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ORIGINAL RESEARCH ARTICLE



# NICU music therapy and mother-preterm infant synchrony: A longitudinal case study in the South of Brazil

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## ABSTRACT

**Introduction:** Having a hospitalised preterm baby is a traumatic experience that may affect parenting and parent-infant interaction. Music therapy in a neonatal intensive care unit (NICU) has been shown to foster the well-being of preterm infants and their mothers, but evidence about its effects on mother-infant interaction is still scarce. This case study explored the contributions of the *Music Therapy Intervention for the Mother-Preterm Infant Dyad* – MUSIP, to mother-preterm infant interaction.

**Method:** Participants were a mother and her extremely preterm son, hospitalised in a Brazilian NICU. The dyad participated in nine sessions of MUSIP, aimed at supporting maternal singing with the baby. In the NICU and then at home (4 months after discharge), the mother was interviewed and the mother-infant interaction was observed during two interactional contexts, breastfeeding and free interaction with singing.

**Results:** The video analysis showed that, during singing and right after singing, the dyad displayed more social behaviours and more synchronous co-occurrences. The thematic analysis of maternal interviews showed that MUSIP contributed to the mother's and the infant's empowerment and to mother-infant bonding.

**Discussion:** MUSIP empowered maternal competence to interact with the baby and facilitated synchrony, which may act as a protective factor for the infant's development, for maternal well-being, and for mother-infant bonding.


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**KEYWORDS** NICU; prematurity; music therapy; maternal singing; mother-infant interaction; synchrony

## Introduction

In the last few decades, music therapy has emerged as a promising early intervention in neonatal intensive care units (NICUs), meeting the needs of preterm infants and their families (Bieleninik et al., 2016; Haslbeck, 2012; Loewy et al., 2013; Standley, 2012). Nowadays more than one in 10 babies are born before 37 weeks of gestational age and preterm birth has a great impact on neonatal mortality and morbidity, as well as on family

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well-being (March of Dimes, PMNCH, Save the Children & WHO, 2012). In this context, music therapy may have beneficial effects in stabilising and regulating the preterm infant's physiological and behavioural responses, such as oxygen saturation, respiratory and heart rate, weight gain, sucking abilities, pain relief, and active and deep sleep states (Bieleninik et al., 2016; Haslbeck, 2012; Palazzi et al., 2018; Standley, 2012). Regarding maternal outcomes, a recent meta-analysis demonstrated significant effects of music therapy on decreasing anxiety (Bieleninik et al., 2016), while some studies suggested that music therapy and music stimulation can promote breastfeeding (Ak et al., 2015; Vianna et al., 2011). Moreover, both qualitative and quantitative studies suggest the benefits of music therapy for parental responsiveness, mother-infant bonding, and interactional synchrony (Ettenberger & Ardila, 2018; Ettenberger et al., 2017; Haslbeck, 2014; Palazzi et al., 2017).

Among the various impacts of preterm birth on overall development, social-communicative disturbances are frequently reported (Feldman, 2007; Forcada-Guex et al., 2006; Korja et al., 2012). While interacting with parents, preterm babies vocalise and play less, show more negative affect and gaze aversion and they are less alert, active, and responsive compared to full-term babies (Forcada-Guex et al., 2006; Korja et al., 2012; De Schuymer et al., 2011). Therefore, parenting a hospitalised preterm baby may be particularly challenging and difficult for parents and may adversely impact their mental health. Especially for mothers, having a baby in this condition may trigger psychological reactions, such as depression, anxiety, symptoms of post-traumatic stress disorder, feelings of guilt, and sadness over the loss of the "perfect" child (Brecht et al., 2012; Forcada-Guex et al., 2011; Gondwe & Holditch-Davis, 2015). Parental mental health plays a fundamental role in the cognitive, behavioural, and socio-emotional development of preterm infants, as well as in the dyadic interaction (Feldman & Eidelman, 2007; Forcada-Guex et al., 2006; Huhtala et al., 2012). Indeed, mothers of preterm babies may be less sensitive, and more intrusive and controlling, which can put mother-preterm infant interaction at risk (Bilgin & Wolke, 2015; Forcada-Guex et al., 2006; Korja et al., 2012).

Within the field of mother-infant interaction, synchrony has been conceptualised as the temporal co-ordination of social exchanges between mother and infant, encompassing several physiological and endocrine systems, and having long-term effects on development throughout childhood (Feldman, 2007; Leclère et al., 2014). During an infant's early development, synchrony relies on the rhythmic and reciprocal adjustment of verbal and non-verbal communicative and emotional behaviours between mother and infant, such as gaze, vocalisations, facial expression, body movements, and arousal levels (Feldman, 2007).

Synchronous and mutually fulfilling interactions are fostered by maternal sensitivity and responsiveness, which are defined as the mother's observation of the infant's cues, the accurate interpretation of these signals and a consistent and sensitive response to the baby's needs (Eshel et al., 2006; Isabella et al., 1989). The quality of mother-infant interaction, in terms of maternal responsiveness and mother-infant synchrony, has been historically associated with the development of a secure attachment (Ainsworth et al., 1978; Isabella & Belsky, 1991; Isabella et al., 1989; Leclère et al., 2014). For example, findings from 30 mother-infant dyads observed during interactions in naturalistic conditions highlighted that secure attachments were associated with a higher frequency of synchronous exchanges. In this study, maternal responsiveness to infants' distress and vocal signals during the first year of life was a predictor of the babies' secure attachment (Isabella et al., 1989).

Different concepts, such as synchronicity, reciprocity, and attunement, which are used to characterise mother-infant interactions, refer to the dyad engagement in proto-conversations with specific musical features (Stern, 2000; Trevarthen, 2008). During an effective communication between a mother and her baby, their vocal and physical gestures are attuned, as in musical dialogue. This communicative musicality (Malloch, 1999) is the intrinsic and innate musicality of mother-infant proto-conversations, whose principal dimensions are the pulse, quality, and narrative. Pulse represents the regular successions of expressive events through time, quality refers to the melodic and timbric characteristics of expressive vocal and body gestures, and narrative is the unit of pulse and quality, that enables the mother and the baby to share a common sense of passing time (Malloch, 1999).

