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Music therapy enhances preterm infant's signs of engagement and sustains maternal singing in the NICU

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ABSTRACT

Hospitalized preterm infants are exposed to stressful stimuli and early parental separation, which can undermine their long-term development and mother-infant bonding. Family-centered music therapy can enable positive mother-infant interactions, mediated by maternal infant-directed singing. This study aimed to investigate the effects of music therapy on preterm infant's signs of engagement, namely Eye Opening (EO) and Smiling (SM), and maternal vocalizations. Participants were 30 mother-preterm infant dyads in a Brazilian Neonatal Intensive Care Unit (NICU), divided into a Music Therapy Group (MTG) and a Comparison Group (CG). The MTG participated in 6 sessions of the *Music Therapy Intervention for the Mother-Preterm Infant Dyad* (MUSIP), with the aim of supporting maternal singing with the infant. Prior to discharge, all mothers were filmed during a Non-singing (NS) and Singing (S) interactional condition; in the S condition, mothers were explicitly asked to address their infants by singing. Results of video and audio analysis showed that infants in the MTG displayed greater Eye Opening (EO) frequency compared to CG, but only when they were in an initial awake state at test, suggesting that music therapy can potentialize infants' alertness, by increasing their disposition and chances of being engaged in the interaction with the mother. Non-religious mothers appeared to sing significantly more in the MTG than in the CG. These preliminary findings indicate that music therapy in the NICU could promote infant's signs of engagement during interactions and can sustain maternal singing, especially with non-religious mothers in Brazil.

1. Introduction

1.1. Neonatal Intensive Care Unit environment: risks for preterm infant and mother-infant interactions

Prematurity affects globally 15 million of infants per year (Chawanpaiboon et al., 2019) and represents a threat for long-term neurodevelopment, involving increased risks for motor, cognitive, linguistic and socioemotional deficits (Aarnoudse-Moens et al., 2009; Cheong et al., 2017; Sansavini et al., 2015), as well as behavioural problems (Huhtala et al., 2012; Langerock et al., 2013) and psychiatric disorders (Johnson & Marlow, 2011). Besides the biological risks of prematurity, preterm infants are early exposed to

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stressors in the Neonatal Intensive Care Unit (NICU), such as painful procedures and routine nursing interventions, which have been found to be associated with decreased brain size in the frontal and parietal regions, altered functional connectivity in both temporal lobes and poor neural network development, as well as with motor and neurobehavioural problems at term equivalent age (Smith et al., 2011). NICU hospitalization also forces preterm babies to an early parental separation, which can impact their long-term development, parental mental health and parent-infant bonding (Flacking et al., 2012). A review of human and animal studies highlights that painful and stressful experiences in the prenatal period, such as early parental separation in the NICU, can affect the oxytocin system, resulting in long-term impacts on mother-infant prosocial behaviours (Filippa et al., 2019). Indeed, compared to full-term newborns, preterm babies display less positive affect and eye contact, have more difficulties in maintaining a quiet alert state and are commonly perceived by parents as less active and responsive (Forcada-Guex et al., 2006; Korja et al., 2012). Similarly, preterm infants' mothers have been described as more stimulating, intrusive and less sensitive (Forcada-Guex et al., 2006; Korja et al., 2012), while mother-infant interactions at infants' 12 months corrected age were found to be characterized by less frequent symmetric and more frequent unilateral co-regulation patterns (Sansavini et al., 2015).

1.2. Protective role of vocal contact in the NICU

As highlighted by research on parent-preterm infant interactions (Hane et al., 2019; Stefana et al., 2019), parental vocalizations seem to play an important role in engaging the preterm baby, and parent-preterm infant dyads were found to show spontaneous bidirectional sequential patterns of communication in the first weeks of life, despite the increased interactional risks of the preterm baby. Hane et al. (2019) found that more sensitive maternal caregiving and higher quality of vocal contact during interactions in the NICU with preterm infants at a gestational age of 36 weeks were associated with more maternal emotional connection at 4 months corrected age. Similarly, Stefana et al. (2019) showed that father's affectionate behaviour, through touch of and gaze at the infant, but without talk, was not as effective as the combination of father's affectionate touch, gaze and talk in eliciting infant engagement. During development, maternal singing is particularly responsible for sustaining infant's attention, modulating arousal and enabling mother-infant protoconversations in at term infants (Trehub, 2017; Trevarthen, 2008). Communicative musicality is the coordinated vocal interplay between a mother and her infant, which happens through three musical dimensions: pulse, representing the timing of protoconversations; quality, consisting of the melody and timbre of vocalizations; and narratives, defined as units of pulse and quality that enable a shared experience of passing time between the mother and the infant (Malloch, 1999/2000).

Considering the detrimental effects of stress, pain and early parental separation on the oxytocin system, interventions that enhance positive parent-infant interactions in the NICU, such as early vocal contact, can attenuate these impacts and act as protective factors for parental skills, parent-infant prosocial behaviours and infant development (Filippa et al., 2019). A systematic review of 15 studies, with a total of 512 preterm infants, showed that maternal voice interventions had short-term effects on infant's physiological and behavioural stability, by reducing critical cardiorespiratory events (Filippa et al., 2017). In particular, maternal speaking is associated with higher frequencies of quiet alert state and singing seems to maintain the infant in an active sleep (Filippa et al., 2013). The systematic review also suggested mid-term and long-term potentials of maternal voice interventions for enhancing neurodevelopment, evidenced by an increase in the quality of the general movements and a larger auditory cortex (Filippa et al., 2017).

The stabilization of alertness is a crucial accomplishment for newborns in the first weeks of life: by six weeks after birth the alert states are more consistent and reliable, allowing the full-term infants to be early engaged in social interactions (Als et al., 2005). The calm awake state, which is characterized by eye opening and lack of movements, is considered more supportive to social interaction (Als et al., 1990), and is associated with long-term attentional and self-regulatory abilities (Als et al., 1994). Nevertheless, premature birth affects the development and displaying of infant's behavioural states and social behaviours. The calm awake state is the most difficult state for the preterm baby and is more easily disrupted than the calm awake state of a full-term infant (Philbin & Klaas, 2000). Because of preterm infants' immaturity and poor behavioural subsystems differentiation, even a simple accomplishment such as eye opening requires an overall high cost of the motor and regulation systems (Als et al., 2005).

With regards to neonatal smiling, from a neurophysiological level smiles occur after the contraction of the zygomatic major muscle and are present at birth in full-terms (Emde & Koenig, 1969) and preterm infants (Emde et al., 1971). Smiling is displayed mostly in sleeping and drowsy states of rapid eye movement (REM), being described as endogenous smiling, since it physically occurs before being integrated in social interaction (Messinger & Fogel, 2007). Depending on infant's neurological maturity, social smiling emerges between the first and second month of age, because of infant's increased alertness and the development of new patterns of visual attention that facilitate the face-to-face contact with the caregiver (Lavelli & Fogel, 2002). In particular, Wolff (1987) observed that at the end of the second week of life half of the infants smiled regularly in response to the human voice when they were awake and, by the fourth week, they had a preference for the human voice. Preterm infants were found to have significantly more endogenous smiling that full-term new-borns (Emde et al., 1971) and premature birth may delay the display of social smiling (Emde & Harmon, 1972).

Despite preterm infants' difficulties in achieving and modulating a calm awake state and displaying social smiling, a recent study carried out with preterm infants (32–36 weeks of post-menstrual age), showed that maternal speech and singing can increase eye opening and self-touch behaviours, while singing seemed to enhance smiling (Filippa et al., 2020). Indeed, maternal infant-directed speech and singing are more emotional (in terms of higher pitch and intensity) during infant eye opening and smiling, which suggests that these behaviours are intuitively interpreted as acts of communication by mothers (Filippa et al., 2018). Therefore, eye opening and smiling can play a crucial role during maternal vocal interactions and might be considered two important markers of preterm infant engagement during vocal interactions (Filippa et al., 2018; Filippa et al., 2020).

Moreover, both mothers and fathers have showed to change their vocal qualities depending on infants' awake or sleep state (Saliba et al., 2020). Taken together, these studies highlight the protective role of parental early vocalizations for preterm infants' neurodevelopment and parent-infant prosocial behaviours, by easing the negative effects of prematurity and the NICU sensory environment and promoting positive parent-infant interactions through speech and singing.

1.3. Family-centered music therapy in the NICU

Family-centered music therapy represents an early intervention that enables positive dyad interactions in the NICU mediated by parental contingent singing; these interactions result in long-term impacts for the infant's neurodevelopment, parental skills and the quality of the parent-infant relationship (Haslbeck et al., 2020; Shoemark, 2017). Research in NICU music therapy has demonstrated positive effects for preterm infants' physiological and behavioural responses (Bieleninik et al., 2016; Haslbeck, 2012; Standley, 2012), as well as for maternal mental health (Bieleninik et al., 2016; Kostilainen et al., 2020; Loewy et al., 2013; Palazzi et al., submitted; Ribeiro et al., 2018).

