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Musical intervention and food preferences in girls born with lower birth weight

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ABSTRACT

Background: Children born after intrauterine growth restriction (IUGR), especially girls, show an increased intake of palatable foods in several developmental stages, which likely contributes to their increased risk for obesity later. Recently, neuroimaging studies suggested that musical exposure activates the mesolimbic region, which is also involved in the processing of food rewards.
Aims: We evaluated the impact of musical intervention in mother/infant pairs on feeding behavior during childhood with regard to birth weight.
Study Design: Cohort study.
Subjects: A total of 28 children exposed to a structured musical intervention in early life were invited for an anthropometric and nutritional evaluation, and were compared to a communitarian age-matched sample.
Outcome Measures: A series of general linear models adjusted for socioeconomic status and maternal education were constructed to evaluate the interaction between music exposure, birth weight, and sex on the consumption of different types of foods, measured using a food frequency questionnaire.
Results: There was an interaction between birth weight, sex, and musical intervention on the consumption of sugar during childhood (Wald = 7.87, $df = 2$, $p = 0.02$); control participants consumed more sugar as birth weight decreased ($B = -8.673$, $p < 0.0001$). No such effect was found for the girls exposed to musical intervention ($B = 3.352$, $p = 0.15$) or for boys (exposed $B = 2.870$, $p = 0.44$; non-exposed $B = 3.706$, $p = 0.236$). The absence of other effects suggests that this finding is specific for sweet foods.
Conclusion: Early music intervention in mother/infant pairs may moderate the effects of IUGR on palatable food preference in girls.

1. Introduction

It is well known that fetal and/or perinatal adversity permanently affects the physiology of many systems, altering the risk for adult diseases [1]. Individuals with low birth weight have an increased prevalence of cardiovascular diseases [2], type II diabetes [3], overweight [4,5], and mental health disorders [6,7]. IUGR (intrauterine growth restriction) has been associated with increased preference for foods rich in sugar or fat in adulthood [8–12] and in other moments during development [13,14]. As these behaviors are profoundly linked to overweight and obesity [15–17], it is important to develop interventions altering the way IUGR individuals behave towards food. However, as these phenotypic characteristics in IUGR children are detectable from their very first day of life [18], it is likely that an effective intervention to reverse such behaviors should target early developmental stages.

The excessive intake of highly palatable foods has been related to the activity of dopamine (DA) modulated circuits in the brain [15,19–22]. Studies using rat models of IUGR demonstrated specific alterations in DA circuitry in several regions of the mesocorticolimbic pathway [23,24], suggesting that this mechanism could be involved in the chronic over-consumption of palatable/rewarding foods, resulting in poor regulation of body weight in IUGR individuals. Bearing this neurochemical basis in mind, we hypothesized that an intervention targeting this system would be relevant to the IUGR population.

Intriguingly, the intense emotion and pleasure elicited by listening to music is associated with DA activity in the mesolimbic reward system (dorsal and ventral striatum) [25–28]. PET studies also suggest that listening to music activates the nucleus accumbens [29–31]. Moreover, musical pleasure influenced performance in a reinforcement learning task [32] and affected food intake and meal duration [33], showing

Abbreviations: ANCOVA, analysis of covariance; ANOVA, analysis of variance; BMI, body mass index; BWR, birth weight ratio; CEBQ, Child Eating Behavior Questionnaire; DA, dopamine; FFQ, Food Frequency Questionnaire; GLM, general linear model; IUGR, intrauterine growth restriction; PEMB, Project "Music for Babies"; RAF, Home Environment Resources Scale.

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that behavioral activities related to the functioning of this neural pathway were influenced by the exposure to music. The present study is a continuation of our series of studies investigating the existence and role of altered feeding behavior and food preferences in IUGR individuals over their life course; in this work, we explored the long-term effects of exposure to a structured music intervention offered to mother/infant pairs on behavioral and nutritional outcomes during childhood. We hypothesized that music exposure during a critical period such as the first 2 years would persistently program the functioning of the mesolimbic DA system and modify food preferences in children, especially as their birth weight decreases.

2. Methods

This cohort study used a convenience sample of 0- to 24-month-old children who participated in a program offered by our University (*Projeto de Extensão Música para Bebês - PEMB UFRGS*—"Music for Babies"), between 2004 and 2007. From 2012 to 2014, participants were contacted and invited for an evaluation in our clinical research center, along with a group of controls. The final sample included 28 children exposed to musical intervention early in life, and 28 age-matched controls recruited from the sanitary district area of the Hospital's Primary Care Unit. The families that participated in the Music for Babies project (PEMB) were recruited through telephonic contact, as their information was available at the School of Music in our University. Families from the control group were also invited by phone or directly during their medical appointments at the Primary Care Unit. At the end of data collection, children from both groups were between 5 and 9 years of age. None of the recruited children had neuromotor disabilities, congenital diseases, or states that could influence food choices and feeding behavior.