Through micro-analysis and spectrographs, Malloch (1999) found communicative musicality in the vocal and gestural interactions between a father and a preterm baby during kangaroo care, showing how even preterm infants can engage in proto-conversation (Trevarthen, 2008), through vocalisations, movements, and facial expressions, and share the pulse, quality, and narrative of musical dialogues with their parents. Baby songs and lullabies, with their repetitiveness, regular pulse, prolonged vowels, and previsible syntax, can be used by the mother to convey intentions and emotions to regulate the infant's arousal levels and to foster mother-infant communicative musicality (Corbeil et al., 2016; Trehub, 2017; Trevarthen, 2008).

The literature shows that mother-infant synchrony is associated with a healthy mother, and a typical infant's development, and more positive child cognitive and behavioural outcomes (Leclère et al., 2014). However, when either a mother or a baby is distressed, as in the case of a preterm infant and an anxious and traumatised mother in the NICU, the rhythm and synchrony between them may be affected (Trevarthen, 2008). In fact, preterm infants and their mothers show lower synchrony in their interactions, since both display short and frequent mutual gaze and more gaze breaks within 2 s of its initiation, compared to full-term infants and their mothers (Harel et al., 2011; Lester et al., 1985).

Early, individualised, and family-centred interventions are necessary to support mother-infant interaction, to decrease maternal stress and anxiety, and to enhance the preterm infant's emotional and social development (Korja et al., 2012). In family-centred care, music therapy creates a partnership with the family, integrating the parent into the process, by empowering him or her to interact musically with the baby through singing (Ettenberger et al., 2017; Kuo et al., 2012; Shoemark, 2018). In the context of the NICU, characterised by the lack of significant auditory stimuli and parent-infant physical closeness, parental singing with a hospitalised preterm baby can be stimulated to enhance communication and closeness, as well as to promote the infant's pacification and stabilisation, and the parent's well-being (Filippa, 2017; Filippa et al., 2013; Haslbeck & Hugoson, 2017; Palazzi et al., 2017; Shoemark, 2018).

In our previous study (Palazzi et al., 2017), we carried out the Music Therapy Intervention for the Mother-Preterm Infant Dyad – MUSIP (Palazzi, 2016; Palazzi et al., 2014a, 2019) with a mother and her extremely preterm daughter. This intervention, aiming to support maternal singing in the NICU, showed contributions to the infant's and the mother's empowerment, for their interaction and communicative musicality. In particular, the thematic analysis of maternal perceptions about the intervention and the qualitative analysis of mother-infant interactions during singing and non-singing episodes highlighted that MUSIP contributed to strengthening maternal competences and the dyad interaction. In particular, during maternal singing

episodes we found more prolonged face-to-face contact and diversified expressions of affection (Palazzi et al., 2017).

As seen from the aforementioned literature, robust evidence about the effects of music therapy on mother-preterm infant interaction is still scarce. The pioneering works of Malloch (1999) and Trevarthen (2008) found communicative musicality in father-preterm infant interactions, showing synchronicity between their vocalisations and gestures. In the field of music therapy, Haslbeck (2014) used micro-video analytic methods and musical transcriptions of video footage of 18 preterm infants during music therapy sessions, finding episodes of interactional synchrony between the music therapist and the infants, as well as between mothers and infants. In particular, infant behaviours and facial expressions during music therapy, such as smiling, mouth and eye opening, and finger movements, happened in a simultaneous or in a dialogical form of interplay between the music therapist or mother and the infant. Within the field of interventions based on parental voice, we must mention the research by Filippa et al. (2018) that investigated the association of the preterm infant's open eyes and smiling with the quality of maternal speech and singing, by analysing the acoustic features of the maternal voice. They showed that a mother's early vocal contact with the baby facilitates her sensitivity and responsiveness to the infant's behaviours, potentially contributing to their synchrony (Filippa, 2017; Filippa et al., 2018). In a recent work, Carvalho et al. (2019) investigated the vocal responsiveness of 36 preterm infants to maternal speech and singing during skin-to-skin contact in the NICU. They found that preterm infants vocalised less during speaking and singing conditions compared to a silent baseline. These results suggest that maternal singing, by enhancing the infant's attention and stimulating drowsiness or sleep states, may decrease infant vocalisations. Moreover, infants took more time to respond to maternal speech than to singing, suggesting that singing might be responsible for a tighter synchrony and a higher co-modulation between mother and infant. Aside from these studies, as far as we know there is no published research that investigates how music therapy affects the mother-preterm infant interactional synchrony, especially during hospitalisation and after discharge, as proposed in this study.

Therefore, the present case study aims to explore the contributions of a music therapy intervention in the NICU for the mother-preterm infant interaction. In particular, the aims were to explore: (a) mother-preterm infant interactional synchrony in the NICU and at home (4 months after discharge) and (b) maternal perceptions about the contributions of the intervention for the infant, the mother, and their interaction, in both periods.