Despite the increasing growth of research in NICU music therapy, the few studies focusing on the dyad interaction show benefits for mother-infant communicative musicality and interactional synchrony (Haslbeck, 2014; Palazzi et al., 2020) and parental bonding (Ettenberger et al., 2017). In particular, a previous longitudinal case study carried out in the south of Brazil investigated the contributions of the *Music Therapy Intervention for the Mother-Preterm Infant Dyad* (MUSIP; Palazzi et al., 2014, 2019), the same intervention used in the present study, for mother-infant interactional synchrony. Results of video microanalysis showed that, prior to discharge and 4 months after discharge, most mother-infant synchronous exchanges occurred during and right after singing compared to a non-singing interaction (during breastfeeding). The mother displayed more affectionate behaviours (such as smiling, touching, rocking and caressing) during or after singing in both assessments. In the NICU, prior to discharge, the infant looked at the mother more during singing, while at home the infant touched and smiled more during singing and vocalized more right after singing (Palazzi et al., 2020). These preliminary results suggest the potentials of MUSIP in stimulating mother-infant interactional competence.

1.4. Aims of the study

This study aimed to investigate the effects of music therapy on preterm infant's signs of engagement and maternal vocalizations. To test these questions, mother-infant dyads were divided into two groups: a Music Therapy Group (MTG), which participated in a music therapy intervention, and a Comparison Group (CG), which received standard care. Both groups were observed during a Non-singing (NS) and a Singing (S) interactional condition prior to discharge.

We formulated three main hypotheses. (1) We expected that infants in the MTG would show greater signs of engagement, compared to the CG, independent of condition (NS and S). Outcomes measures were: infants' Eye Opening (EO) frequency and duration, and infants' Smiling (SM) frequency in the NS and S conditions and overall. (2) In the NS condition, we expected that mothers in the MTG would speak more to the infants compared to mothers in the CG, showing a transfer effect from the music therapy intervention to the amount of infant-directed speech. The outcome measure was the duration of maternal speech in the NS condition. (3) In the S condition, we expected that, mothers in the MTG would sing more to the infants compared to mothers in the CG, showing an increased ease in the use of infant-directed singing in interactional contexts. The outcome measure was the duration of maternal singing in the S condition.

2. Material and methods

2.1. Participants

Participants were admitted to the NICU at the Hospital Nossa Senhora da Conceição, which is a public hospital in Porto Alegre (Brazil). A convenience and non-randomized sampling method was used: recruitment started in January 2018 with the participants of the CG, who were in process of discharge; afterwards, from June 2018, participants of the MTG were recruited. Eligibility criteria were: adult mothers (>18 years old) that were Brazilian or fluent in Portuguese; preterm infants (gestational age <37 weeks) in stable condition, without sensory diseases or neurological impairment. Infants were excluded if they had grade III and IV intraventricular or periventricular haemorrhage. Participants were excluded if they did not participate in at least 4 out of the 6 music therapy sessions.

Thirty-nine mothers (17 in the CG and 22 in the MTG) met the eligibility criteria, agreed to participate in this study and signed an informed consent form. From the initial sample, one case in the CG was excluded because had discharge before completing the assessment. With regards to the MTG, eight cases were excluded: three cases that did not participate to the whole intervention because of maternal withdrawal; two cases that had discharge before final assessment; one case that participated only in two out of the six sessions; and two cases whose video footage had audio problems. A final sample of 30 mother-preterm infant dyads (16 dyads in the CG and 14 dyads in the MTG) was finally included and their data were analysed. Detailed demographic and clinical characteristics of the sample, as well as differences between MTG and CG, are shown in Table 1. Maternal age in both groups was similar, all mothers were married or lived with a partner, most of them had secondary and tertiary education (MTG: 78.60 %; CG: 68.80 %) and had middle-low socioeconomic status (MTG: 50 %; CG: 68.80 %). Most of mothers declared having a religion (MTG: 71.40 %; CG: 75 %), and half of them in both groups reported having sung to the baby during NICU hospitalization (before participating in the intervention in the case of the MTG). Infants' gestational age was 30.57 weeks (SD = 2.17), while post-menstrual age at test was 36.75 weeks (SD = 2.24). Infants in both groups had similar clinical characteristics, and most of them were in active sleep at the beginning of the test (MTG: 64.30 %; CG: 75.00 %).

Variables that were different between groups, such as maternal employment ($p = .047$), income ($p = .026$) and infant's Apgar at 5

Table 1
Sociodemographic and Clinical Characteristics of Mothers and Infants.

Characteristics	MTG ($n = 14$)	CG ($n = 16$)	Test	P
Mother				
Age (y)	30.29 ± 6.28	29.75 ± 6.80	$t = -0.22$	$p = .825$
Number of children	1.93 ± 0.62	2.50 ± 1.21	$t = 1.66$	$p = .111$
Educational level (%)[a]			$\chi^2 = 0.37$	$p = .544$
IEE – ISE	3 (21.40 %)	5 (31.30 %)		
SE – TE	11 (78.60 %)	11 (68.80 %)		
Religion (%)			$\chi^2 = 0.05$	$p = .825$
Religious mothers	10 (71.40 %)	12 (75 %)		
Non-religious mothers	4 (28.6 %)	4 (25 %)		
Employment (%)			$\chi^2 = 5.13$	$\mathbf{p = .024}$
Employed	11 (78.60 %)	6 (37.50 %)		
Unemployed	3 (21.40 %)	10 (62.50 %)		
Income (Brazilian Real)[c]	3597.14 ± 1340.08	2603.13 ± 1273.90	$t = -2.08$	$\mathbf{p = .047}$
Socioeconomic status (%)[b]			$\chi^2 = 1.09$	$p = .296$
E - C1	7 (50 %)	11 (68.80 %)		
B2 - B1	7 (50 %)	5 (31.30 %)		
Delivery			$\chi^2 = 1.20$	$p = .273$
Vaginal (%)	2 (14.30 %)	5 (31.30 %)		
Caesarean (%)	12 (85.70 %)	11 (68.80 %)		
STAI-T at test[d]	36.64 ± 10.74	47.75 ± 11.66	$t = 2.70$	$\mathbf{p = .012}$
STAI-S at test[e]	36.86 ± 4.96	46.13 ± 11.17	$t = 3.00$	$\mathbf{p = .007}$
EPDS at test[f]	6.00 ± 4.61	11.06 ± 6.28	$t = 2.49$	$\mathbf{p = .019}$
PSS at test[g]	23.14 ± 8.38	30.00 ± 9.65	$t = 2.06$	$\mathbf{p = .049}$
Previous singing (%)	7 (50 %)	8 (50 %)	$\chi^2 = 0.00$	$p > .999$
Infant				
Gestational age (w)	30.64 ± 1.78	30.50 ± 2.53	$t = -0.18$	$p = .861$
Post-menstrual age at test (w)	35.86 ± 2.54	36.75 ± 2.24	$t = 1.02$	$p = .314$
Birth weight (g)	1372.36 ± 349.19	1354.38 ± 376.27	$t = -0.13$	$p = .894$
Weight at test (g)	2480.86 ± 522.44	2689.81 ± 872.97	$t = 0.78$	$p = .442$
Weight gain (g)	22.56 ± 3.77	22.03 ± 6.83	$t = -0.26$	$p = .800$
Apgar at 1 min	6.50 ± 2.38	5.31 ± 1.96	$U = 151.50$	$p = .097$
Apgar at 5 min	8.29 ± 1.27	7.62 ± 1.09	$U = 157.50$	$\mathbf{p = .045}$
Length of hospitalization (d)	48.49 ± 18.96	57.19 ± 31.32	$U = 104.00$	$p = .739$
Initial behavioural state			$\chi^2 = 2.64$	$p = .450$
Deep sleep	2 (14.30 %)	0 (0.00 %)		
Active sleep	9 (64.30 %)	12 (75.00 %)		
Quiet awake	2 (14.30 %)	2 (12.50 %)		
Active awake	1 (7.10 %)	2 (12.50 %)		
Crying	0 (0.00 %)	0 (0.00 %)		

Note: *t:* Student's independent *t*-test; *U:* Mann–Whitney *U* test; χ^2: chi-square test; [a] Educational level: IEE = incomplete elementary education, ISE = incomplete secondary education, SE = secondary education, TE = tertiary education; [b] Socioeconomic status: E – C1 = from less than 1–3 minimum salaries; B2 – B1 = between 5 and 10 minimum salaries (Associação Brasileira de Empresas de Pesquisa, 2018); [c] Income: 1 dollar (USD) is about 5.33 Brazilian Reais (Retrieved in 2020, August 03, from https://www.exchangerates.org.uk/Dollars-to-Brazilian-Reals-currency-conversion-page.html); [d] STAI-T: State-Trait Anxiety Inventory – Trait; [e] STAI-S: State-Trait Anxiety Inventory – State; [f] EPDS: Edinburgh Postnatal Depression Scale; [g] PSS: Perceived Stress Scale.

min ($p = .045$), did not associate with outcome variables. Maternal mental health scores at discharge also were significantly higher in the CG compared to the MTG but did not associate or correlated just marginally with outcome measures (see Table A.1 in Appendix A).

2.2. Ethical considerations

This study received ethical approval from the Ethical Review Board of the Psychology Institute of the Universidade Federal do Rio Grande do Sul (UFRGS) (no. 2.268.801) and the Ethical Review Board of the hospital (no. 2.301.686).

2.3. Procedures

Before the intervention, when the baby was in stable conditions and ready for skin-to-skin contact, the demographic and clinical data of the MTG were collected.

