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ORIGINAL ARTICLE

No impact of parental singing during the neonatal period on cognition in preterm-born children at 2–3 years

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Abstract

Aim: Studies examining the long-term effects of neonatal music interventions on the cognition of children born preterm are scarce. We investigated whether a parental singing intervention before term age improves cognitive and language skills in preterm-born children.

Methods: In this longitudinal, two-country Singing Kangaroo, randomised controlled trial, 74 preterm infants were allocated to a singing intervention or control group. A certified music therapist supported parents of 48 infants in the intervention group to sing or hum during daily skin-to-skin care (Kangaroo care) from neonatal care until term age. Parents of 26 infants in the control group conducted standard Kangaroo care. At 2–3 years of corrected age, the cognitive and language skills were assessed with the Bayley Scales of Infant and Toddler Development, Third Edition.

Results: There were no significant differences in cognitive and language skills between the intervention and control groups at the follow-up. No associations between the amount of singing and the cognitive and language scores were found.

Conclusion: Parental singing intervention during the neonatal period, previously shown to have some beneficial short-term effects on auditory cortical response in

Abbreviations: Bayley-III, Bayley Scales of Infant and Toddler Development, Third Edition; GA, gestational age; NICU, neonatal intensive care unit; RCT, randomised controlled trial.

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preterm infants at term age, showed no significant long-term effects on cognition or language at 2–3 years of corrected age.

KEYWORDS
Bayley Scales of Infant and Toddler Development, neurodevelopment, parental singing, preterm infant, randomised controlled trial

1 | INTRODUCTION

Preterm-born children are at an elevated risk for adverse long-term neurocognitive development,[1,2] including impairments of speech and language.[1–4] The risk has been found to correlate negatively with gestational age (GA).[5] A Swedish national cohort[6] of extremely preterm infants (<27 GA), found a moderate-to-severe delay in cognition or language in 20% of the children measured with Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III). The composite scores in Bayley-III increased per gestational week by 2.5 points for cognitive and 3.6 points for language scores.[6]

During a critical period of brain development, preterm infants in the neonatal intensive care unit (NICU) are exposed to abnormal sensory experiences and simultaneously deprived of customary sensory experiences, which may affect their long-term development.[7–9] To promote optimal brain development after preterm birth, researchers have suggested that developmentally relevant stimuli exposure, such as parental speaking and singing, should be offered routinely during NICU care.[10,11]

Early maternal voice and music interventions in the NICU have shown beneficial short-term effects on physiological and behavioural stabilisation and brain development in preterm infants. Maternal singing has been found to improve preterm infants' autonomic stability[12–14] and decrease cardiorespiratory events, such as apnoea and bradycardia.[13] Recorded music[15,16] and infant-directed lullaby singing offered by a trained music therapist,[17] in turn, have been shown to support brain development by promoting functional network connectivity at term age. However, no effects of these music interventions on neurodevelopmental outcomes were found at 12 and 24 months of age.[18,19]

The long-term effects of early music interventions on cognition in preterm-born children have not been widely studied thus far. In this follow-up study of a two-country, Singing Kangaroo randomised controlled trial (RCT), we examined whether parental singing during the neonatal period would improve cognitive and language outcomes in preterm infants. The primary outcome of this trial was neural speech sound processing measured with auditory event-related potentials at term age. The results showed that parental singing during skin-to-skin care (Kangaroo care) improved preterm infants' change detection processing of speech sound changes in both cohorts.[20,21]

Here, we investigated the secondary outcome of the trial which was an assessment of cognition at 2–3 years of corrected age. We hypothesised that the preterm-born children in the singing intervention group would have better cognitive and language skills when compared to the control group. Furthermore, we hypothesised that the amount of singing would be positively associated with cognitive and language skills in the follow-up.