## Method

### *Participants*

Participants were a Brazilian mother (36 years old) and her extremely preterm son, admitted to a NICU of a public hospital in Porto Alegre (State of Rio Grande do Sul, Brazil). The mother had an incomplete primary education and was unemployed. She lived with her husband and their other two children, and the family had a low socio-economic income. The infant was born extremely preterm with a very low birth weight (880 g). The obstetrical estimate of the baby's gestational age was 25 weeks + 4 days, while the Ballard score was between 26

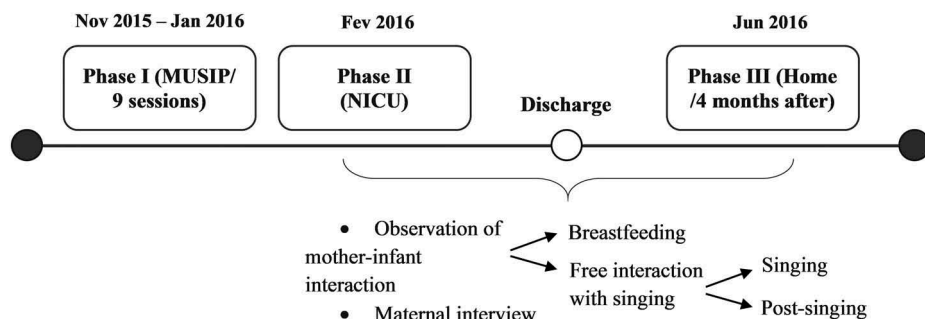
and 27 weeks. The baby's 1-min Apgar score was one, the 5-min score was three, and the 10-min score was seven. After birth, the infant presented bradycardia and respiratory distress that required orotracheal intubation and mechanical ventilation. He was put in an incubator and submitted to phototherapy. Throughout the hospitalisation in the NICU, which lasted 119 days, he had several clinical complications, which required invasive procedures and surgery: he had sepsis, intra-parenchymal haemorrhage and ventriculomegaly, and underwent an ileostomy. During the infant's hospitalisation, the mother received psychological and psychiatric support from hospital staff. Despite the severity of this case, it was chosen from nine cases that took part in MUSIP (Palazzi et al., 2019), since this dyad completed all the intervention sessions and demonstrated a richness of mother-infant interactions in the video footage. This case provides "good opportunities to learn" about how NICU music therapy can contribute to mother-preterm infant interactions (Stake, 2006, p. 23).

### **Design**

A longitudinal case study (Stake, 2006) was carried out. Data derived from the video footage of mother-infant interaction were examined through micro-analysis (Wosch & Wigram, 2007), while mothers' responses to the interviews were examined through thematic analysis (Braun & Clarke, 2006).

### **Data collection**

Data collection took place in three phases. In phase I (MUSIP), that occurred from November 2015 to January 2016, the mother signed a written informed consent and filled out demographic and clinical data forms. Afterwards, she took part in an interview about her musical history (Palazzi et al., 2014b). This structured interview was carried out by the music therapist to assess the mother's experiences and musical preferences, her musical habits during pregnancy, and her expectations about music therapy. The music therapist also used the interview to identify songs that could be used in the intervention. After the interview was completed, the mother-infant dyad took part in nine sessions of MUSIP (Palazzi et al., 2014a), which aimed at supporting maternal singing in the NICU. Phase II (NICU) took place in February 2016, after the intervention and before discharge from the hospital. Maternal perceptions about the music therapy intervention were assessed through a structured interview (Palazzi & Piccinini, 2014) (Document A – Online supplement), carried out by a research assistant (a psychology student). In addition, in phase II, the mother-infant dyad was observed during two interactional contexts: breastfeeding and free interaction with singing. In the first interactional context, the mother was oriented to interact with the infant during breastfeeding for 5 min, as she was accustomed. In the second interactional context, the mother was oriented to interact freely with the infant through singing for 5 min. The observation sessions were videotaped by the music therapist and the research assistant, using a GoPro Hero3+. Phase III (Home) took place in June 2016, 4 months after discharge from the hospital. In this final phase, all the assessment procedures carried out in phase II were repeated (Figure 1).



**Figure 1.** Timeline of data collection

## Intervention

MUSIP is a music therapy intervention aimed at sensitising and supporting the mother to sing to her preterm baby when in a NICU. It is based on the growing literature in NICU family-centred music therapy (Ettenberger et al., 2017; Haslbeck, 2014; Haslbeck & Hugoson, 2017; Loewy et al., 2013; Shoemark, 2004, 2008, 2011, 2018), and early vocal contact with preterm infants (Filippa, 2017; Filippa et al., 2013), as well as on research into infant-directed singing and communicative musicality (Malloch, 1999; Malloch & Trevarthen, 2009; Nakata & Trehub, 2004; Trehub et al., 1993).

The original protocol of MUSIP was created in 2014 and was implemented for 9 months during 2015 at the hospital's NICU that is described in the present study. Nine mothers participated in MUSIP and contributed to its process of adaptation, including the mother that took part in this case study. The original protocol of the intervention, as well as the process of implementation and adaptation in the NICU, are described in detail in Palazzi et al. (2019). Originally, it was organised into eight sessions, alternating individual sessions with the mother, and sessions with the mother-infant dyad in the NICU. During the development and implementation of the intervention, the original protocol was adapted to the mothers' needs and the demands of the hospital, by making the number of sessions more flexible and by prioritising the sessions with mother-infant dyads in the NICU. In the present case study, which contributed to the adaptation process of the intervention, MUSIP was carried out in nine sessions, each with the mother and the infant in the NICU. In particular, sessions 1, 2, 4, 5, and 6 were carried out with the infant in the incubator, while sessions 3 and 7 were carried out with the mother and the infant during skin-to-skin contact, and sessions 8 and 9 with the infant on the mother's lap. MUSIP sessions took place once or twice a week, for 20–30 min, and were carried out by a music therapist (the first author). During the intervention with the mother-infant dyad, the music therapist provided information about infant early auditory skills and guided the mother to observe the baby's stress and self-regulatory behaviours.

In the first MUSIP sessions, with the baby in the incubator or during skin-to-skin contact, the music therapist and the mother sang maternal preferred songs, that were harmonically accompanied by the music therapist with a guitar. This activity was inspired by one of the techniques of the “First Sounds: Rhythm, Breath and Lullaby” training (Loewy et al., 2013). Maternal “songs of kin” were sung or hummed in a lullaby style, using repetitive and regular patterns, with a slower tempo and a simpler harmony.



