



Neural correlates of music-syntactic processing in two-year old children



Sebastian Jentschke^{a,*}, Angela D. Friederici^b, Stefan Koelsch^a

^a Freie Universität Berlin, Cluster “Languages of Emotion”, Berlin, Germany

^b Max Planck Institute for Human Cognitive and Brain Sciences, Department of Neuropsychology, Leipzig, Germany

ARTICLE INFO

Article history:

Received 30 September 2013

Received in revised form 23 April 2014

Accepted 23 April 2014

Keywords:

Music perception

Musical syntax

Neurophysiology

ERPs

EEG

Infants (30-month-olds)

ABSTRACT

Music is a basic and ubiquitous socio-cognitive domain. However, our understanding of the time course of the development of music perception, particularly regarding implicit knowledge of music-syntactic regularities, remains contradictory and incomplete. Some authors assume that the acquisition of knowledge about these regularities lasts until late childhood, but there is also evidence for the presence of such knowledge in four- and five-year-olds. To explore whether such knowledge is already present in younger children, we tested whether 30-month-olds ($N=62$) show neurophysiological responses to music-syntactically irregular harmonies. We observed an early right anterior negativity in response to both irregular in-key and out-of-key chords. The N5, a brain response usually present in older children and adults, was not observed, indicating that processes of harmonic integration (as reflected in the N5) are still in development in this age group. In conclusion, our results indicate that 30-month-olds already have acquired implicit knowledge of complex harmonic music-syntactic regularities and process musical information according to this knowledge.

© 2014 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

1. Introduction

Music is one of the oldest, most basic, and ubiquitous socio-cognitive domains of the human species (cf., e.g., Fitch, 2006; Huron, 2001; Koelsch, 2012). In early childhood, musical communication (such as maternal singing) has been proposed to play a major role in the emotional, cognitive, and social development of children (cf., e.g., Gerry et al., 2012; Trehub, 2003). Responsiveness to infant-directed singing appears to be inborn (Masataka, 1999),

and infants demonstrate more sustained attentiveness and engagement during maternal singing than maternal speaking (Nakata and Trehub, 2004; Trehub, 2003). Music also has an arousal-modulating effect, leading to changes in cortisol levels in 6-month-olds (Shenfield et al., 2003) and promoting reciprocal emotional ties (for a review, see, e.g., Trehub and Nakata, 2001).

Musical sequences contain perceptually discrete elements (tones and chords) that unfold in time and that are concatenated according to music-syntactic regularities into sequences to form melodic and harmonic structures. In order to fully appreciate harmonic sequences, knowledge about such regularities must be acquired (for reviews, see, e.g., Stalinski and Schellenberg, 2012; Trainor and Corrigan, 2010). It has been hypothesised that the order of knowledge acquisition about different aspects of music is related to the degree of universality (Hannon and Trainor, 2007).

* Corresponding author at: Cluster “Languages of Emotion”, Freie Universität Berlin, Habelschwerdter Allee 45, 14195 Berlin, Germany. Tel.: +49 30 838 57855; fax: +49 30 838 57519.

E-mail addresses: Sebastian.Jentschke@fu-berlin.de, Sebastian.Jentschke@gmail.com (S. Jentschke), angelafr@cbs.mpg.de (A.D. Friederici), koelsch@cbs.mpg.de (S. Koelsch).

Sensitivity to consonance or dissonance is regarded universal and emerges earliest, suggesting processing constraints in the auditory system (cf., e.g., [Chiandetti and Vallortigara, 2011](#); [Fishman et al., 2001](#); [Fritz et al., 2009](#); [Trainor et al., 2002](#)). Knowledge about which pitches belong to a particular scale (i.e., key membership) develops next: in Western tonal music, an octave is divided into 12 pitches, which constitute the so-called chromatic scale. Smaller subsets of these 12 pitches form the diatonic scales (e.g., the major scale). Behavioural studies with melodies as stimuli indicate that knowledge of key membership is established in 5-year-olds ([Trainor and Trehub, 1994](#)). Musical chords refer to several pitches sounding simultaneously. The succession of chords follows regularities that refer to local as well as non-local dependencies. Regularities regarding local dependencies have been described by the theory of harmony, and can be demonstrated using statistical analyses of transition probabilities in music corpora ([Rohrmeier and Cross, 2008](#)). Regularities regarding non-local dependencies have been described by generative theories of (tonal) music (cf. [Lerdahl and Jackendoff, 1996](#); [Rohrmeier, 2011](#)). The acquisition of these music-syntactic regularities by exposure to music represents a complex learning problem which is solved by employing statistical learning in concert with other learning mechanisms (cf. [McMullen and Saffran, 2004](#); [McMullen Jonaitis and Saffran, 2009](#); [Saffran et al., 1999](#); [Rohrmeier and Rebuschat, 2012](#)).