2.3.1. Intervention

The mother-infant dyads in the MTG participated individually in MUSIP (Palazzi et al., 2014, 2019), a 6-session music therapy intervention aimed at supporting maternal singing with the preterm infant. The intervention was carried out by the first author, with the monthly supervision of an expert music therapist (third author). The 6 MUSIP sessions are carried out twice a week for 20−30 min, with the infant on the mother's lap or during skin-to-skin contact. The MUSIP protocol involves 3 music therapy techniques: singing of "songs of kin", infant-directed singing and song writing. In sessions 1 and 2, the mother and the music therapist sang maternal preferred songs for the baby, using a slower tempo, a simpler harmony and repetitive patterns, such as in a lullaby (Loewy et al., 2013). These "songs of kin" were accompanied by the music therapist with a guitar. In sessions 3 and 4, the music therapist guided the mother in observing the infant's signals and using infant-directed singing to entrain these behavioural cues (Shoemark, 2011, 2018). In sessions 5 and 6, the music therapist helped the mother in composing a song parody for the baby, based on the musical characteristics of a familiar song, with new lyrics containing the infant's name and messages from parents, siblings or other family members (Baker et al., 2005; Ettenberger & Ardila, 2018). As part of MUSIP, from Session 1 mothers were invited to sing for their baby whenever they wanted and were comfortable in the NICU, even when the music therapist was not present.

2.3.2. Post-intervention

Mothers of the CG, who received standard care, were recruited only in the post-intervention phase. Prior to discharge, maternal mental health in the MTG and CG was assessed, after an equivalent period of hospitalization, as highlighted by similar length of stay between groups. Maternal mental health was assessed through the *State-Trait Anxiety Inventory* (STAI; Spielberger et al., 1970), the *Edinburgh Postnatal Depression Scale* (EPDS; Cox et al., 1987) and the *Perceived Stress Scale* (PSS; Cohen et al., 1983). In the present study these measures were used to describe maternal mental state and not as a comparison between groups. Infants' clinical information was obtained from NICU medical reports. Mothers in both groups were also filmed in the NICU during two 5-minute interactional episodes with the infant on their lap: a free interaction, in which mothers were asked to interact freely with their infant, without singing (NS condition), and a singing interaction, in which mothers were explicitly asked to sing to their infant (S condition). Mother-infant dyads were filmed with a GoPro Hero 5 camera, connected to an external microphone (Zoom H4n) placed near the mother and the baby.

2.4. Measures

2.4.1. Coding of infants' signs of engagement

Research questions for hypothesis 1 were infants' EO frequency and duration and infants' SM frequency. The definitions of infants' behaviours were derived from Filippa et al. (2018). Eye Opening (EO) was defined as both infant's eyes opened, including half-closed eyes, and this behaviour was codified from the beginning of the eyelids opening until the end of the eyelids closing. Smiling (SM) was defined as simultaneous lip corner raising.

Because of technical problems during data collection, the duration and homogeneity of video footage of the two 5-minute interactional episodes was often compromised. For this reason, only the first two minutes were selected and coded in the two groups (MTG and CG). EO frequency and duration and SM frequency, in both the NS and S conditions, were coded. The frame-by-frame analysis of infants' behaviours was carried out using ELAN 5.7 software by two independent coders, and reliability was assessed. Thirty per cent of infants' behaviours were double-coded by the first author and a research assistant. Inter-observer reliability was estimated via intraclass correlation coefficients (ICC). For all variables, high agreement coefficients were found: EO frequency, ICC = .998, $p = .000$; EO duration, ICC = .995, $p = .000$; SM frequency, ICC = .852; $p = .000$. After the reliability process, each coder analysed half of the remaining data set.

To determine the homogeneity of the population during the video assessment, the infants' initial behavioural state was coded by two independent researchers, experts in neonatal behavioural coding, using Precht's behavioural states (Precht, 1974): (1) deep sleep: eyes closed, regular respiration, no movements; (2) active sleep: eyes closed, irregular respiration, small movements; (3) quiet awake: eyes open, no movements; (4) active awake: eyes open, gross movements; and (5) crying. In addition, considering that active sleep comprises more than 70 % of the sleep time of infants prior to 30 weeks of gestation (Holditch-Davis, 1990; Zaiwalla & Stern, 1993), we decided to code as active sleep when infants showed mixed signs of active and quiet sleep, in line with similar studies in this field (Foreman et al., 2008). Thirty per cent of infants' behavioural states were double-coded and inter-rater reliability was high (Cohen's kappa = 0.82).

2.4.2. Coding of maternal vocalizations

Audio sequences were extracted from the corresponding video footage, considering the total amount of mother's vocalizations during each 5-minute episode. Following criteria from Gratier et al. (2015), maternal vocalizations were defined as the production of an audible vocal sound where interruption of sound did not exceed 300 ms. The outcome measure for hypothesis 2 was the duration of maternal speech, which was defined as the duration of mother's spoken vocalizations within the 5-minute episode of the NS interaction, excluding all internal pauses (greater than 300 ms) and unvoiced sounds such as onomatopoeic and rhythmic sounds. The outcome measure for hypothesis 3 was the duration of maternal singing, which was defined as the duration of mother's sung vocalizations within the 5-minute episode of the S interaction, excluding all internal pauses (greater than 300 ms) and unvoiced sounds such as onomatopoeic and rhythmic sounds.

Thirty per cent of maternal vocalizations were double-coded by the first author and a research assistant. Inter-observer reliability was estimated via ICC and, for all variables, high agreement coefficients were found: speech duration, ICC = .991, $p = .000$; and singing duration, ICC = .997, $p = .000$. After the reliability process, each coder analysed half of the remaining data set. The analysis was carried out using Audacity Team (2019). When the audio of the mothers lasted less than 5 min, the duration of maternal speech or singing proportionate to 5 min was calculated.

2.5. Data analysis

Statistical analysis was carried out using SPSS 18.0 software. First, data distribution was examined, and descriptive statistics (mean, standard deviation and frequency) were calculated. All variables were tested for normality (Kolmogorov–Smirnoff, $p > .05$; Shapiro–Wilk, $p > .05$). Normally distributed data were analysed through Student's *t*-test; data without normal distribution were analysed through Mann–Whitney's *U* test; and categorical data were analysed with the chi-squared test. Differences between MTG and CG in relation to sociodemographic and clinical characteristics were calculated (Spearman's correlation, $p > .05$; Mann–Whitney *U* test, $p > .05$; Kruskal–Wallis *H* test, $p > .05$), as well as associations between these variables with all outcome measures (Table A1 in Appendix A). In this study, a 5% significance level was used.

Mann–Whitney *U* tests were used to calculate the effects of Group (MTG and CG) on all outcomes variables. Afterwards, linear regressions analyses (enter method) were carried out with each outcome measure: (1) EO frequency and duration (Overall, NS and S condition); (2) duration of maternal speech; and (3) duration of maternal singing. In the regression models, all the variables that showed a significant or marginally significant association were introduced, besides Group. It was not possible to conduct regressions with SM frequency (Overall, NS and S condition) because the values were too small, and they were not associated with any other variable. Model collinearity was verified through the variance inflation factor (VIF) statistics. Normality of residuals was also verified. All variables with an association of $p > .10$, except for Group, were removed from the regression model. Finally, interactions between the remaining variables associated with the outcome ($p < .10$) and the Group were calculated through analysis of variance (ANOVA).

3. Results

Descriptive statistics of infant's signs of engagement, maternal vocalizations and the results of the non-parametric tests between MTG and CG are reported in Table 2. Final regression models of infants' and mothers' outcomes are presented in Table 3. First, results regarding preterm infants' signs of engagement will be presented. Afterwards, we will present the findings related to mothers' vocalizations, in particular maternal speech and singing.

3.1. *Infants' signs of engagement*

As shown in Table 2, there were no significant differences ($p > .05$) between MTG and CG with regards to infants' overall behaviours ($p > .05$), although the MTG showed higher EO frequency, EO duration and SM frequency, in line with hypothesis 1. Similarly, there were no significant differences between groups in NS and S conditions ($p > .05$).

With regards to regression models reported in Table 3, infants' initial behavioural state at test showed to be the only predictor of the overall EO frequency (R square = 0.62; Beta = 0.78; $t = 6.50$; $p = .000$) and overall EO duration (R square = 0.85; Beta = 0.93; $t = 12.39$; $p = .000$). However, ANOVA showed a significant interaction between Group and initial behavioural state for the overall EO frequency (F = 6.98; $p = .014$), revealing that when infants in intervention and control groups were in awake states at the beginning of the test, the MTG displayed a significantly higher overall EO frequency than the CG (MTG: M = 36.33; SD = 4.15; CG: M = 19.50; SD = 3.59; $p = .005$). Conversely, when infants were in sleep states, there was no difference between MTG and CG in the overall EO frequency (MTG: M = 4.59; SD = 2.17; CG: M = 4.36; SD = 2.17; $p = .941$). No significant interaction between Group and behavioural state in NS was found for the overall EO duration (F = 3.01; $p = .095$).

Further regressions and ANOVAs were carried out for each condition, NS and S, and results were confirmed only in the S interaction. During singing, the infants' initial behavioural state was the only predictor of EO frequency S (R square = 0.66; Beta = 0.81; $t = 7.10$; $p = .000$) and EO duration S (R square = 0.65; Beta = 0.81; $t = 7.02$; $p = .000$). Significant interactions were found between Group and initial behavioural state for EO frequency S ($F = 6.65$; $p = .016$), but not for EO duration S ($F = 2.53$; $p = .124$). With regards to the NS condition, the initial behavioural state was the only predictor of EO frequency NS (R square = 0.44; Beta = 0.65; $t = 4.41$; $p = .000$) and EO duration NS (R square = 0.87; Beta = 0.94; $t = 13.47$; $p = .000$). However, no significant interactions between Group and initial behavioural state were found for EO frequency NS ($F = 3.33$; $p = .080$) and duration NS ($F = 1.04$; $p = .318$), indicating a different tendency, compared to overall EO frequency and duration and to S condition.