Subsequently, when the baby was more stable and was positioned in skin-to-skin contact or on the mother's lap, the mother was guided in infant-directed singing, by entraining her preferred songs to her infant's signals, especially respiration patterns. Maternal infant-directed singing or humming was supported by the music therapist, through singing and guitar accompaniment. This activity was inspired by Haslbeck's (2014) work with creative music therapy in the NICU, where the music therapist carefully observes the baby's "music" (respiration patterns, facial expressions, and gesture), and integrates it in the infant-directed singing or humming, contingent to the baby's signals. In addition, aside from MUSIP sessions, the mother was invited to sing autonomously for the baby in the NICU, without the presence of the music therapist.

## Data analysis

### Video analysis

The last 2 min of mother-infant interactions from each context (NICU and home) were selected for analysis, since the mother had assumedly acclimated to the conditions (breastfeeding and free interaction with singing) by that point. During the free interaction with singing, the mother made some pauses and the baby was particularly responsive during those pauses. For this reason, we separated two different episodes for analysis: the singing episode and the post-singing episode, which was made of several short pauses that occurred directly following any period of singing and that were merged together as one unit (Figure A – Online supplement). A total of six episodes were obtained: (a) breastfeeding in the NICU; (b) singing in the NICU; (c) post-singing in the NICU; (d) breastfeeding at home; (e) singing at home; and (f) post-singing at home.

After excluding all the excerpts in which it was not possible to see the infant's and the mother's face or where the mother was talking to other people, the elapsed time of each episode never reached 2 min, but ranged from 45 s to 1 min and 55 s. Therefore, we marked the mother's and the infant's behaviour in the selected episodes, independent of their duration, and then we calculated the number of behaviours proportionately to 2 min.<sup>1</sup>

Two independent researchers (A. P. and M. D. M.) analysed the six episodes in 5-s intervals with the ELAN 5.0.0-beta software (2017), marking each behaviour when it occurred at least once within the interval. In case of disagreement, we took into account the opinion of a third researcher (a psychology student). For codification, we used an observational protocol adapted from Isabella et al. (1989), in which we considered: (1) maternal behaviours (look, talk/vocalise, sing, smile, rock, caress/kiss, stimulate, and position face-to-face); (2) infant behaviours (look, vocalise, smile, touch/caress, cry/agitated, and drowsy<sup>2</sup>), and (3) synchronous sequences. The last ones were defined as sequential exchanges between mother and infant, or when their behaviours occurred simultaneously or one before the other within the interval of the analysis. Examples of synchronous sequences are: *look = look*; *look = vocalise*; *smile = vocalise*; *smile = caress*; and *vocalise = vocalise*. For a more detailed description of the observational protocol and

<sup>1</sup>The mathematical formula used to make the proportion was:  $[n \text{ behaviours in } 120 \text{ s} = (n \text{ behaviours in } x \text{ s} * 120 \text{ s}) / x \text{ s}]$ . For example, the infant looks at the mother three times in 55 s. To know how many behaviours he would display in 120 s, we calculated:  $n \text{ behaviours in } 120 \text{ s} = (3 * 120 \text{ s}) / 55 \text{ s} = 360 / 55 = 6.54 \text{ behaviours in } 120 \text{ s}$ .

<sup>2</sup>Despite having coded all these infant behaviours, we decided to exclude "drowsy" and "cry" from the final analysis, in order to prioritise infant social behaviours. However, we kept all the infant behaviours in the analysis of the synchronous sequences, as long as these two ones, "drowsy" and "cry", were responded to by the mother within a sequential exchange.



the operational definitions of the mother's and infant's behaviours and synchronous sequences, see Table A and Document B (Online supplement).

### **Maternal interviews**

Maternal interviews in the NICU and at home were analysed through thematic analysis (Braun & Clarke, 2006), with the aim of investigating the mother's perceptions about the intervention, focusing in particular on the contributions of MUSIP for the infant, the mother, and their interaction. Interviews were analysed following the six phases of thematic analysis. After familiarisation with the data, initial codes were generated by two of the authors (A. P. and M. D. M.), identifying meaningful patterns throughout the dataset. The coding process was driven by a theoretical approach that took into account the thematic maps of previous qualitative studies in the music therapy field (Ettenberger & Ardila, 2018; Ettenberger et al., 2017; Haslbeck, 2014; Palazzi et al., 2017). Codes were collated into potential themes and sub-themes, and discussed in relation to the research question and to the entire dataset. Themes were reviewed and named, by defining the essence of each one in light of the research question and the theoretical background, and finally a thematic map of the analysis was generated. All phases of the thematic analysis were constantly reviewed and refined by the two researchers and discrepancies were resolved through in-depth discussions.

### **Ethical considerations**

The main study, from which this case was drawn, was approved by the Ethical Review Board of the Psychology Institute of the Universidade Federal do Rio Grande do Sul (UFRGS) (n. 985.941) and the Ethical Review Board of the "Presidente Vargas" Mother-Infant Hospital (n. 1.069.283). Written informed consent was acquired from the mother who participated in this case study.

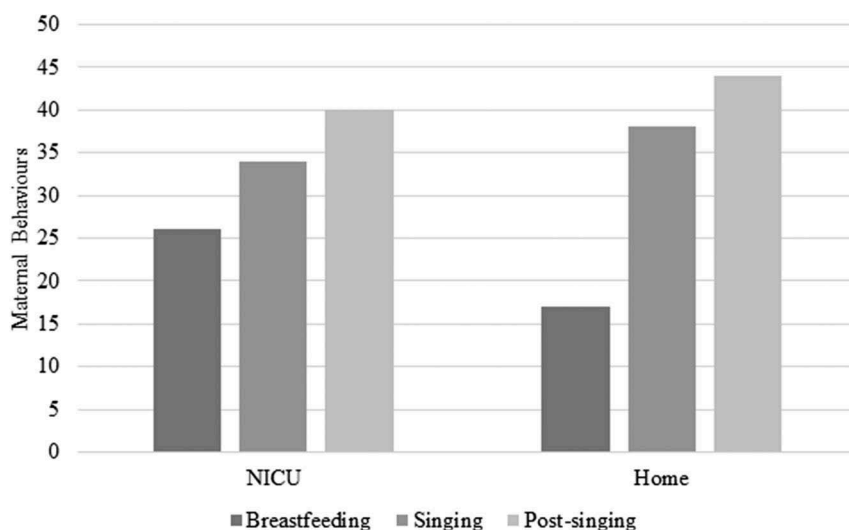
## **Results**

### **Video analysis**

#### **Maternal behaviours**

The total number of maternal behaviours in the NICU and at home was 303, with a higher percentage in the home phase (59%) than in the NICU (41%). We expected such a result, which is related to the infant's growth and the natural development of maternal competences over time. With regards to the NICU phase, we highlight that the majority of behaviours were in the post-singing episode (40%), followed by singing (34%) and breastfeeding (26%), as shown in Figure 2.