It was previously assumed, that “sensitivity to culture-specific details of tonal and harmonic structure seems to emerge between 5 and 7 years of age” ([Trehub, 2003, p. 670](#)). This assumption was built upon results from several behavioural studies exploring how this knowledge is acquired during development: most of these experiments ([Krumhansl and Keil, 1982](#); [Trainor and Trehub, 1992, 1994](#)) used short melodies to explore knowledge about tonal and harmonic music-syntactic regularities. In [Krumhansl and Keil \(1982\)](#) sequences of six tones were presented, the first four tones (C – E – C – G) established a tonal context followed by two tones. These two tones either belonged to the diatonic scale or were two non-diatonic (out-of-key) tones. Tones from the diatonic scale were further categorised into tonics (C), belonging to the tonic triad (C – E – G), or not belonging to the tonic triad (D – F – A – B). Six possible combinations of the last two tones were evaluated: (a) both tonics, (b) both belonging to the triad, (c) first belonging to the triad, second not belonging to the triad, (d) first not belonging to the triad, second belonging to the triad, (e) both not belonging to the triad, and (f) both non-diatonic. Children judged whether these tones sounded “good” or “bad”. [Krumhansl and Keil \(1982\)](#) demonstrated that, with increasing age, children become capable of differentiating (i.e., giving different ratings to) the six conditions listed above. Whereas 6–7-year-olds gave different preference ratings only to diatonic vs. non-diatonic probe tones, older 8–9-year-olds in addition gave different preference ratings for diatonic continuations that either belonged to the tonic triad or not. Adults gave different ratings to all six conditions. This was taken as evidence that the 6–7-year-olds had acquired knowledge about scale membership, whereas 8–9-year-olds had additional knowledge, which

tones belonged to the tonic triad (and are therefore most stable within the tonal system). [Trainor and Trehub \(1992, 1994\)](#) used short melodies of 10 tones. In some, the 6th was replaced by another tone. The replacement tones either belonged to the same scale (diatonic change) or not (non-diatonic change); in [Trainor and Trehub \(1994\)](#) the diatonic change was further divided into a within-harmony and an out-of-harmony change (the out-of-harmony condition represents a change to another syntactically correct in-key harmony, and the within-harmony condition a change to another tone of the same syntactically correct in-key harmony). Participants were trained to signal if they detected a change in comparison to the standard melody, using a go/no-go head turn procedure ([Trainor and Trehub, 1992](#)), or by raising their hand ([Trainor and Trehub, 1994](#)). In one of these studies ([Trainor and Trehub, 1992](#)), 8- to 9-month-old infants and adults were tested. Whereas adults detected non-diatonic (out-of-key) more readily than diatonic (within-key) changes, infants detected both changes equally well, indicating that the performance in infants was not affected by knowledge about key membership. The other study ([Trainor and Trehub, 1994](#)) compared 5 and 7 year old children to adults. It was revealed that all age groups detected replacement tones that did not belong to the established key (non-diatonic change) more easily than those which belonged to the same key, indicating that all age groups had acquired sufficient knowledge about which tones constitute a scale. Furthermore, adults and 7-year-olds also performed better on the out-of-harmony than on the within-harmony change, suggesting that 5-year-olds were not capable of differentiating as well as 7-year-olds which tones belong to a chord function.

More recent behavioural and neurophysiological evidence indicates that already 4–5-year old children possess some implicit knowledge about harmonic regularities. [Corrigall and Trainor \(2010\)](#) demonstrated both knowledge of key membership as well as of harmonic regularity in this age group, using a short well-known melody (Twinkle, Twinkle Little Star), its harmonised version, and short sequences of chords (which were derived from the harmonisation of the melody but unknown to the children). The last tone of the melody, the last chord in the harmonised version, or the last chord of the chord sequences was modified. Children compared the modified to the unmodified sequences and gave preference ratings. We focus on the chord sequences which are most comparable to the stimuli of the present experiment (cf. Fig. 4 in [Corrigall and Trainor, 2010](#)). In response to these chord sequences, the highest preference ratings were given to the standard (unmodified) version which ended on a (syntactically correct) tonic chord in root position (following a dominant without a fifth). The second highest ratings were given to versions that ended on a tonic presented as a six–four chord (“within-harmony”, which is harmonically less regular at the end of a chord progression than a tonic in root position). The third highest ratings were given to versions that ended on a supertonic without a fifth (“out-of-harmony”), which is less likely to occur after a dominant than a tonic, and which is syntactically incorrect at the end of a chord progression. The lowest ratings were given for the sequences that ended on a chord that left

Download English Version:

<https://daneshyari.com/en/article/4316640>

Download Persian Version:

<https://daneshyari.com/article/4316640>

[Daneshyari.com](https://daneshyari.com)