were limited. Thus, only the author of this article reviewed retrieved references, assessed and selected relevant studies, extracted and analyzed the data, and interpreted the findings. However, a close dialogue with the author's doctoral mentor framed the review process. In addition, in order to enhance rigor in this review, standards of qualitative research have been incorporated (Whittemore, 2007; Robson, 2002; Polit & Beck, 2004); above all transparency and clear documentation of the systematic methodological process, the data extraction and analysis by using tables as well as evidence of critical appraisal.

Conclusions

What we currently know from research is that music therapy may have beneficial effects on premature infants, especially in terms of infants' physiological and behavioral parameters. This is significant given that music therapy in the NICU is still a young and expanding field of practice and research. Yet, there are still open questions and aspects to be addressed in practice and future research. For example, why are interventions that go beyond auditory stimulation not being utilized? Where are (inter-) active approaches seeking interaction, individual emotional regulation and a support of a healthy child-parent bonding process? What are the qualitative characteristics of these approaches? Which changes occur when, how and why? What is the potential of music therapy in the NICU and, of course, what are its limits?

These questions have various implications. Without doubt, there is a need to further elucidate the benefits of music therapy for premature children and their parents with well-designed high quality trials. It is

necessary to clarify existing heterogeneous and inconclusive findings in order to improve the clinical practice of music therapy in the NICU. Also, the focus of future research activities should be on long-lasting and sustainable outcomes of music therapy in the NICU. In addition, more evidence is needed concerning different methods of music therapy, their quality, length, and optimal timing for the neonate as well as on age and gender differences. So far, mainly receptive approaches have been the center of research on music therapy in the NICU, with a particular focus on the premature infant. Thus, research should be expanded to include interactive live music interventions and the vulnerable group of premature parents, including the father's perspective. This also calls for enhancing qualitative research activities in order to not only focus on the effectiveness of interventions, but also to come up with an in-depth understanding of the basic principles and fundamentals of the therapeutic process itself, and how music influences the bonding process between parents and child. Qualitative research may help identify more opportunities but also possible limitations of music therapy in the NICU; it can be an asset to elucidate existing inconclusive findings and provide explanations as to why music therapy interventions succeeded or failed. Increasingly used mixed-method designs (Ridder, 2007; Bryman, 2006) appear to be promising to address some of the questions and challenges listed here.

Also, there is a need to enhance the existing knowledge base in order to create an evidence-based set of recommendations for music therapy in neonatal care. In clinical practice, it is particularly important to address the changing needs of premature infants and their parents over time. The same intervention can have different effects on different infants or different ages (Thoman et al., 1991; Cevasco & Grant, 2005), for instance the PAL method seems to be contraindicated for premature infants as young as 32 GA weeks (Standley et al., 2010). Thus, it has to be further analyzed whether detailed prescriptions or overriding recommendations for music therapy in the NICU are needed and preferable. Each infant's and family's constellations, resources, and needs are unique, and the question of how much and what type of stimulation the preterm infants need for healthy development may have to be answered in an individualized and continuously attuned manner. In consequence, the overall aim may not be to merely formulate specific prescriptions of generalized standardized stimulation programs in the NICU; rather more to define overriding recommendations across programs. Most of all, music therapy in the NICU has to be provided by specially trained music therapists who can provide an individualized, process-orientated, and relationship-based therapy based on and guided by the astute observation of the individual infant's current behavioral cues and the parents' needs (Als et al., 1986; Hanson-Abromeit et al., 2008). Guidance for this could be the astute observation and support of premature infants' and parents' needs as

recommended in the Newborn Individualized Developmental Care and Assessment Program (NIDCAP) developed and evaluated by Als (1983; 2009; Als & Gilkerson, 1997). An orientation towards the NIDCAP guidelines could link inner- and interdisciplinary collaboration and serve as an overriding profile for music therapy in the NICU (Abromeit, 2003). It could also be used as a basis for overriding guidelines and necessary initial and on-going training programs for music therapists in the NICU (Haslbeck, 2009b; Haslbeck & Costes, 2011).

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