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Do newborn infants sense the beat?

Henkjan Honing[a], Olivia Ladinig[a], Gábor P. Háden[b], & István Winkler[b]

[a]*ILLC | CSCA, Universiteit van Amsterdam*

[b]*Institute for Psychology, Hungarian Academy of Sciences*

honing@uva.nl; http://www.musiccognition.nl/newborns/

ABSTRACT

I. BACKGROUND

Music is present in some form in all human cultures. Sensitivity to various elements of music appears quite early on in infancy with understanding and appreciation of music emerging later through interaction between developing perceptual capabilities and cultural influence. Whereas there is already some information regarding spectral processing abilities of newborn infants, little is known about how they process rhythm. The ability to sense beat (a regular pulse in an auditory signal; termed '*tactus'* in music theory); helps individuals to synchronize their movements with each other, such as necessary for dancing or producing music together. While beat induction would be very difficult to assess in newborns using behavioral techniques, it is possible to measure electrical brain responses to sounds (auditory event related brain potentials, ERP), even in sleeping babies.

II. AIMS

In order to understand how humans can learn to understand music, we need to discover what perceptual capabilities infants are born with. Theorists are divided on the issue whether the processing of beat is innate or learned. The goal of the current study was to test beat induction in sleeping newborn babies, by assessing whether or not the neonate auditory system forms expectation for the onset (downbeat) of the cycle in a regular rhythmic sound sequence.

III. METHODS

We presented 14 healthy sleeping neonates with sound sequences based on a typical two-measure rock drum accompaniment pattern (S1) composed of snare, bass and hi-hat spanning eight equally spaced (isochronous) positions. Four further variants of the S1 pattern (S2-S4 and D) were created by omitting sounds in different positions. The omissions in S2, S3, and S4 do not break the rhythm when presented in random sequences of S1-S4 linked together, because the omitted sounds are at the lowest level of the metrical hierarchy of this rhythm and, therefore, perceptually less salient. The four strictly metrical sound patterns (S1-S4; standard) made up the majority of the patterns in the sequences. Occasionally, the D pattern was delivered in which the downbeat was omitted. A control sequence repeating the D pattern 100% of the time was also delivered ("deviant-control").

Sleeping newborn infant participating in the experiment. The rhythm was delivered to the baby through self-adhesive ear-couplers at a low volume while electrical brain activity was measured with electrodes attached to the scalp and the face. Measurements followed feeding and lasted for about 20 minutes. The mother of the baby was present during the procedure *(Photo courtesy of Gabor Stefanics, MTAPI, Budapest).*

IV. RESULTS

The results demonstrate that violating the beat of a rhythmic sound sequence is detected by the brain of newborn infants. We show that newborn infants develop expectation for the onset of rhythmic cycles (the downbeat), even when it is not marked by stress or other distinguishing spectral features. Omitting the downbeat elicits brain activity associated with violating sensory expectations. So it appears that the capability of detecting beat in rhythmic sound sequences is already functional at birth (Honing *et al.*, 2009; Winkler *et al.*, 2009).

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