Key notes

- We examined whether music therapist-guided parental singing during the neonatal period would improve cognitive and language outcomes in preterm-born children at 2–3 years of corrected age.
- The before-term age parental singing intervention did not show significant long-term effects on cognition and language when compared to the control group.
- The amount of singing during the neonatal period was not associated with cognitive and language skills at the follow-up.

2 | METHODS

2.1 | Study design

The present study was a longitudinal, two-country Singing Kangaroo RCT, conducted in Finland between March 2013 and June 2021 and in Sweden between November 2014 and November 2020 respectively (Figure 1). The children were recruited at Jorvi Hospital and Kätilöopisto Maternity Hospital, Finland, or Karolinska/Danderyd and Sachsska Children's and Youth Hospital, Sweden. In Finland, the inclusion criteria were clinically stable infants born at 26–33 GA to Finnish-speaking parents. In Sweden, the inclusion criteria were clinically stable infants born before 32 GA to parents fluent in Swedish or English.

The families were randomised into a singing intervention or control group. In Finland, cluster randomisation was used in two hospitals to avoid contamination of the singing and control families. The Swedish infants were randomised with a 1:1 allocation ratio by throwing dice. A local music therapist (KK or PH) recruited the participating families, randomised them to the allocated groups and supported families with the intervention.

The Finnish and Swedish studies were approved by the Ethics Committee of the Hospital District of Helsinki and Uusimaa

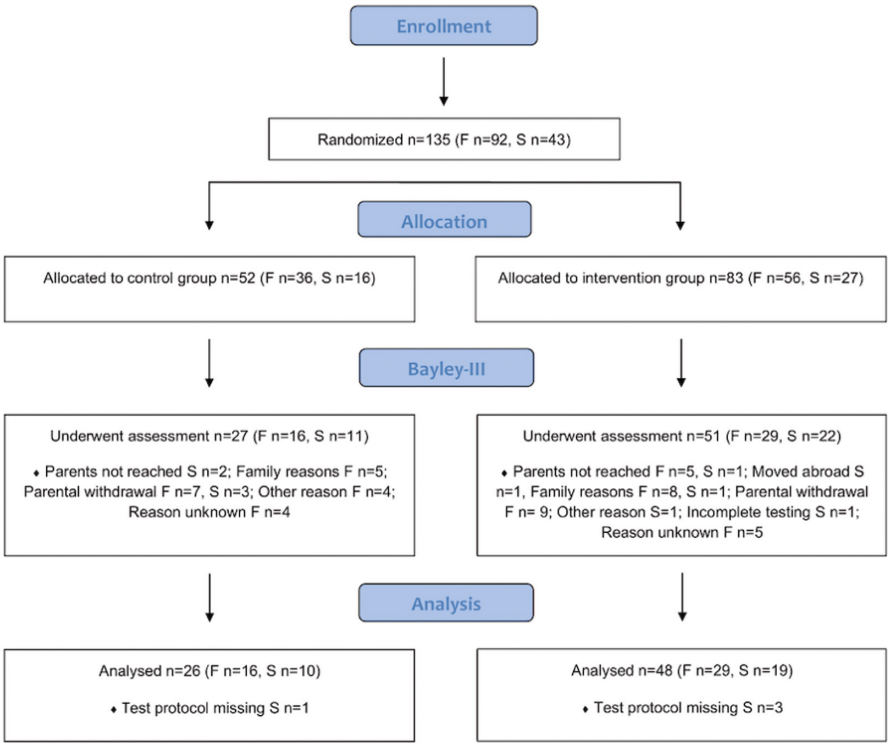

FIGURE 1 Flow diagram of the two-country, Singing Kangaroo RCT conducted in Finland (F) and Sweden (S).

(65/13/03/03/2012) and the Swedish Ethical Authority (registry number 2014/1318–31) respectively. The whole study was registered in Clinical Trials (ID IRB00003181SK) and conducted in line with the principles of the Declaration of Helsinki. The parents in both groups signed a written informed consent before entering the study.