Table 2
Descriptive statistics of infant's signs of engagement and maternal vocalizations and results of non-parametric tests between MTG and CG.

	MTG M (SD)	CG M (SD)	Test	*Sig.*
Infant's signs of engagement				
Overall EO[a] frequency	11.39 (15.69)	8.40 (9.01)	$U = 100.00$	$p = .847$
Overall EO duration	46.06 (76.47)	45.44 (66.19)	$U = 104.00$	$p = .983$
Overall SM[b] frequency	1.00 (1.58)	0.37 (0.90)	$U = 79.500$	$p = .270$
EO frequency NS[c]	7.18 (10.20)	4.97 (6.42)	$U = 88.50$	$p = .477$
EO duration NS	27.90 (42.05)	29.90 (41.19)	$U = 96.00$	$p = .715$
SM frequency NS	0.54 (1.18)	0.20 (0.77)	$U = 90.00$	$p = .533$
EO frequency S[d]	4.21 (6.19)	3.43 (4.70)	$U = 99.50$	$p = .813$
EO duration S	18.16 (37.83)	15.54 (28.71)	$U = 105.00$	$p = 1.000$
SM frequency S	0.46 (0.84)	0.17 (0.52)	$U = 81.000$	$p = .310$
Maternal vocalizations				
Speech	47.69 (39.75)	38.15 (46.81)	$U = 136.00$	$p = .334$
Singing	177.88 (30.02)	142.24 (71.56)	$U = 136.00$	$p = .334$

Notes. [a] Eye Opening; [b] Smiling; [c] Non-singing; [d] Singing.

Table 3
Final models of linear regressions analyses of infants' and maternal outcomes.

	R Square	B	95.0 % Confidence Interval for B		Beta	t	Sig.
			Lower Bound	Upper Bound			
Overall EO frequency[a]	0.62						
Group		4.17	−1.93	10.27	0.17	1.41	$p = .172$
Behavioural state		22.53	15.41	29.66	0.78	6.50	$\mathbf{p = .000}$
Overall EO duration[b]	0.85						
Group		8.42	−12.74	29.59	0.06	0.82	$p = .421$
Behavioural state		149.00	124.28	173.72	0.93	12.39	$\mathbf{p = .000}$
EO frequency NS[c]	0.44						
Group		2.87	−2.12	7.85	0.17	1.18	$p = .248$
Behavioural state		12.49	6.67	18.31	0.65	4.41	$\mathbf{p = .000}$
EO duration NS[d]	0.87						
Group		2.62	−8.88	14.09	0.03	0.466	$p = .645$
Behavioural state		87.91	74.50	101.32	0.94	13.47	$\mathbf{p = .000}$
EO frequency S[e]	0.66						
Group		1.31	−1.18	3.79	0.12	1.08	$p = .290$
Behavioural state		10.04	7.14	12.95	0.81	7.10	$\mathbf{p = .000}$
EO duration S[f]	0.65						
Group		5.82	−9.49	21.13	0.09	0.78	$p = .441$
Behavioural state		61.09	43.21	78.97	0.81	7.02	$\mathbf{p = .000}$
Speech[g]	0.29						
Group		3.00	−26.47	32.48	0.03	0.21	$p = .836$
Delivery		38.59	3.71	73.46	0.38	2.27	$\mathbf{p = .031}$
Previous singing		34.16	5.26	63.07	0.40	2.43	$\mathbf{p = .022}$
Singing[h]	0.47						
Group		38.46	5.50	71.42	0.34	2.39	$\mathbf{p = .024}$
Religion		79.04	41.85	116.22	0.61	4.36	$\mathbf{p = .000}$

Notes: Excluded variables: [a] Delivery and STAI-S at test; [b] Delivery; [c] GA and delivery; [d] Delivery; [e] STAI-S at test; [f] STAI-S at test; [g] Maternal age, income and behavioural state; [h] Birth weight and STAI-T at test. B: Unstandardized Coefficient; Beta: Standardized Coefficient.

3.2. *Maternal vocalizations*

There were no significant between-group differences for maternal vocalizations ($p > .05$). Nevertheless, the MTG tended to show higher duration of Speech and Singing compared to the CG, which is in line with hypotheses 2 and 3 (Table 2). Regarding hypothesis 2, the regression models reported in Table 3 showed that the duration of maternal Speech was predicted by the type of birth delivery (R square = 0.29; Beta = 0.38; $t = 2.27$; $p = .031$) and mother's previous singing (R square = 0.29; Beta = 0.40; $t = 2.43$; $p = .022$). Further analysis through ANOVA showed no significant interaction between Group and delivery ($F = 0.13$; $p = .725$) or Group and previous singing ($F = 0.14$; $p = .707$) in maternal Speech.

With regards to hypothesis 3, the duration of maternal Singing appeared to be predicted both by Group (R square = 0.47; Beta = 0.34; $t = 2.39$; $p = .024$) and religion (R square = 0.47; Beta = 0.61; $t = 4.36$; $p = .000$). ANOVA highlighted a significant interaction between Group and religion (F = 8.38; $p = .008$), indicating that the impact of music therapy in the duration of maternal singing was particularly strong in non-religious mothers, who appeared to sing 3 times more than non-religious mothers in the CG (MTG: M = 155.45; SD = 19.43; CG: M = 48.93; SD = 19.43; $p = .001$). Alternatively, this effect was not found with religious mothers (MTG: M = 186.85; SD = 12.29; CG: 173.34; SD = 11.22; $p = .424$).

4. Discussion

This study aimed to investigate the effects of music therapy on preterm infant's signs of engagement and maternal vocalizations.

4.1. *Infants' signs of engagement*

We expected that infants in the MTG would show greater signs of engagement compared to the CG, independently of condition (NS and S). This hypothesis was partially confirmed, as results showed that when infants in intervention and control groups were in an initial awake state and more available for the interaction, the infants in the MTG displayed a higher EO frequency compared to CG, during both maternal S and NS interaction. Therefore, although we can expect that any baby in an awake state is naturally more alert to surrounding stimuli, our findings suggest that this effect was significantly greater for the MTG, which indicates that music therapy potentialized infants' readiness, increasing their disposition and their chances of being engaged in the interaction.

Compared to full-term newborns, preterm infants can have more difficulties in maintaining a quiet alert state, which is considered more supportive to social interaction (Als et al., 1990) and is associated with long-term attentional and self-regulatory abilities, as well as better mother-infant bonding (Als et al., 1994). A recent study, whose sample had a similar post-menstrual age to the infants in our study, showed that EO can be increased both by maternal speech and singing (Filippa et al., 2020). EO and SM have also been shown to be associated with more emotional maternal vocalizations (Filippa et al., 2018). Infant's behavioural states can influence the vocal qualities of parental vocalizations (Filippa et al., 2018; Saliba et al., 2020) and maternal speech and singing are likely to become more infant-directed when the infant displays EO and SM, which mothers intuitively interpret as social behaviours (Filippa et al., 2018). Hane et al. (2019) found that behaviours displayed during closed face-to-face interactions, such as eye contact, can be used to determine the mutual emotional connection between the mother and the infant, which suggests that a higher EO frequency can be associated with a greater mother-infant emotional connection. In line with these studies, our findings showed that music therapy enhanced infant's signs of engagement during interaction and has potential effects on maternal interactional abilities and mother-infant co-regulation and emotional connection.

We suggest that music therapy had a partially undirected effect on infant's signs of engagement, mediated by maternal affective behaviours during singing. Compared to the CG, MTG infants were used to heightened maternal singing throughout the hospitalization, which took place during music therapy sessions and might have enhanced maternal vocal contact during infant's everyday life in the NICU. When mothers sing, they frequently integrate their vocalizations with other infant-directed behaviours, which constitute multi-modal stimulation for the baby (Trehub et al., 2016; Trehub, 2017). Therefore, it is possible that MTG infants were more used to this richer and multisensory experience throughout the NICU stay, which might have affected their greater responsiveness and alertness during the interaction with the mother prior to discharge.

Music therapy predicted infants' overall EO frequency during awake states, independent of the condition, which suggests a transfer effect of the intervention in other mother-infant interactional contexts besides singing. This is particularly important considering the increased risks of prematurity and NICU hospitalization for mother-infant interactional competences (Forcada-Guex et al., 2006; Korja et al., 2012; Sansavini et al., 2015). Moreover, music therapy also predicted EO frequency during awake states in the S condition, which supports previous evidence concerning the effect of infant-directed singing on infants' engagement and attention (Trehub, 2017).

4.2. Maternal vocalizations

With regards to maternal speech, we expected that mothers in the MTG would speak more in the NS condition compared to CG mothers. This hypothesis was not confirmed, because the only two predictors of speech were infant's initial behavioural state and previous maternal singing. Mothers who sang spontaneously for their preterm infants in the NICU, independent of participation in music therapy or before starting the intervention, were more likely to talk to them prior to discharge. This result highlights the close connection between different kinds of intuitive maternal vocalizations, which can be stimulated early in the NICU to enhance mother-preterm infant vocal contact (Filippa et al., 2013; Filippa, Kuhn et al., 2017). This tendency of association between singing, parental musical engagement and general use of vocalization has also been described in previous studies (McLean, 2016; McLean et al., 2018; Shoemark & Arnup, 2014). Parental singing and use of voice, supported by a music therapist in the NICU, are linked to the development and strengthening of parental identity (McLean, 2016). Surprisingly, in our study, previous maternal singing did not affect the duration of maternal singing prior to discharge.

