



Music reduces pain perception in healthy newborns: A comparison between different music tracks and recoded heartbeat

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ABSTRACT

Objectives: To assess the effect of 3 musical interventions, as compared to no music, on the physiological response of healthy newborns undergoing painful medical procedures (Guthrie test and/or intramuscular antibiotic injections).

Methods: Prospective study of 80 full-term newborns, aged 1 to 3 days, randomly allocated to exposure to Mozart's Sonata for two pianos K.448, Beethoven's Moonlight Sonata, heartbeat sound recordings (70 bpm) or no music.

Pain perception (evaluated using the Neonatal Infant Pain Scale), heart rate and oxygen saturation were measured 10 min before (T0), during (T1), 10 (T2) and 20 (T3) minutes after the interventions.

Results: Infants who were exposed to the three music interventions displayed a significant reduction in heart rate and in pain perception and an increase in oxygen saturation, as compared to the control group, which showed less modifications on stress measurements after painful medical procedures ($F_{(3,76)} = 6.40$, $p = .001$, partial $\eta^2 = 0.20$).

Conclusions: Exposure to music and heartbeat sound recordings changes short-term physiological parameters in healthy newborns undergoing potentially painful procedures. The similar effect shown by the 3 interventions might be explained by the common characteristics of the sound shared by the various tracks. Further research is needed to investigate the impact of different types of music used in intervention, in order to develop guidelines and include music as a part of evidence-based strategies to promote the outcome for neonates.

1. Introduction

Several studies have proven that listening to music, voices and heartbeats can positively affect physiological indicators, feeding, length of stay, and pain outcomes for *newborn babies* [1–10]. Listening to music and to parent-preferred lullabies can be used to objectively determine the effects of these interventions on the heart rate, oxygen saturation (O₂Sat), nutritive sucking and caloric intake of premature newborns [4,5,8,10]. Music may also improve oxygen saturation in preterm infants undergoing endotracheal suctioning [11] and also reduce stress and pain in children undergoing painful medical procedures, such as intravenous injections, lumbar punctures and dental procedures [12–14].

Although the available literature suggests that the presence of

harmonic and rhythmic sound can positively affect neonatal neurobehavioral development and reduce parental stress during neonatal intensive care unit (NICU) stays [1–3], the heterogeneity of study populations, interventions and outcomes precludes definitive conclusions on the efficacy of music for specific indications [1].

To date, the main criticisms from published works relates to a lack of categorisation of the impact that various types of music, different genres or variables within the music have on physiological outcomes.

This study evaluated the effects of three music interventions (compared to no intervention) on physiological parameters and pain perception in healthy newborns undergoing painful medical procedures. A comparison between the effects of each musical intervention was conducted in order to investigate the optimal characteristics of the sound stimuli to be used with healthy newborns, to avoid the risk of

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Table 1
Clinical characteristics and values at baseline (N = 80).

Groups (type of music intervention)	GND	GA (SD)	BW (SD)	Physiological measures 10 min before injection		
				Heart rate (SD)	O ₂ Sat (SD)	NIPS (SD)
Mozart piano Sonata K.448	9 F	39.5	3430	112.3	98.7	10.6
	11 M	(0.76)	(380)	(10.4)	(1.2)	(15.5)
Beethoven Moonlight Sonata	11 F	39.7	3244	119.8	98.1	11.7
	9 M	(0.98)	(458.1)	(16.3)	(1.7)	(17.5)
Heartbeat sound (70 bpm)	12 F	39.4	3226	111.8	98.7	5.6
	8 M	(0.76)	(445.7)	(11.8)	(1.6)	(12.2)
Control group	12 F	39.7	3201	124.2	98.35	7.2
	8 M	(1.1)	(360.1)	(23.89)	(1.72)	(18.47)
p value	$\chi^2_{(3)} = 1.21; p = .75$	$F_{(3,76)} = 0.36; p = .78$	$F_{(3,76)} = 1.28; p = .28$	$F_{(3,76)} = 2.67; p = .06$	$F_{(3,76)} = 2.32; p = .37$	$F_{(3,76)} = 0.63; p = .60$

Legend: GND, gender; GA, gestational age; BW, birth weight; O₂Sat, oxygen saturation; SD, standard deviation.

hyperstimulation and to best reduce procedural pain perception and stress.

2. Methods

2.1. Participants

The study was conducted in the Neonatal Intensive Care Unit of the University Hospital of Brescia, Italy.