2.1. Intervention

From 1999 to 2010, our University offered PEMB to the community. Families signed up for the course via electronic, printed, or digital media, or by personal indication. The classes were held in classrooms of the UFRGS Art Institute, and involved the project coordinator, two invited teachers, and interns. Each semester, 70 infant–caregiver pairs participated in these classes, which included up to 10 pairs and were offered at 4 different levels according to the infants' age at enrollment (0–6 months, 7–12 months, 13–18 months, or 19–24 months). Each pair could participate for 1–4 semesters.

The PEMB (directed by Prof. Esther Beyer [*in memoriam*]) focused on music education and covered the subareas of art, language, and technology, through studies on the specificity of knowledge construction/meaningfulness in musical language and its implications for education. The proposed activities aimed at the integral development of the child, allowing neurological, emotional, motor, and linguistic progress and sought to contribute to and strengthen the development of the bond between babies and their parents or guardians through music. The musical education program for all age groups consisted of a 50-min weekly class using a pre-established routine of musical activities: singing reception; music appreciation, dance, and rounds; storytelling; songs with small choreographies; exploration of musical materials; relaxation; and farewell song. The repertoire included popular children's songs, children's folklore, and classical music, either played live (e.g. using the piano) or through recordings. The routine was always maintained, but the songs were selected according to age group. Classes were directed to the infant–caregiver pair (maximum 10 pairs in each class) who participated in 15–18 meetings each semester.

2.2. Data collection (2012–2014)

For the data collection, children came accompanied by their caregivers for a single visit to the Clinical Research Center (HCPA), where informed consent and acceptance forms were signed. The following questionnaires were applied for sample description purposes:

(a) Standard questionnaire: This questionnaire included questions about the child's birth weight and birth status; former participation or not in PEMB. It also contained queries about music lessons, dance, and rhythmic gymnastics that the child could have attended from 2 years old to the current age; questions about age of entrance into kindergarten and elementary school, professional activity of the caregiver, and presence or absence of music professionals in the immediate family. In this study, the definition of IUGR was based on the birth weight ratio (BWR), which is the ratio between the infant birth weight and the sex-specific mean birth weight for each gestational age for the local population. Children were classified as IUGR if they had a BWR <0.85, but this information could also be used as a continuous variable [34].
(b) Socioeconomic questionnaire: Socioeconomic variables were evaluated according to the Brazil Economic Classification Criterion in a pre-coded questionnaire administered to caregivers. This questionnaire enables the identification of socioeconomic class through questioning about the presence and quantity of certain household items [35].
(c) The Home Environment Resources Scale (RAF): The RAF assesses factors in the family environment that may contribute to learning in the elementary school years, in three areas—resources that promote proximal processes (e.g. if parents read or play with the children at home), activities that signal stability in family life (e.g. if the child has a routine time for having lunch, going to bed), and parenting practices that promote family–school connection (e.g. if there is somebody at home that supervises homework) [36]. The higher the score, the better the environment in each of the three domains. This questionnaire was used to obtain more information about the children's history during the period between participation in PEMB and the time of the survey interview.

The outcome variables were as follows:

(a) Current Food Frequency Questionnaire (FFQ): This questionnaire assesses the usual dietary intake of the children. The FFQ used in this study consists of 93 foods, and household measures were demonstrated to families to facilitate the understanding of the quantities set. The chemical composition of food tables and information obtained through labels were used to estimate the consumption of energy, carbohydrates, proteins, and lipids [37]. The foods listed in this FFQ were classified into the following food groups: I—baked goods and cereals, legumes, roots, tubers, and their derivates; II—vegetables; III—fruits, juices, nectars, and soft drinks; IV—milk and milk products; V—meat and eggs; VI—oils, fats, and oilseeds; and VII—sugars, sweets, and goodies. The FFQ contains 8 response categories ranging from "never or rarely" to "more than 3 times a day". Both macro and micronutrients, as well as the food groups, were analyzed.
(b) Children Eating Behavior Questionnaire (CEBQ): This questionnaire assesses children's eating styles that are related to risk for obesity [38]. It consists of 35 items evaluating 8 dimensions: satiety responsiveness, slowness in eating, food fussiness, food responsiveness, food enjoyment, desire to drink, and emotional over- and undereating.
(c) Anthropometrics: Children were weighed wearing a standard hospital gown, using a hospital scale. Standing height, without shoes, was measured (to the nearest 0.1 cm) with the use of a stadiometer. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2), and WHO *z*-score standards were used for analysis [39]. Head