Regarding maternal singing, we expected mothers in the MTG would sing more to infants compared to mothers in the CG, showing an increased ease in the use of infant-directed singing in interactional contexts. Our findings partially supported this hypothesis, showing that both Group and Religion were predictors of the duration of maternal singing. In particular, non-religious mothers in the MTG sang significantly more than non-religious mothers in the CG, and this difference was not found with religious participants. This unexpected result suggests that music therapy might have represented a sustaining experience for non-religious mothers, and a resource to cope with all the difficulties associated with infant's health and hospitalization and to stimulate an increased participation in the interaction with the baby through singing.

Several studies have highlighted the beneficial effects of family-centered music therapy in empowering parental skills in the NICU (Ettenberger et al., 2017; Haslbeck, 2014; Palazzi, Meschini, Baggio et al., submitted; Shoemark, 2017). A previous qualitative study that used MUSIP (Palazzi, Meschini, Baggio et al., submitted) showed its contributions to infant's development, maternal empowerment and mother-infant connection. Music therapy in palliative and cancer care has already been shown to help people connect with their spiritual side (Clements-Cortés, 2017) and create a sense of trust and faith (McClean et al., 2012). However, so far, we have not found any published study that has highlighted the relationship between music therapy and mothers' religiosity or spirituality in the NICU. This unexpected result can be better understood in relation to the Brazilian cultural context, whose intrinsic musicality emerges through the strong connection of singing, playing and dance expressions, and encompasses different aspects of social, cultural and spiritual life. Preterm mothers' *sound identity* (ISO; Benenzon, 2008), besides involving their individual musical legacy and preferences throughout life, is influenced by Brazilian musicality and its close connection with religion. Evangelical music in Brazil, known as Brazilian gospel music, has progressively been consumed outside the religious context, becoming a remarkable social phenomenon (Bandeira, 2017). Indeed, even non-religious mothers in Brazilian NICUs are used to singing gospel songs during music therapy, because they can identify with the themes of the spiritual lyrics, such as hope and resilience (Vianna et al., 2020).

We suggest that the healing effects of music therapy might be particularly strong in cultures characterized by an intrinsic musicality and a close connection between music, spirituality and religion. Taking into account the higher risks for mental health disorders and psychological distress among mothers of preterm infants (Gondwe & Holditch-Davis, 2015; Loewenstein, 2018; McGowan et al., 2017;

Trumello et al., 2018; Vigod et al., 2010), we suggest that non-religious mothers in Brazil might be particularly vulnerable to a preterm birth and the early parental separation, which may result in increased difficulties for establishing positive vocal interactions with their infants. Therefore, non-religious mothers might particularly benefit from music therapy, which can facilitate early vocal contact with the preterm baby, by retrieving maternal intuitive abilities and helping them to express (without words) and give meaning to the inexplicable and painful experience of having a hospitalized baby.

Nevertheless, it is important to point out that these are only preliminary findings. Future studies are needed to investigate the association between musicality and religion with bigger samples, highlighting if these results can be generalized to other cultures, through specific questionnaires or interviews focused on religious and spiritual dimensions in the NICU. Beyond reflections about cultural specificity that need to be further investigated, our results highlight the relevant connection between maternal religiosity and musical habits and familiarity towards singing, which is not normally taken into consideration in early dyadic studies about infant-directed singing. We hope that these findings may inspire broader reflections about the effects of cultural belonging on families' musicality in the early interaction with the newborn.

Before ending, it is important to point out some limitations of this study. First, the small sample size may explain the few significant results. We found overall positive trends for music therapy in enhancing almost all infant behaviours in the NS and S conditions and in increasing the duration of maternal speech and singing, although these between-group differences did not reach the level of significance. Moreover, participants were not randomized and some of the sample demographic and clinical characteristics were not homogeneous between groups. However, during data analysis, possible associations between these characteristics and the outcome variables were verified. As part of the intervention, mothers were invited to sing autonomously in their NICU daily life, but we did not assess and control for the amount of maternal singing outside the MUSIP sessions, which may limit the reliability of our results; it is important to take into account this methodological limitation in light of possible replications of the study and future research. Fathers were not included in the study, because mothers are generally the most present and available caregivers in Brazilian NICUs. Nevertheless, fathers need to be involved in future research, because they possess intuitive abilities for coping with their preterm newborns (Saliba et al., 2020), are as likely as mothers to be negatively affected by the stressful experience of having a preterm baby (Loewenstein, 2018) and music therapy has already been shown to be beneficial for fathers as well (Ettenberger et al., 2017). Despite these limitations, the present study compensates for the lack of research in this area, showing the influences of music therapy on the interactive dimension of preterm infants and their mothers.

Overall, this study has some important clinical implications for music therapy and early vocal contact interventions in the NICU. Our results indicate that music therapy can potentialized infant's alertness during the interaction with the mother, increasing their disposition and their chances of being engaged. Moreover, music therapy was shown to be particularly effective with non-religious mothers, empowering their intuitive abilities and increasing their singing interaction with the infant. Considering hospitals' limited financial resources and the need to establish priorities in referrals, non-religious mothers in Brazil might be considered a specifically vulnerable population that would particularly benefit from early and family-centered music therapy interventions. Future studies are necessary to investigate the effects of music therapy on other infant behaviours, such as vocalizations, and on maternal vocal qualities in speech and singing. Moreover, further transcultural studies are needed to explain the relationship between music therapy, religion and parental mental health in the NICU.

5. Conclusions

Early vocal contact and music therapy interventions should be implemented in the NICU to mitigate the adverse effects of prematurity and parental separation on mother-infant prosocial behaviours. This study showed that music therapy can enhance preterm infants' signs of engagement during the interaction by increasing their eye opening frequency, especially when the infants are in awake states at the beginning of the interaction. Moreover, music therapy can promote maternal intuitive abilities, resulting in an increase of the amount of singing, particularly in non-religious mothers. Our findings underscore the importance of supporting maternal infant-directed singing in the NICU, which can act as a protective factor for mother-infant interactional competences and connectedness.

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CRediT authorship contribution statement

A. Palazzi: Conceptualization, Methodology, Investigation, Formal analysis, Writing - original draft, Writing - review & editing, Project administration. **M. Filippa:** Methodology, Formal analysis, Writing - review & editing. **R. Meschini:** Conceptualization, Methodology, Supervision, Writing - review & editing. **C.A. Piccinini:** Conceptualization, Methodology, Investigation, Supervision, Writing - review & editing, Project administration.

Declaration of Competing Interest

Authors declare no conflict of interest

Appendix A

Table A1
Correlations and associations between variables.