Among the maternal behaviours in the NICU, the mother smiled more to the infant during singing (50%), followed by post-singing (36%) and breastfeeding (14%); the mother talked to the infant more in post-singing (62%), compared to singing (15%) and breastfeeding (13%). Similarly, the mother caressed the infant more during post-singing (57%), compared to singing (30%) and breastfeeding (13%). However, maternal gaze to the infant remained stable throughout the three episodes. Lastly, the mother only showed rocking behaviours when she was singing, and she only positioned her infant face to face in the breastfeeding episode (Figure B – Online supplement).



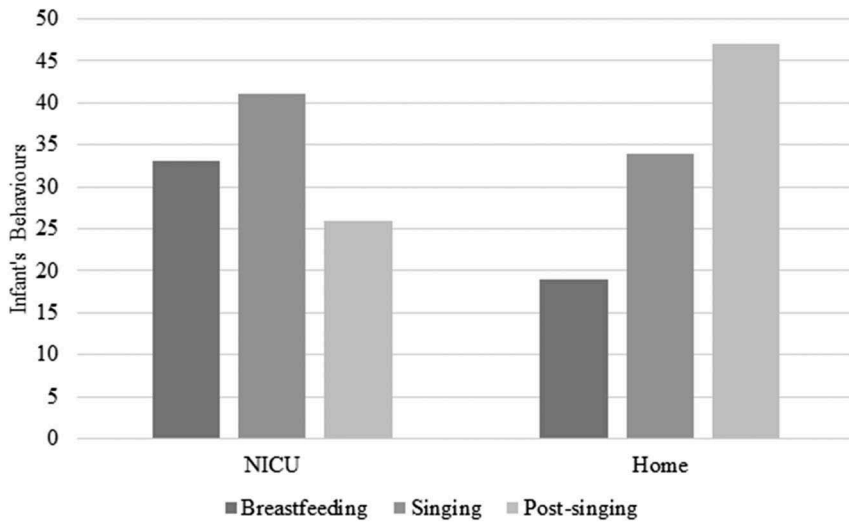
**Figure 2.** Total percentage of maternal behaviours during episodes of breastfeeding, singing, and post-singing

At home, the majority of maternal behaviours occurred during post-singing (44%), followed by singing (38%) and breastfeeding (17%) (Figure C – Online supplement). Despite maternal gaze remaining stable during the three episodes, affective behaviours during singing and post-singing were notably higher than in breastfeeding. In particular, the mother smiled more to the infant after singing (54%), compared to singing (39%) and breastfeeding (7%); moreover, she talked to the infant more in the post-singing episode (79%; singing = 14%; breastfeeding = 7%). With regards to maternal behaviours involving touch or movement, it is important to point out that the mother only caressed the infant while she was singing (53%) or after singing (47%); she predominantly stimulated the infant during singing (93%; post-singing = 7%), while she rocked the infant similarly throughout the three episodes (Figure C – Online supplement). For a more detailed description of the percentage and frequencies of maternal behaviours, see Tables B.1 and B.2 (Online supplement).

### **Infant behaviours**

The total number of infant behaviours was 102, with a higher percentage at home (59%) than in the NICU (41%). With regards to the NICU phase, the majority of the behaviours occurred during singing (41%), followed by breastfeeding (33%) and post-singing (26%), as shown in Figure 3. Nevertheless, it is worth noting that, in this phase, the infant showed few behaviours in general, with the predominance of gaze during maternal singing (42%), followed by breastfeeding (30%) and post-singing (28%). Moreover, the infant did not vocalise in any of the episodes, but only smiled and touched the mother during breastfeeding (Figure D – Online supplement).

However, at home the infant showed more diversified behaviours, which is expected due to the infant's development. As can be seen in Figure E (Online supplement), almost all of the infant's social behaviours occurred just during or after maternal singing. In particular, it is worth noting that the infant vocalised more after maternal



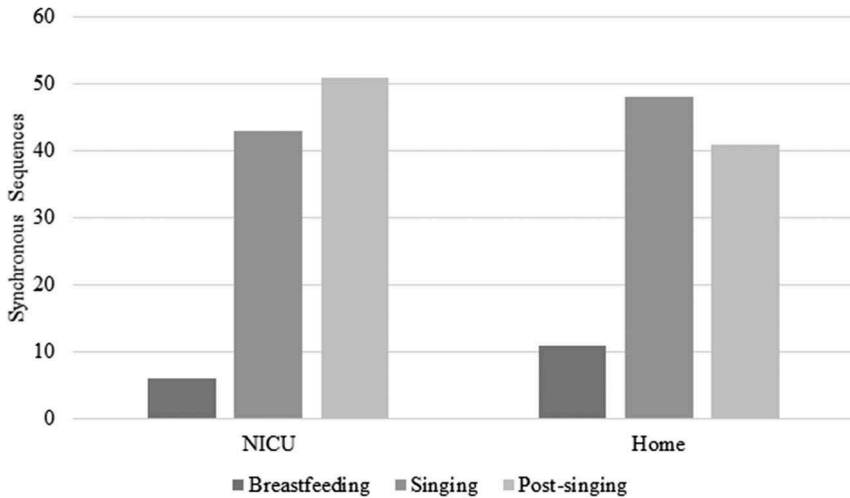
**Figure 3.** Total percentage of infant's behaviours during episodes of breastfeeding, singing, and post-singing

singing (82%), and smiled and touched the mother more when she was singing (67% and 60%, respectively). Conversely, the infant looked at the mother more in the breastfeeding episode (42%), followed by singing (35%) and post-singing (23%) (Figure E). For a more detailed description of the percentage and frequencies of infant behaviours, see Tables C.1 and C.2 in the Online supplement.