Eighty full-term healthy infants were enrolled during a 15 month period, with Apgar score of 8 or above, breathing spontaneously and hemodynamically stable. We verified that all infants recruited to this study had normal brainstem auditory responses (a routine procedure in all infants who are discharged from our NICU). The exclusion criteria were congenital malformations, mechanical ventilation, anomalies associated with neurological impairments or other comorbid conditions that might interfere with the reaction to musical stimuli or data collection. The institutional Research Ethics Committee approved the study and written informed consent was obtained from both parents of the newborns.

2.2. Procedure

This study was a prospective, randomised controlled trial of the effect of 3 music interventions (as compared to no music) on infants undergoing painful medical procedures (Guthrie test and/or intramuscular antibiotic injections).

The 3 interventions included Mozart's Sonata for two pianos K.448, Beethoven's Moonlight Sonata and heartbeat sound recordings (70 bpm). Music was played on a CD player at a volume of between 55 and 70 dB, as recommended by the American Academy of Pediatrics. According to this acoustic measurement, speakers were placed at a distance of 2 m from the infant's bed unit. For all the groups, the ambient noise level was controlled to maintain constancy and minimize outside noise. Enrolled patients were randomly assigned, using random numbers, to one of the 3 groups exposed to music interventions or to control group, where no explicit stimulation was used. The infants underwent the music session once in the first three days of life, while were lying in a supine position, asleep and at the same time of the day (late morning). Each session lasted 40 min, and was carried out 1 h after feeding. The music was started 10 min before the beginning of the procedure and was continued for 20 min after the intervention. Except for the exposure as part of this study, no music was heard by the infants during the whole study period.

2.3. Measurements

The selected parameters were heart rate (beats per minute), oxygen saturation level (O₂Sat) and the infant's pain perception. The heart rate

and O₂Sat were recorded with a pulse oximeter, placed on the wrist and kept in place for the entire duration of the experiment. Pain perception was evaluated according to the Neonatal Infant Pain Scale (NIPS), a behavioural assessment tool for measurement of pain in preterm and full-term neonates [15] and expressed as a percentage of the total score. Measurements of the outcomes were taken 10 min before (T0), during (T1), and 10 (T2) and 20 (T3) minutes after the intervention. The same procedure was applied for the no-music exposure group. *There was no controlling inter-observer variation as all measurements were collected by a single investigator for the duration of the study.*

2.4. Statistical analysis

Data analyses were performed using SPSS 15.0 software. Means and standard deviation of the selected parameters were calculated for all groups to identify potential baseline differences. *Two-factor mixed design ANOVA were performed to compare heart rate, O₂Sat and NIPS scores at each predefined time point relative to the intervention assigned to each baby. A p value 0.05 was considered as statistically significant.*

3. Results

No significant differences were found at baseline in the clinical characteristics of the subjects, nor in all the selected outcome measures (Table 1).

Between T0 and T3 the mean heart rate varied from 112.35 to 110.7 bpm in the first group (Mozart's Sonata for two pianos K.448), from 119.8 to 110.8 bpm in the second group (Beethoven's Moonlight Sonata) and from 111.8 to 105.6 in the third group (heartbeat sound recordings). By contrast, the average heart rate varied from 124.2 to 128.75 in the control group (Fig. 1). Between T0 and T3 the average oxygen saturation varied from 98.75% to 99.7% in the first group

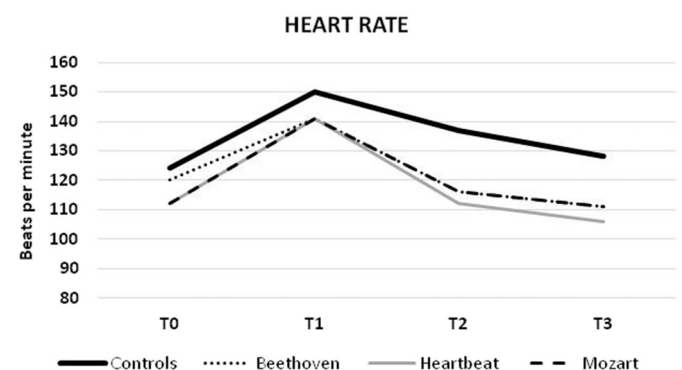


Fig. 1. Heart rate (beats per minute) values 10 min before (T0), during (T1), and 10 (T2) and 20 (T3) minutes after the intervention.

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