}	EO freq NS}	EO dur NS}	SM freq NS}	EO freq S}	EO dur S}	SM freq S}	Ov EO freq}	Ov EO dur}	Ov SM freq}	Speech}	Singing}
Maternal age	$r = -0.003$	$r = 0.015$	$r = 0.310$	$r = 0.103$	$r = 0.070$	$r = 0.075$	$r = 0.093$	$r = 0.067$	$r = 0.273$	$r = 0.382$*	$r = 0.159$
	$p = .986$	$p = .938$	$p = .101$	$p = .596$	$p = .717$	$p = .701$	$p = .632$	$p = .731$	$p = .151$	$p = .037$	$p = .400$
Number of children	$r = -0.050$	$r = 0.006$	$r = 0.140$	$r = 0.227$	$r = 0.232$	$r = -0.022$	$r = 0.101$	$r = 0.100$	$r = 0.054$	$r = 0.021$	$r = -0.128$
	$p = .796$	$p = .975$	$p = .469$	$p = .235$	$p = .226$	$p = .910$	$p = .603$	$p = .605$	$p = .782$	$p = .914$	$p = .500$
Educational level	$U = 92.500$	$U = 83.000$	$U = 75.000$	$U = 85.000$	$U = 81.000$	$U = 87.000$	$U = 93.000$	$U = 88.000$	$U = 90.000$	$U = 114.000$	$U = 112.000$
	$p = .407$	$p = .749$	$p = .865$	$p = .660$	$p = .826$	$p = .497$	$p = .401$	$p = .564$	$p = .419$	$p = .223$	$p = .260$
Religion	$U = 71.500$	$U = 76.000$	$U = 75.000$	$U = 78.500$	$U = 75.000$	$U = 69.500$	$U = 72.000$	$U = 66.000$	$U = 73.500$	$U = 103.000$	$U = 152.000$**
	$p = .769$	$p = .957$	$p = .865$	$p = .934$	$p = .913$	$p = .610$	$p = .793$	$p = .564$	$p = .828$	$p = .482$	$p = .003$
Employment	$U = 108.500$	$U = 96.000$	$U = 98.000$	$U = 89.500$	$U = 89.000$	$U = 127.500$	$U = 92.000$	$U = 88.000$	$U = 111.500$	$U = 86.000$	$U = 132.000$
	$p = .763$	$p = .781$	$p = .768$	$p = .551$	$p = .535$	$p = .132$	$p = .649$	$p = .524$	$p = .608$	$p = .305$	$p = .368$
Socioeconomic status	$U = 102.500$	$U = 105.000$	$U = 112.000$	$U = 104.500$	$U = 106.000$	$U = 83.500$	$U = 100.000$	$U = 101.000$	$U = 97.500$	$U = 96.000$	$U = 104.000$
	$p = .981$	$p = .889$	$p = .460$	$p = .905$	$p = .849$	$p = .275$	$p = .927$	$p = .964$	$p = .808$	$p = .611$	$p = .866$
Income	$r = 0.192$	$r = 0.221$	$r = 0.126$	$r = -0.001$	$r = 0.012$	$r = 0.044$	$r = 0.097$	$r = 0.147$	$r = 0.096$	$r = 0.424$*	$r = 0.046$
	$p = .319$	$p = .248$	$p = .514$	$p = .995$	$p = .951$	$p = .821$	$p = .618$	$p = .448$	$p = .621$	$p = .019$	$p = .810$
Delivery	$U = 110.000$*	$U = 110.000$*	$U = 81.000$	$U = 83.000$	$U = 88.000$	$U = 61.500$	$U = 101.000$	$U = 105.000$*	$U = 70.500$	$U = 129.000$*	$U = 71.000$
	$p = .021$	$p = .021$	$p = .281$	$p = .417$	$p = .271$	$p = .590$	$p = .076$	$p = .046$	$p = .921$	$p = .017$	$p = .641$
Previous singing	$U = 106.000$	$U = 108.000$	$U = 102.000$	$U = 116.000$	$U = 122.000$	$U = 91.000$	$U = 107.500$	$U = 111.000$	$U = 89.500$	$U = 160.000$*	$U = 143.000$
	$p = .963$	$p = .891$	$p = .827$	$p = .605$	$p = .424$	$p = .415$	$p = .911$	$p = .788$	$p = .409$	$p = .049$	$p = .206$
STAI-T at test	$r = 0.014$	$r = 0.097$	$r = -0.151$	$r = 0.134$	$r = 0.177$	$r = 0.032$	$r = 0.156$	$r = 0.190$	$r = -0.035$	$r = -0.043$	$r = -0.313$
	$p = .941$	$p = .618$	$p = .435$	$p = .489$	$p = .359$	$p = .870$	$p = .420$	$p = .322$	$p = .858$	$p = .821$	$p = .092$
STAI-S at test	$r = 0.239$	$r = 0.289$	$r = -0.073$	$r = 0.333$	$r = 0.332$	$r = -0.149$	$r = 0.360$	$r = 0.348$	$r = -0.139$	$r = 0.114$	$r = -0.077$
	$p = .212$	$p = .129$	$p = .707$	$p = .078$	$p = .078$	$p = .440$	$p = .055$	$p = .064$	$p = .474$	$p = .549$	$p = .687$
EPDS at test	$r = -0.014$	$r = 0.036$	$r = -0.142$	$r = 0.094$	$r = 0.100$	$r = 0.123$	$r = 0.096$	$r = 0.124$	$r = 0.009$	$r = 0.008$	$r = -0.243$
	$p = .941$	$p = .854$	$p = .463$	$p = .629$	$p = .607$	$p = .527$	$p = .620$	$p = .520$	$p = .963$	$p = .964$	$p = .196$
PSS at test	$r = -0.049$	$r = 0.068$	$r = -0.089$	$r = 0.029$	$r = 0.067$	$r = -0.005$	$r = 0.032$	$r = 0.099$	$r = -0.114$	$r = 0.142$	$r = -0.241$
	$p = .801$	$p = .727$	$p = .645$	$p = .883$	$p = .728$	$p = .981$	$p = .870$	$p = .608$	$p = .555$	$p = .453$	$p = .200$
Gestational age	$r = 0.350$	$r = 0.289$	$r = -0.248$	$r = 0.220$	$r = 0.255$	$r = 0.114$	$r = 0.304$	$r = 0.294$	$r = -0.063$	$r = -0.123$	$r = -0.299$
	$p = .063$	$p = .129$	$p = .195$	$p = .251$	$p = .183$	$p = .555$	$p = .109$	$p = .122$	$p = .747$	$p = .517$	$p = .109$
Post-menstrual age at test	$r = 0.229$	$r = 0.134$	$r = -0.094$	$r = 0.164$	$r = 0.129$	$r = -0.129$	$r = 0.261$	$r = 0.186$	$r = -0.012$	$r = -0.143$	$r = -0.153$
	$p = .231$	$p = .487$	$p = .629$	$p = .397$	$p = .504$	$p = .506$	$p = .171$	$p = .335$	$p = .951$	$p = .450$	$p = .418$
Birth weight	$r = 0.234$	$r = 0.285$	$r = -0.056$	$r = 0.263$	$r = 0.297$	$r = 0.203$	$r = 0.229$	$r = 0.246$	$r = 0.083$	$r = 0.057$	$r = -0.315$
	$p = .221$	$p = .134$	$p = .773$	$p = .168$	$p = .117$	$p = .292$	$p = .233$	$p = .199$	$p = .668$	$p = .763$	$p = .090$
Weight at test	$r = -0.015$	$r = -0.022$	$r = -0.070$	$r = 0.107$	$r = 0.058$	$r = 0.276$	$r = 0.020$	$r = -0.037$	$r = 0.253$	$r = -0.264$	$r = 0.101$
	$p = .937$	$p = .910$	$p = .717$	$p = .582$	$p = .766$	$p = .147$	$p = .920$	$p = .847$	$p = .185$	$p = .159$	$p = .594$
Weight gain	$r = -0.053$	$r = -0.129$	$r = -0.166$	$r = 0.015$	$r = -0.052$	$r = 0.239$	$r = -0.012$	$r = -0.071$	$r = 0.172$	$r = -0.263$	$r = -0.030$
	$p = .784$	$p = .506$	$p = .390$	$p = .937$	$p = .789$	$p = .211$	$p = .952$	$p = .713$	$p = .373$	$p = .160$	$p = .876$
Apgar at 1 min	$r = -0.086$	$r = -0.110$	$r = 0.119$	$r = 0.273$	$r = 0.220$	$r = 0.202$	$r = 0.003$	$r = -0.037$	$r = 0.157$	$r = -0.098$	$r = 0.059$
	$p = .658$	$p = .572$	$p = .538$	$p = .152$	$p = .252$	$p = .292$	$p = .988$	$p = .847$	$p = .417$	$p = .606$	$p = .756$
Apgar at 5 min	$r = -0.063$	$r = -0.066$	$r = 0.081$	$r = 0.161$	$r = 0.136$	$r = 0.141$	$r = -0.015$	$r = -0.019$	$r = 0.117$	$r = 0.012$	$r = 0.053$
	$p = .745$	$p = .736$	$p = .677$	$p = .403$	$p = .481$	$p = .465$	$p = .936$	$p = .921$	$p = .545$	$p = .952$	$p = .779$
Length of hospitalization	$r = -0.042$	$r = -0.072$	$r = 0.016$	$r = 0.068$	$r = 0.020$	$r = 0.104$	$r = 0.007$	$r = -0.051$	$r = 0.181$	$r = -0.063$	$r = 0.209$
	$p = .830$	$p = .709$	$p = .936$	$p = .727$	$p = .917$	$p = .592$	$p = .972$	$p = .791$	$p = .347$	$p = .740$	$p = .268$
Initial behavioural state at test	$H = 11.763$**	$H = 17.601$**	$H = 1.055$	$H = 16.132$**	$H = 18.295$**	$H = 2.287$	$H = 15.338$**	$H = 17.253$**	$H = 1.242$	$H = 7.346$	$H = 0.814$
	$p = .008$	$p = .001$	$p = .788$	$p = .001$	$p = .000$	$p = .515$	$p = .002$	$p = .001$	$p = .743$	$p = .062$	$p = .846$

Notes: EO freq NS: Eye Opening frequency in Non-Singing; EO dur NS: Eye Opening Duration in Non-Singing; SM freq NS: Smiling frequency in Non-Singing; EO freq S: Eye Opening frequency in Singing; EO dur S: Eye Opening Duration in Singing; SM freq S: Smiling frequency in Singing; Ov EO freq: Overall Eye Opening frequency; Ov EO dur: Overall Eye Opening duration; Ov SM freq: Overall Smiling frequency.
** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