**Synchronous sequences**

In the NICU and at home, we found a total of 177 synchronous co-occurrences, with a higher percentage at home (63%) than in the NICU (37%). During hospitalisation, the majority of the synchronous exchanges were in post-singing (51%), followed by singing (43%) and breastfeeding (6%), as shown in Figure 4. Of all the analysed synchronous co-occurrences, only *look = look* occurred in all three episodes, showing a higher percentage during singing (50%), followed by post-singing (42%) and breastfeeding (8%). We did not find the *look = vocalise*, *smile = vocalise*, and *smile = caress* co-occurrences during singing, but we found them more in post-singing (75%) than in breastfeeding (25%). Similarly, the *look = caress* sequence did not occur during breastfeeding and showed a higher percentage after maternal singing (71%) than during singing (29%) (Figure F – Online supplement).

Regarding synchronous co-occurrences at home, we point out that the majority of them occurred during singing (48%), followed by post-singing (41%) and breastfeeding (11%) (Figure G – Online supplement). In particular, we found the *look = vocalise* sequence more after maternal singing (50%), followed by singing (38%) and breastfeeding (12%); on the contrary, the *look = look* sequence remained stable throughout the three episodes (breastfeeding = 36%; singing = 32%; and post-singing = 32%). It is worth noting that these are the only two synchronous co-occurrences that appeared in all three episodes, while all the other synchronous exchanges occurred almost exclusively, or in a much higher percentage, only during or after singing. For example, we found the *look = smile*, *smile = smile*, and *smile = caress* sequences more during singing



**Figure 4.** Total percentage of synchronous sequences during episodes of breastfeeding, singing, and post-singing

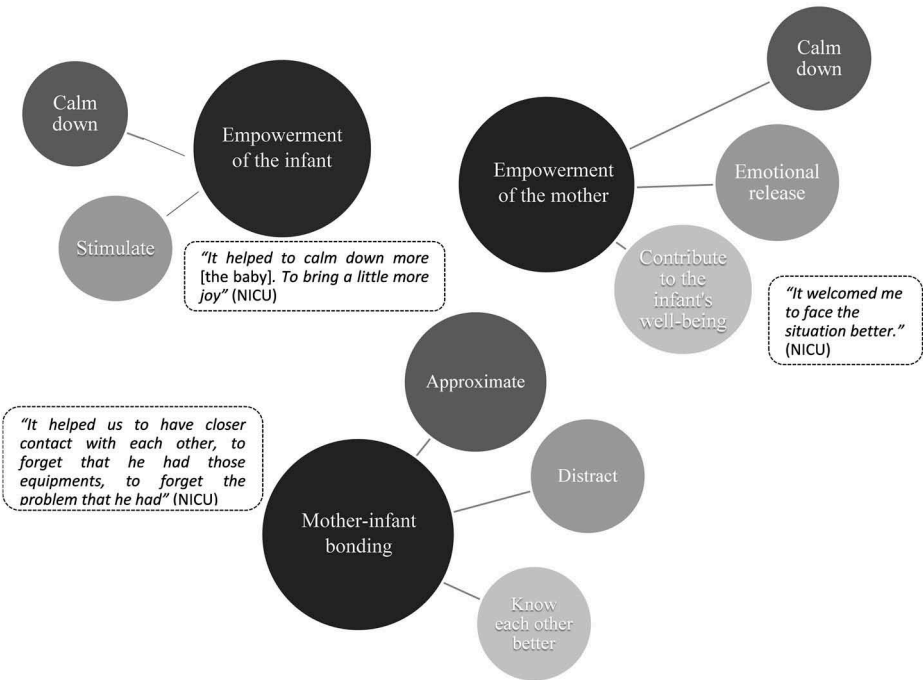
(71%, 67%, and 80%, respectively) than after singing. However, *vocalise = caress* occurred more in the post-singing episode (71%).

Lastly, it is important to highlight that several co-occurrences (*look = sing*; *look = caress*; *look = stimulate*; *vocalise = stimulate*; *vocalise = sing*; *smile = sing*; *smile = stimulate*; and *caress = sing*) were found only during maternal singing. On the other hand, the synchronous exchanges *vocalise = vocalise*, *vocalise = smile*, and *caress = caress* were found only in post-singing. For a more detailed description of the percentage and frequencies of mother-infant synchronous co-occurrences, see Tables D.1 and D.2 (Online supplement).

### **Mother's perceptions about the intervention**

The analysis of the NICU and at home interviews generated the following themes involving the mother's perceptions about the intervention: *empowerment of the mother*, *empowerment of the infant*, and *mother-infant bonding*. In Figure 5 we show our thematic map, organised in themes and sub-themes.

The *empowerment of the mother* refers to the mother's abilities to relax, calm down, interact with the baby, and improve her maternal skills (Haslbeck, 2013, 2014). In this study, this theme involves three sub-themes: *calm down*, *emotional release*, and *contribute to the infant's well-being*. Regarding the first sub-theme, *calm down*, the mother referred to feeling calmer and more peaceful during the sessions, also reporting that they helped ease her anguish. With regards to the *emotional release* sub-theme, the mother outlined that, through music therapy, she could "cry and banish" bad feelings and "felt better". The *contribute to the infant's well-being* sub-theme refers to the maternal perceptions that, during sessions, she was able to "transfer something good" to the infant, helping him to stay well. She said: "Sometimes I was kinda sad and then I sang. Because, depending on the situations, you are not able to hold on, even though you are strong, you can't hold on. Then comes the person [the music therapist],



**Figure 5.** Thematic map

starts singing, singing for you, singing for your baby, you sing for your baby and this gives you strength, a better mood to pass security to him [the baby]”.