2.2 | Participants

Overall, 135 preterm-born infants were recruited to the study, from which 83 were allocated to the singing intervention group and 52 to the control group. Of the children, 57 did not participate in the follow-up measurement. Hence, the cognitive and language skills of 51 children in the singing intervention group and 27 children in the control group were assessed with Bayley-III. The data of four children were missing, leaving data from 48 children in the singing intervention group and 26 children in the control group for final analysis (Table 1).

2.3 | Singing Kangaroo intervention

In Finland and Sweden, all parents conducted daily Kangaroo care as a standard care protocol. Neonatal care in the Nordic countries is strongly family centred. Parents are welcome to visit the ward anytime and they are involved in their infants' care from early on. The qualified music therapist supported and inspired parents in the intervention group to sing or hum to their infants during Kangaroo care in an infant-directed way. The preferred way to sing was in a lullaby style: with warm and tender voice timbre, slow tempo, repetitive melody or humming without words in synchronisation with the baby's breathing and movements. When applicable, the parents were encouraged to sing songs from their own culture and in their native language. The parents in the control group were neither encouraged to sing nor prevented from singing to their infants. Parents in both groups reported the daily amount of Kangaroo care and singing in diaries.

The music therapist (KK) met the Finnish parents in both groups only once at the beginning of the intervention, after which the parents conducted the intervention independently until term age (40 GA). The music therapist was available for the parents during the intervention in case any questions emerged. In Sweden, both groups met the music therapist (PH) twice a week for 4 consecutive weeks. The music therapy sessions with the intervention families were interactive and tailored to the family's needs. The sessions contained parents' musical background, sharing, singing songs and dialogue.[22] Families in the control group were provided psychosocial support on a general level.

2.4 | Outcome and data collection

The children were assessed with Bayley-III, which is a standardised individually administered test to assess development in children aged 1–42 months.[23] Bayley-III is widely used in research when evaluating neurodevelopment in preterm-born children worldwide.[24,25] The Bayley-III consists of five domains: cognition, language (including

TABLE 1 Background characteristics of the participants who attended the Bayley-III assessment. Data presented as median and range, or as *n* (%).

	Singing intervention (*n* = 48)	Preterm controls (*n* = 26)	*p*-Value
Background characteristics			
Male	27 (56.3%)	14 (53.8%)	1.000
Multiparity	11 (22.9%)	2 (7.7%)	0.122
Monolinguals[a]	40 (87.0%)	19 (76.0%)	0.322
Maternal education level[b]			0.286
Compulsory school	0 (0%)	1 (4.0%)	
Secondary school	9 (20.0%)	7 (28.0%)	
Tertiary school	36 (80.0%)	17 (68.0%)	
Paternal education level[c]			0.741
Compulsory school	7 (17.9%)	3 (13.6%)	
Secondary school	7 (17.9%)	6 (27.3%)	
Tertiary school	25 (64.1%)	13 (59.1%)	
Corrected age at Bayley-III assessment, months	26.5 (22.9–37.6)	26.1 (24.0–38.2)	0.781
Clinical risk factors			
Gestational age at birth, weeks[d]	30.0 (24.0–33.3)	30.1 (25.7–34.1)	0.522
Birth weight, g[e]	1263.0 (485–2800)	1330.0 (815–1880)	0.610
Small for gestational age[e,f]	9 (19.6%)	6 (23.1%)	0.725
Intervention			
Duration of singing, days[g]	26.0 (14–28)	0 (0–28)	<0.001
Amount of singing, hours[g]	18.9 (3.6–83.8)	0 (0–94.1)	<0.001

Note: *p*-Values were derived from exact χ^2 tests and Mann–Whitney *U* tests.

[a]Missing data for two children in the intervention group and one child in the control group.

[b]Missing maternal education level for three children in the intervention group and one child in the control group.

[c]Missing paternal education level for nine children in the intervention group and four children in the control group.