References

Als, H., Duffy, F. H., & McAnulty, G. B. (1990). Neurobehavioral regulation disorder of prematurity. *Infant Behavior & Development, 13*, 159.
Als, H., Lawhon, G., Duffy, F. H., McAnulty, G. B., Gibes-Grossman, R., & Blickman, J. G. (1994). Individualized developmental care for the very low-birth-weight preterm infant. Medical and neurofunctional effects. *JAMA, 272*(11), 853–858.
Als, H., Butler, S., Kosta, S., & McAnulty, G. (2005). The Assessment of Preterm Infants' Behavior (APIB): Furthering the understanding and measurement of neurodevelopmental competence in preterm and full-term infants. *Mental Retardation and Developmental Disabilities Research Reviews, 11*(1), 94–102. https://doi.org/10.1002/mrdd.20053.
Aarnoudse-Moens, C. S. A., Weisglas-Kuperus, N., Goudoever, J. B., & Oosterlaan, J. (2009). Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics, 124*(2), 717–728. https://doi.org/10.1542/peds.2008-2816.
Associação Brasileira de Empresas de Pesquisa. (2018). *Critério de Classificação Econômica Brasil*. http://www.abep.org/criterio-brasil.
Audacity Team. (2019). *Audacity(R): Free audio editor and recorder [Computer application]*. Version 2.3.3. https://audacityteam.org/.
Baker, F., Kennelly, J., & Tamplin, J. (2005). Songwriting to explore identity change and sense of self-concept following traumatic brain injury. In F. Baker, & T. Wigram (Eds.), *Songwriting methods, techniques and clinical applications for music therapy clinicians, educators and students* (pp. 116–133). Jessica Kingsley Publishers.
Bandeira, O. (2017). Música gospel no Brasil - reflexões em torno da bibliografia sobre o tema. *Religião & Sociedade, 37*(2), 200–228. https://doi.org/10.1590/0100-85872017v37n2cap08.
Benenzon, R. O. (2008). *La nueva musicoterapia* (2nd ed.) Lumen.
Bieleninik, Ł., Ghetti, C., & Gold, C. (2016). Music therapy for preterm infants and their parents: A meta-analysis. *Pediatrics, 138*(3). https://doi.org/10.1542/peds.2016-0971. e20160971.
Chawanpaiboon, S., Vogel, J. P., Moller, A.-B., Lumbiganon, P., Petzold, M., Hogan, D., et al. (2019). Global, regional, and national estimates of levels of preterm birth in 2014: A systematic review and modelling analysis. *The Lancet Global Health, 7*, e37–46. https://doi.org/10.1016/S2214-109X(18)30451-0.
Cheong, J. L., Doyle, L. W., Burnett, A. C., Lee, K. J., Walsh, J. M., Potter, C. R., et al. (2017). Association between moderate and late preterm birth and neurodevelopment and social-emotional development at age 2 years. *JAMA Pediatrics, 171*(4). https://doi.org/10.1001/jamapediatrics.2016.4805. e164805.
Clements-Cortés, A. (2017). Singing and vocal interventions in palliative and cancer care: Music therapists' perceptions of usage. *Journal of Music Therapy, 54*(3), 336–361. https://doi.org/10.1093/jmt/thx010.
Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*, 385–396. https://doi.org/10.2307/2136404.
Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. *The British Journal of psychiatry: The Journal of Mental Science, 150*, 782–786. https://doi.org/10.1192/bjp.150.6.782.
ELAN (Version 5.7) [Computer software]. (2018). *Nijmegen: Max Planck institute for psycholinguistics, the language archive*. https://archive.mpi.nl/tla/elan.
Emde, R. N., & Harmon, R. J. (1972). Endogenous and exogenous smiling systems in early infancy. *Journal of the American Academy of Child Psychiatry, 11*(2), 177–200. https://doi.org/10.1016/s0002-7138(10)60071-4.
Emde, R. N., & Koenig, K. (1969). Neonatal smiling and rapid eye movement states. *Journal of the American Academy of Child Psychiatry, 8*, 57–67.
Emde, R. N., McCartney, R. D., & Harmon, R. J. (1971). Neonatal smiling in REM states. IV. Premature study. *Child Development, 42*, 1657–1661.
Ettenberger, M., & Ardila, Y. M. B. (2018). Music therapy song writing with mothers of preterm babies in the Neonatal Intensive Care Unit (NICU) – A mixed-methods pilot study. *The Arts in Psychotherapy, 58*, 42–52. https://doi.org/10.1016/j.aip.2018.03.001.
Ettenberger, M., Cárdenas, C. R., Parker, M., & Odell-Miller, H. (2017). Family-centred music therapy with preterm infants and their parents in the Neonatal Intensive Care Unit (NICU) in Colombia – A mixed-methods study. *Nordic Journal of Music Therapy, 26*(3). https://doi.org/10.1080/08098131.2016.1205650.
Filippa, M., Devouche, E., Arioni, C., Imberty, M., & Gratier, M. (2013). Live maternal speech and singing have beneficial effects on hospitalized preterm infants. *Acta Paediatrica (Oslo, Norway: 1992), 102*(10), 1017–1020. https://doi.org/10.1111/apa.12356.
Filippa, M., Gratier, M., Devouche, E., & Grandjean, D. (2018). Changes in infant-directed speech and song are related to preterm infant facial expression in the neonatal intensive care unit. *Interactional Studies, 19*(3), 427–444. https://doi.org/10.1075/is.16019.fil.
Filippa, M., Kuhn, P., & Westrup, B. (Eds.). (2017). *Early vocal contact and preterm infant brain development*. Springer International Publishing.
Filippa, M., Menin, D., Panebianco, R., Monaci, M. G., Dondi, M., & Grandjean, D. (2020). Live maternal speech and singing increase self-touch and eye-opening in preterm newborns: A preliminary study. *Journal of Nonverbal Behavior, 44*, 453–473. https://doi.org/10.1007/s10919-020-00336-0.
Filippa, M., Panza, C., Ferrari, F., Frassoldati, R., Kuhn, P., Balduzzi, S., & D'Amico, R. (2017). Systematic review of maternal voice interventions demonstrates increased stability in preterm infants. *Acta Paediatrica (Oslo, Norway: 1992), 106*(8), 1220–1229. https://doi.org/10.1111/apa.13832.
Filippa, M., Poisbeau, P., Mairesse, J., Monaci, M. G., Baud, O., Hüppi, P., Grandjean, D., & Kuhn, P. (2019). Pain, parental involvement, and oxytocin in the neonatal intensive care unit. *Frontiers in Psychology, 10*, 715. https://doi.org/10.3389/fpsyg.2019.00715.
Flacking, R., Lehtonen, L., Thomson, G., Axelin, A., Ahlqvist, S., Moran, V. H., et al. (2012). Closeness and separation in neonatal intensive care. *Acta Paediatrica (Oslo, Norway: 1992), 101*(10), 1032–1037. https://doi.org/10.1111/j.1651-2227.2012.02787.x.
Forcada-Guex, M., Pierrehumbert, B., Borghini, A., Moessinger, A., & Muller-Nix, C. (2006). Early dyadic patterns of mother-infant interactions and outcomes of prematurity at 18 months. *Pediatrics, 118*(1), e107–e114. https://doi.org/10.1542/peds.2005-1145.
Foreman, S. W., Thomas, K. A., & Blackburn, S. T. (2008). Individual and gender differences matter in preterm infant state development. *Journal of Obstetric, Gynecologic, and Neonatal Nursing: JOGNN, 37*(6), 657–665. https://doi.org/10.1111/j.1552-6909.2008.00292.x.
Gondwe, K. W., & Holditch-Davis, D. (2015). Posttraumatic stress symptoms in mothers of preterm infants. *International Journal of African Nursing Sciences, 3*, 8–17. https://doi.org/10.1016/j.ijans.2015.05.002.
Gratier, M., Devouche, E., Guellai, B., Infanti, R., Yilmaz, E., & Parlato-Oliveira, E. (2015). Early development of turn-taking in vocal interaction between mothers and infants. *Frontiers in Psychology, 6*, 1167. https://doi.org/10.3389/fpsyg.2015.01167.
Hane, A. A., LaCoursiere, J. N., Mitsuyama, M., Wieman, S., Ludwig, R. J., Kwon, K. Y., et al. (2019). The Welch Emotional Connection Screen: Validation of a brief mother-infant relational health screen. *Acta Paediatrica (Oslo, Norway: 1992), 108*(4), 615–625. https://doi.org/10.1111/apa.14483.
Haslbeck, F. B. (2012). Music therapy for premature infants and their parents: An integrative review. *Nordic Journal of Music Therapy, 21*(3), 203–226. https://doi.org/10.1080/08098131.2011.648653.
Haslbeck, F. B. (2014). The interactive potential of creative music therapy with premature infants and their parents: A qualitative analysis. *Nordic Journal of Music Therapy, 23*(1), 36–70. https://doi.org/10.1080/08098131.2013.790918.
Haslbeck, F. B., Jakab, A., Held, U., Bassler, D., Bucher, H. U., & Hagmann, C. (2020). Creative music therapy to promote brain function and brain structure in preterm infants: A randomized controlled pilot study. *NeuroImage. Clinical, 25*, Article 102171. https://doi.org/10.1016/j.nicl.2020.102171.
Holditch-Davis, D. (1990). The development of sleeping and waking states in high-risk preterm infants. *Infant Behavior & Development, 13*(4), 513–531. https://doi.org/10.1016/0163-6383(90)90020-9.
Huhtala, M., Korja, R., Lehtonen, L., Haataja, L., Lapinleimu, H., Rautava, P., et al. (2012). Parental psychological well-being and behavioral outcome of very low birth weight infants at 3 years. *Pediatrics, 129*(4), e937–e944. https://doi.org/10.1542/peds.2011-2411.
Johnson, S., & Marlow, N. (2011). Preterm birth and childhood psychiatric disorders. *Pediatric Research, 69*(5 Pt 2). https://doi.org/10.1203/PDR.0b013e318212faa0, 11R–8R.
Korja, R., Latva, R., & Lehtonen, L. (2012). The effects of preterm birth on mother-infant interaction and attachment during the infant's first two years. *Acta Obstetricia et Gynecologica Scandinavica, 91*(2), 164–173. https://doi.org/10.1111/j.1600-0412.2011.01304.x.
Kostilainen, K., Mikkola, K., Erkkilä, J., & Huotilainen, M. (2020). Effects of maternal singing during kangaroo care on maternal anxiety, wellbeing, and mother-infant relationship after preterm birth: A mixed methods study. *Nordic Journal of Music Therapy*. https://doi.org/10.1080/08098131.2020.1837210.