The *empowerment of the infant* refers to the infant’s abilities to relax, calm down, and enhance self-regulation, orientation, and interaction (Haslbeck, 2013, 2014). This theme involves the two sub-themes: *calm down* and *stimulate*. In particular, in the NICU the mother stated that, during the music therapy sessions, she felt the infant was “calmer and more peaceful”. She said that music seemed to calm her and the infant down and “provided comfort” to them. Moreover, the mother noticed that through singing she could *stimulate* and engage the baby more: “He pays more attention to my voice too. In these last days he seems to be more awake. He pays more attention to people’s voices”. Similarly, in the interview at home we found that the mother was still singing to the baby to *stimulate* him. She stated that when she was singing she could “take him to a magical world”.

The *mother-infant bonding* refers to the capacity of the dyad to connect with, and relate to each other, and to express their feelings and emotions (Ettenberger & Ardila, 2018). In this study, this theme involves three sub-themes, *approximate*, *distract*, and *know each other better*, and refers to the music therapy contributions to approximate mother and infant, to distract them from the NICU’s environment, and to help them to get to know each other better. Regarding the first sub-theme, *approximate*, the mother said that the infant paid more attention to her voice during music therapy and that the intervention “helped to have a closer contact” between them. Moreover, the mother reported that, before music therapy, she did not feel secure bonding with the infant, because of the fear of losing him, while throughout the sessions she was able to believe in his recovery. She commented: “I think that music helped me to bond, to have more faith, believe more”. The *distract* sub-theme

refers to the maternal perception that music therapy brought joy to the NICU environment, helping her “to forget that there was all that equipment and to forget about the problems of the baby”. Lastly, the *know each other better* sub-theme refers to maternal perceptions that the sessions helped her to know her baby better and to pay more attention to his reactions and behaviours. She stated: “[Music therapy] helped me to observe him more [...], to know him better, [...] to feel him more”.

## Discussion

This study aimed to explore the contributions of a music therapy intervention in the NICU for mother-preterm infant interaction, examining the dyad interactional synchrony in the NICU and at home, as well as maternal perceptions about the music therapy. Our results from the video analysis highlighted that, during and after maternal singing, the mother and the baby showed more synchronous exchanges, and displayed more affective and social behaviours. It is plausible to think that MUSIP contributed to these effects during hospitalisation and at home, since the intervention aimed at supporting maternal singing in the NICU. These findings are strengthened by the mother’s perceptions about the intervention: music therapy fostered her relaxation, allowed her to contribute to her baby’s well-being, approximated them, and helped them to know each other better. As far as we know, this is the first study in NICU music therapy that compares mother-infant synchrony, with and without singing, during hospitalisation, and 4 months after discharge.

Regarding maternal behaviours, our results revealed that, during singing and post-singing episodes, maternal affective and social behaviours (such as smile, caress, talk, rock, and stimulate) were notably higher than in breastfeeding, especially at home. Singing represents a multi-modal experience that integrates auditory, visual, and vestibular stimuli (Trehub, 2017). During singing, mothers can hold, move, or rock the baby, and provide visual cues, such as distinct facial expressions and smiling (Trehub, 2017; Trehub et al., 2016). Trehub et al. (2016) found that 21 mothers of 5-month-old infants smiled considerably more when singing to their babies than when talking. In particular, while they showed an intermittent smile when talking to the infant, during singing they smiled almost constantly. Similarly, in our study the mother smiled more at the baby during singing in the NICU and smiled more after singing at home. In line with the literature (Trehub, 2017; Trehub et al., 2016), the experience of singing allowed her to provide a multi-modal stimulation, through social and affective behaviours, such as smiling, talking, rocking, and caressing, that occurred during singing or right after it.

Interestingly, our results showed that the mother tended to use singing with different purposes in the NICU and at home, as she also reported in the interviews. During the hospitalisation, she predominantly smiled and rocked the baby while she was singing, which is confirmed from her perception that the music calmed the baby down in the NICU. Conversely, during singing at home the mother was constantly stimulating the baby, as she reported in the interview at home. Our results support previous qualitative studies in showing the contributions of music therapy for the *empowerment of the mother* (Ettenberger & Ardila, 2018; Ettenberger et al., 2017; Haslbeck, 2014; Palazzi et al., 2017). Similarly, Ettenberger and Ardila (2018), interviewing mothers who participated in music therapy sessions with their hospitalised preterm babies, found that music therapy helped them to relax by promoting moments of calm and peace and made them feel capable of playing a more active role in the care

of their baby. Also, Haslbeck (2014) found that, through music therapy, parents could be empowered in interacting with their baby by helping them to trust in themselves more. In our previous study, we also found music therapy contributes to relaxing the mother and helping her to feel less powerless about her baby's well-being (Palazzi et al., 2017). These results may be related to music therapy effects in decreasing the mother's anxiety and stress levels. The literature shows that by promoting the mother's relaxation and empowering her in the care of the baby, anxiety and stress levels can be reduced (Ak et al., 2015; Arnon et al., 2014; Cevasco, 2008).

With regards to the infant's behaviours, we highlight that, in the NICU, gaze occurred more during maternal singing. Opening eyes and smiling are two important markers of preterm infant engagement during music therapy and maternal directed-speech and singing in the NICU (Filippa et al., 2018; Haslbeck, 2014). In our study, the baby smiled just once during the breastfeeding episode in the NICU, while he looked at the mother more during singing, compared to the other episodes. At home, while gaze was more frequent in the breastfeeding episode, all the other social behaviours such as vocalise, smile, and touch, occurred only during singing and after singing.

In the same direction, in the interviews the mother reported that music therapy and maternal singing calmed the baby down and engaged him more during interactions. Singing allows a mother to engage the baby more, to sustain his or her attention and to regulate arousal levels (Trehub, 2017). Previous qualitative research showed that music therapy helps preterm infants to relax, to self-regulate, and to engage in interactions (Ettenberger & Ardila, 2018; Ettenberger et al., 2017; Haslbeck, 2014).