[d]Missing gestational age for one child in the intervention group.

[e]Missing weight for two children in the intervention group.

[f]Weight below the 10th percentile for the gestational age.

[g]Missing data for nine participants in the intervention group.

expressive and receptive communication), motor (including gross and fine motor), social–emotional and adaptive behaviour. In the present study, only the cognition and language domains were examined as parental singing was expected to be associated with these outcomes. Age-standardised subtest scaled scores with a mean of 10 (standard deviation 3) were used. Higher scores indicate better performance. Both the Finnish and Swedish versions of the Bayley-III use the US norms.[23]

In Finland, the children were assessed in the Department of Psychology and Logopedics, Faculty of Medicine, the University of Helsinki. The assessments were conducted by undergraduate students under the supervision of a licensed psychologist (EP). The Swedish cohort was tested by clinical psychologists at the neonatal follow-up clinics in Stockholm. In both countries, the assessments were completed on one occasion, and the psychologists were blinded to group allocation.

2.5 | Statistical analysis

Statistical analyses were conducted using SPSS version 28.0 (IBM Corporation). Before the main analyses, background characteristics between the intervention and control groups were compared using the exact chi-square and Mann–Whitney *U* tests. The total singing time and intervention duration were calculated from the parent diaries. The effect of the neonatal parental singing intervention on the Bayley-III scaled scores was examined using linear regression with group, sex, GA and maternal education of two levels: compulsory or secondary school versus tertiary school. Missing values were excluded pairwise. The effects of total singing time and intervention duration up until 28 days on the outcome variables were assessed with partial correlation analyses controlled for sex, GA, maternal education and country of birth. Considering the drop-out rate of the study, we furthermore analysed whether the available background characteristics

TABLE 2 The Bayley-III subtest scaled scores in the two groups.

	Intervention ($n=48$)	Control ($n=26$)	*B* (SE)	*β*	*p*-Value
Bayley-III subtests					
Cognitive	10.5 (2.7) 1–18	10.0 (3.2) 2–19	0.358 (0.645)	0.061	0.581
Expressive communication	9.9 (3.3) 1–15	10.0 (3.1) 2–15	−0.206 (0.824)	−0.030	0.804
Receptive communication	11.3 (2.9) 1–16	11.1 (2.8) 5–16	0.209 (0.686)	0.036	0.762

Note: Mean (standard deviation) and range are presented. *p*-Values are derived from a linear regression adjusted for sex, gestational age at birth and maternal education level (two levels).

(GA, birth weight) of the nonparticipants differed from those of the participants country-wise using the Mann–Whitney *U* test.

3 | RESULTS

The median age at Bayley-III assessment was 26.5 months of corrected age for the 48 children in the singing intervention group (range 22.9–37.6 months; mean 27.9 months; standard deviation 3.9 months) and 26.1 months of corrected age for the 26 children in the control group (range 24.0–38.2 months; mean 27.8 months; standard deviation 4.2 months). The intervention and control groups were comparable regarding background characteristics, including age, sex, multiparity, multilingualism, parental education level and clinical risk factors, including GA at birth, birth weight and the number of children born small for GA. According to the diaries, parents in both groups sang during the study period, except for some families in the control group who did not sing. The intervention group had, on a group level, a significantly longer singing duration and more singing hours compared to the control group (Table 1).

In the linear regression analyses with group (intervention vs. control group), sex, GA and maternal education, group allocation did not predict performance in the cognitive, expressive or receptive communication subtests of the Bayley-III (Table 2; all $p>0.05$). When controlled for sex, GA, maternal education and country of birth, singing time or intervention duration was not significantly correlated with the Bayley-III scores (Table 3; all $p>0.05$).