Langerock, N., de Jonge, L. V. H., Graz, M. B., Hüppi, P. S., Tolsa, C. B., & Barisnikov, K. (2013). Emotional reactivity at 12 months in very preterm infants born at <29 weeks of gestation. *Infant Behavior & Development, 36*(3), 289–297. https://doi.org/10.1016/j.infbeh.2013.02.006.

Lavelli, M., & Fogel, A. (2002). Developmental changes in mother-infant face-to-face communication: Birth to 3 months. *Developmental Psychology, 38*, 288–305. https://doi.org/10.1037//0012-1649.38.2.288.

Loewenstein, K. (2018). Parent psychological distress in the neonatal intensive care unit within the context of the social ecological model: A scoping review. *Journal of the American Psychiatric Nurses Association, 24*(6), 495–509. https://doi.org/10.1177/1078390318765205.

Loewy, J., Stewart, K., Dassler, A. M., Telsey, A., & Homel, P. (2013). The effects of music therapy on vital signs, feeding, and sleep in premature infants. *Pediatrics, 131*(5), 902–918. https://doi.org/10.1542/peds.2012-1367.

Malloch, S. (1999-2000). Mother and infants and communicative musicality. *Musicæ Scientiæ, Special issue: Rhythm, musical narrative, and the origins of human communication* (pp. 29–57).

McClean, S., Bunt, L., & Daykin, N. (2012). The healing and spiritual properties of music therapy at a cancer care center. *Journal of Alternative and Complementary Medicine (New York, NY), 18*(4), 402–407. https://doi.org/10.1089/acm.2010.0715.

McGowan, E. C., Du, N., Hawes, K., Tucker, R., O'Donnell, M., & Vohr, B. (2017). Maternal mental health and neonatal intensive care unit discharge readiness in mothers of preterm infants. *The Journal of Pediatrics, 184*, 68–74. https://doi.org/10.1016/j.jpeds.2017.01.052.

McLean, E. (2016). Exploring parents' experiences and perceptions of singing and using their voice with their baby in a Neonatal Unit: An interpretative phenomenological analysis. *Qualitative Inquiries in Music Therapy, 11*, 1–42. https://search.proquest.com/scholarly-journals/exploring-parents-experiences-perceptions-singing/docview/1829749325/se-2?accountid=8144.

McLean, E., McFerran, K. S., & Thompson, G. A. (2018). Parents' musical engagement with their baby in the neonatal unit to support emerging parental identity: A grounded theory study. *Journal of Neonatal Nursing, 25*(2), 78–85. https://doi.org/10.1016/j.jnn.2018.09.005.

Messinger, D., & Fogel, A. (2007). The interactive development of social smiling. *Advances in Child Development and Behavior, 35*, 327–366. https://doi.org/10.1016/b978-0-12-009735-7.50014-1.

Palazzi, A., Meschini, R., Medeiros, M. D. M., & Piccinini, C. A. (2020). NICU music therapy and mother-preterm infant synchrony: A longitudinal case study in the South of Brazil. *Nordic Journal of Music Therapy, 29*(4), 334–352. https://doi.org/10.1080/08098131.2020.1752777.

Palazzi, A., Meschini, R., & Piccinini, C. A. (2014). *Music therapy intervention for the mother-preterm infant dyad – MUSIP*. Unpublished material.

Palazzi, A., Meschini, R., & Piccinini, C. A. (2019). Music therapy intervention for the mother-preterm infant dyad: A proposal of intervention in the neonatal intensive care unit. *Psicologia em Estudo, 24*, e41123. https://doi.org/10.4025/psicolestud.v24i0.41123.

Palazzi, A., Meschini, R., & Piccinini, C. A. NICU Music Therapy Effects on Maternal Mental Health and Preterm Infant's Emotional Arousal. Submitted paper.

Palazzi, A., Meschini, R., Baggio, Y. G., & Piccinini, C. A. (2020). *"I Try to Create Our Own Time Here": Maternal perceptions of music therapy in a Brazilian NICU*. Submitted paper.

Philbin, M. K., & Klaas, P. (2000). Evaluating studies of the behavioral effects of sound on newborns. *Journal of Perinatology, 20*(1), S61–S67.

Precht, H. F. (1974). The behavioural states of the newborn infant (a review). *Brain Research, 76*(2), 185–212. https://doi.org/10.1016/0006-8993(74)90454-5.

Ribeiro, M., Alcântara-Silva, T., Oliveira, J., Paula, T. C., Dutra, J., Pedrino, G. R., et al. (2018). Music therapy intervention in cardiac autonomic modulation, anxiety, and depression in mothers of preterms: Randomized controlled trial. *BMC Psychology, 6*(1), 57. https://doi.org/10.1186/s40359-018-0271-y.

Saliba, S., Esseily, R., Filippa, M., Gratier, M., & Grandjean, D. (2020). Changes in the vocal qualities of mothers and fathers are related to preterm infant's behavioural states. *Acta Paediatrica (Oslo, Norway: 1992)*. https://doi.org/10.1111/apa.15238, 10.1111/apa.15238. Advance online publication.

Sansavini, A., Zavagli, V., Guarini, A., Savini, S., Alessandroni, R., & Faldella, G. (2015). Dyadic co-regulation, affective intensity and infant's development at 12 months: A comparison among extremely preterm and full-term dyads. *Infant Behavior & Development, 40*, 29–40. https://doi.org/10.1016/j.infbeh.2015.03.005.

Shoemark, H. (2011). Translating' infant-directed singing' into a strategy for the hospitalized family. In J. Edwards (Ed.), *Music therapy and parent-infant bonding* (pp. 161–178). Oxford University Press.

Shoemark, H. (2017). Empowering parents in singing to hospitalized infants: The role of the music therapist. In M. Filippa, P. Kuhn, & B. Westrup (Eds.), *Early vocal contact and preterm infant brain development. Bridging the gaps between research and practice* (pp. 202–215). Springer.

Shoemark, H. (2018). Time together: A feasible program to promote parent-infant interaction in the NICU. *Music Therapy Perspectives, 36*(1), 6–16. https://doi.org/10.1093/mtp/mix004.

Shoemark, H., & Arnup, S. (2014). A survey of how mothers think about and use voice with their hospitalized newborn infant. *Journal of Neonatal Nursing, 20*(3), 115–121. https://doi.org/10.1016/j.jnn.2013.09.007.

Smith, G. C., Gutovich, J., Smyser, C., Pineda, R., Newnham, C., Tjoeng, T. H., et al. (2011). Neonatal intensive care unit stress is associated with brain development in preterm infants. *Annals of Neurology, 70*(4), 541–549. https://doi.org/10.1002/ana.22545.

Spielberger, C. D., Gorsuch, R. C., & Lushene, R. E. (1970). *Manual for the state trait anxiety inventory*. Consulting Psychologists Press.

SPSS Inc. (2009). *PASW statistics for windows, version 18.0*. SPSS Inc.. Released.

Standley, J. (2012). Music therapy research in the NICU: An updated meta-analysis. *Neonatal Network: NN, 31*(5), 311–316. https://doi.org/10.1891/0730-0832.31.5.311.

Stefana, A., Lavelli, M., Rossi, G., & Beebe, B. (2019). Interactive sequences between fathers and preterm infants in the neonatal intensive care unit. *Early Human Development, 140*, 104888. https://doi.org/10.1016/j.earlhumdev.2019.104888. Advance online publication.

Trehub, S. E. (2017). The maternal voice as a special signal for infants. In M. Filippa, P. Kuhn, & B. Westrup (Eds.), *Early vocal contact and preterm infant brain development* (pp. 39–54). Springer.

Trehub, S. E., Plantinga, J., & Russo, F. A. (2016). Maternal vocal interactions with infants: Reciprocal visual influences. *Social Development, 25*, 665–683. https://doi.org/10.1111/sode.12164.

Trevarthen, C. (2008). The musical art of infant conversation: Narrating in the time of sympathetic experience, without rational interpretation, before words. *Musicae Scientiae, 12*(1), 15–46. https://doi.org/10.1177/1029864908012001021.

Trumello, C., Candelori, C., Cofini, M., Cimino, S., Cerniglia, L., Paciello, M., et al. (2018). Mothers' depression, anxiety, and mental representations after preterm birth: a study during the infant's hospitalization in a neonatal intensive care unit. *Frontiers in Public Health, 6*, 359. https://doi.org/10.3389/fpubh.2018.00359.

Vianna, M. N., Palazzi, A., & Barcellos, L. R. M. (2020). Music therapy and culture in Brazilian Neonatal Units—Research and clinical practice. In H. Shoemark, & M. Ettenberger (Eds.), *Music therapy in Neonatal Intensive Care: Influences of culture* (pp. 207–228). Barcelona Publishers.

Vigod, S. N., Villegas, L., Dennis, C. L., & Ross, L. E. (2010). Prevalence and risk factors for postpartum depression among women with preterm and low-birth-weight infants: A systematic review. *BJOG, 117*(5), 540–550. https://doi.org/10.1111/j.1471-0528.2009.02493.x.

Wolff, P. H. (1987). *The development of behavioral states and the expression of emotions in early infancy: New proposals for investigation*. The University of Chicago Press.

Zaiwalla, Z., & Stern, A. (1993). The physiology of sleep in infants and young children. In I. S. T. James-Roberts, G. Harris, & D. Messer (Eds.), *Infant crying, feeding, and sleeping: Development, problems, and treatments* (pp. 135–149). Simon and Schuster.