The literature shows that mother-preterm infant interactions and synchrony may be at risk during hospitalisation and at home (Feldman & Eidelman, 2007; Harel et al., 2011; Lester et al., 1985). Our findings highlighted that, during maternal singing and just after singing, the mother and her baby displayed a rich and diverse repertoire of synchronised behaviours, while co-occurrences were rare during breastfeeding, both in the NICU and at home. Interestingly, gaze synchrony (*look = look*) was found more during singing in the NICU, while other co-occurrences involving vocalisations, smiling, and affective behaviours were displayed more after singing. Similarly, at home the synchronous exchanges that involved the infant's vocalisations were displayed more after singing than during singing.

The greater presence of gaze synchrony during singing, compared to breastfeeding and post-singing, may be explained because singing is responsible for enhancing infants' attention, reducing their motor activity, and inducing more drowsiness and sleep states (Filippa et al., 2013; Trehub, 2017). Regarding other co-occurrences that were more frequent after singing, a recent study also showed that preterm infants vocalise more after maternal speech and singing, than during mother's vocalisations (Carvalho et al., 2019). We suggest that preterm infants are already skilled in engaging themselves in a turn-taking communication (Dominguez et al., 2016). These proto-conversations are multi-modal (Stern, 2000; Trehub, 2017; Trehub et al., 2016; Trevarthen, 2008) and usually happen within a response latency time of 1000 ms (Dominguez et al., 2016). Besides finding more synchrony in mother-infant interactions during and after singing, maternal reports also showed that music therapy facilitated mother-infant bonding, helping the mother to connect with her baby and to know him better, as previous qualitative studies suggested (Ettenberger & Ardila, 2018; Ettenberger et al., 2017; Haslbeck, 2014; Palazzi et al., 2017).



Enhancing the infant's attention, as well as the temporality and attunement of mother-infant proto-conversations, singing is responsible for strengthening maternal sensitivity to the infant's cues and for promoting mother-infant co-modulation (Carvalho et al., 2019; Corbeil et al., 2016; Stern, 2000; Trehub, 2017; Trevarthen, 2008). We can hypothesise that our music therapy intervention, aimed at facilitating maternal singing in the NICU, strengthened the mother's responsiveness to the baby's signals and enabled more synchronous exchanges between them, showing positive effects not just during the hospitalisation, but 4 months after discharge (Eshel et al., 2006; Isabella et al., 1989).

As a whole, our results are in line with recent research in this field, showing the impacts of music therapy on preterm infant development, for maternal well-being and for mother-infant relationships (Ettenberger & Ardila, 2018; Ettenberger et al., 2017; Haslbeck, 2014; Palazzi et al., 2017). However, our findings bridge the gap between research involving music therapy and interventions involving maternal singing, by showing synchronous co-occurrences during and after singing in a mother-infant dyad that participated in a music therapy intervention.

Nevertheless, this study has some limitations. Firstly, it is a single case study, and the results cannot be generalised and must be interpreted within the cultural context of a NICU in a public hospital in the South of Brazil. Secondly, we used an adapted protocol, originally created to analyse interactions between mothers and older full-term babies, which might not have been sensitive enough to the behaviours of hospitalised preterm infants. Besides this, each behaviour of the protocol was marked when it occurred at least once within a 5-s interval, which did not allow us to consider the behaviour duration and frequency within the interval. We think that this might have affected gaze quantification particularly, and we suggest that future studies investigate the impacts of maternal singing in the duration of gaze, gaze aversions, and gaze synchrony in mother-preterm infant interaction. Moreover, the choice of the two interactional contexts (breastfeeding and free interaction with singing) might have generated some biased results, since breastfeeding is a very peculiar moment in which the infant needs to concentrate on sucking, swallowing, and breathing behaviours, and might not be available enough for interaction with the mother. In addition, the interviews used to assess the mother's perceptions about the music therapy intervention often involved leading questions, which could have biased some of the maternal answers. Lastly, our observation of mother-infant interaction was carried out in the NICU and at home, involving several intervening stimuli and distractions (e.g. NICU professionals, the baby's siblings and father), that might have affected the dyad interaction. On the other hand, this allowed for a more ecological observation.

Despite these limitations, our findings can be particularly useful in terms of future interventions in the NICU: facilitating and supporting maternal singing with the preterm baby represents an early cost-effective intervention that contributes to maternal responsiveness and mother-infant synchrony, and may result in long-term benefits for their attachment and for the infant's development (Ainsworth et al., 1978; Eshel et al., 2006; Filippa, 2017; Isabella et al., 1989; Shoemark, 2018). Aside from clinical implications, we highlight the relevance of our design, since we investigated longitudinally the mother-preterm infant interaction from hospitalisation to 4 months after discharge. Moreover, we collected both behavioural data from video footage and maternal perceptions from the interviews, which showed convergent findings, and allowed for data triangulation.

## Conclusions

Our study suggested that MUSIP, being an early, individualised, and family-centred intervention focused on maternal singing and mother-infant interaction, contributed to the mother's and the infant's empowerment, and the dyad's interactional synchrony. MUSIP allowed the mother to participate in the infant's well-being in the NICU, using maternal singing autonomously as a way to calm the baby down during hospitalisation and to stimulate him at home.

Valuing and supporting maternal singing is important in early family-centred interventions in the NICU, since it can promote mother-infant interaction during hospitalisation and potentially has longitudinal effects at home. Our study confirmed the importance of maternal singing in the NICU as a resource to foster the infant's and mother's well-being and to enhance mother-infant synchrony, being a possible protective factor for the long-term infant's development and parent-infant attachment.

Future studies are necessary to investigate the impact of music therapy on mother-infant interactions during hospitalisation and after discharge, using a larger sample and a control group. Besides this, a validated observational protocol addressed to hospitalised preterm infants and their parents is also needed.

## Disclosure statement

The authors report no conflicts of interest.

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