The dropout analysis revealed that GA at birth did not differ between the participants and nonparticipants in Finland, $p=0.136$ ($n=47$, median 31.4 GA for nonparticipants; $n=44$, median 30.7 GA for participants), or in Sweden, $p=0.664$ ($n=10$, median 29.6 GA for nonparticipants; $n=29$, median 29.3 GA for participants). However, birth weight differed between participants and nonparticipants in Finland, $p=0.046$ ($n=47$, median 1.60 kg for nonparticipants; $n=43$, median 1.46 kg for participants).

4 | DISCUSSION

The present study examined the effects of parental singing during neonatal care on cognitive and language skills in preterm-born children at 2–3 years. In the primary outcome analysis of the RCT, the results showed that parental singing improved neural change detection of speech sounds at term age.[20,21] However, this secondary outcome analysis showed no significant differences in the cognitive and language skills between the singing and control groups at the follow-up. The amount of singing was neither associated with the Bayley-III cognitive nor language scores.

Our findings were in line with other recent studies that showed similarly beneficial short-term effects of neonatal music interventions at term age[15–17] without long-term benefits.[18,19] These results imply that early music interventions may not improve long-term outcomes in preterm-born children, proposing more sustained interventions to be implemented and investigated. However, it should be considered that the sensitivity of Bayley-III has been criticised.[25] The effects of parental singing may also not be visible at this stage of development. The impact could be seen later in more sensitive measures of cognition and language or other outcomes, such as socio-emotional development.

In our data, both groups had age-expected Bayley-III scores. The level of cognitive and language development was similar to a Swedish follow-up study,[6] showing an average level of development in preterm-born children at 2.5 years of age. It should be noted, however, that in our study, most of the parents had either secondary or tertiary education, and all the parents conducted Kangaroo care before term age, offering the children protective factors for development. It could be more beneficial to focus long-term music interventions on families with fewer protective factors.

Music exposure is not only relevant in the neonatal period but various music activities are also prevalent in childcare throughout childhood. Virtala and Partanen[26] proposed that musical interaction between the caretaker and the child can have broad benefits for child development by promoting auditory and language skills. Interactive music activities at home have been associated with improved neural sound discrimination, attention and communication skills in children born at term.[27,28] Furthermore, music playschool has been shown to promote linguistic skills in typically developing children.[29] Future studies should therefore focus on investigating whether such interactive early childhood music interventions could promote cognitive outcomes also in at-risk children. Other factors, such as parental well-being and parent–infant interaction, are known to be closely connected with the neurodevelopment of

TABLE 3 Correlation coefficients between the intervention variables and Bayley-III scores.

	Cognitive subtest	Expressive communication	Receptive communication
Intervention duration, days	−0.152	−0.147	−0.042
Amount of singing, h	−0.090	−0.137	−0.094

Note: Partial correlation adjusted for sex, GA, maternal education and country of birth.

preterm-born children.[7,30] For these reasons, interactive music and singing interventions that focus on creating positive mutual moments and strengthening parent–infant interaction and parental sensitivity should be taken into consideration when planning future early childhood interventions.

4.1 | Limitations

The assessments of the children were originally intended to be carried out at 24 ± 3 months of corrected age. Due to scheduling difficulties, some children were tested at a later age. Also, some assessments were postponed due to the COVID-19 pandemic, which affected the participation rate and delayed test schedules. However, as the Bayley-III is an age-standardised test, all results were comparable despite the prolonged time window. Music activities during childhood may impact development. Unfortunately, we did not collect data about musical exposure after term age in both countries. For this reason, the associations between early childhood music activities and Bayley-III performance in this two-country sample could not be investigated.

5 | CONCLUSION

Even though parental singing during the neonatal period showed beneficial short-term effects on auditory change detection, this secondary outcome analysis of the Singing Kangaroo RCT showed no long-term effects on cognitive and language outcomes in preterm-born children at 2–3 years of age. Whether a neonatal music intervention influences language development in this at-risk population should be assessed in a larger study, when linguistic skills have developed and more robust assessments are available.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

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