Music in our life span: learning and rehabilitation

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IOP Havana, Cuba 2016

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Music – why?

- For fun and enjoyment
- For social cohesion and bonding
- For emotion regulation
- For regulation of vigilance
  - Physical exercise vs. lullabies

Music – why?

- For fun and enjoyment
- For social cohesion and bonding
- For emotion regulation
- For regulation of vigilance

- Neural encoding and cognitive benefits of music in learning and re-learning?

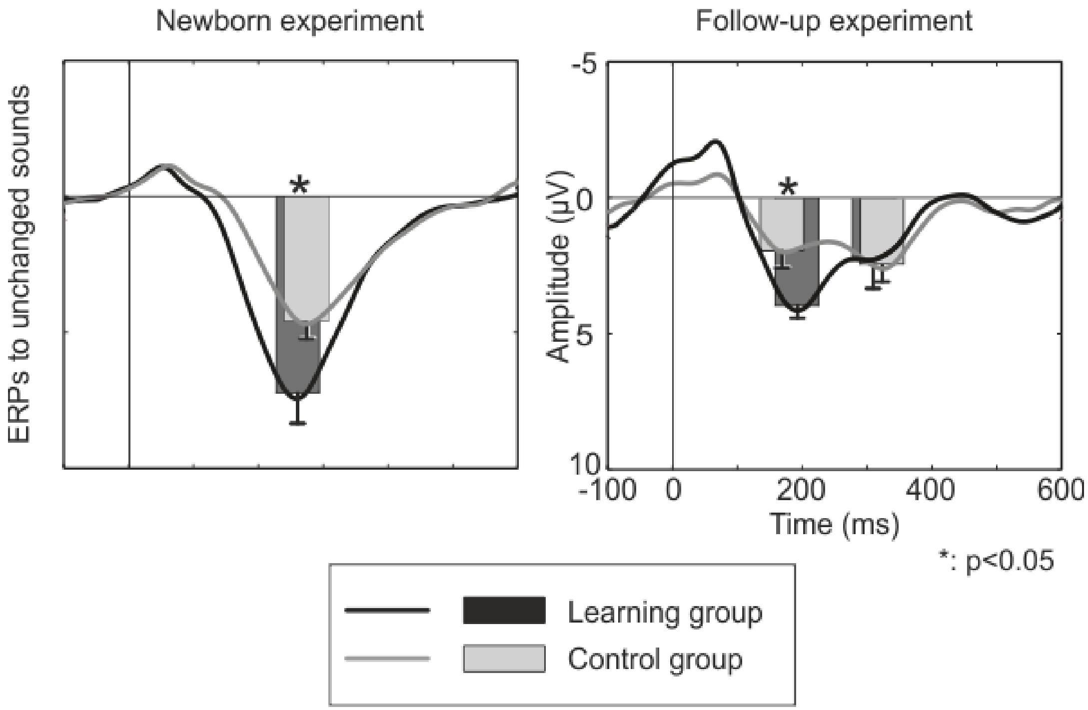
Auditory learning before birth?

- Fetuses hear during the last trimester of pregnancy
  - The voices of the parents
  - Native language of the family
  - Melodies or environmental sounds

- In our studies
  - Pregnant women were given a CD. They were instructed to play the sounds daily from the last trimester of pregnancy until giving birth.
  - After birth the newborn’s EEG was recorded and brain activity elicited by the sounds was compared to that of naïve controls.

Partanen et al. (2013) PLOS ONE
Partanen et al. (2013) PNAS

Neural correlates of fetal music learning?



Mothers listened for the last trimester of pregnancy ”Twinkle twinkle little star”

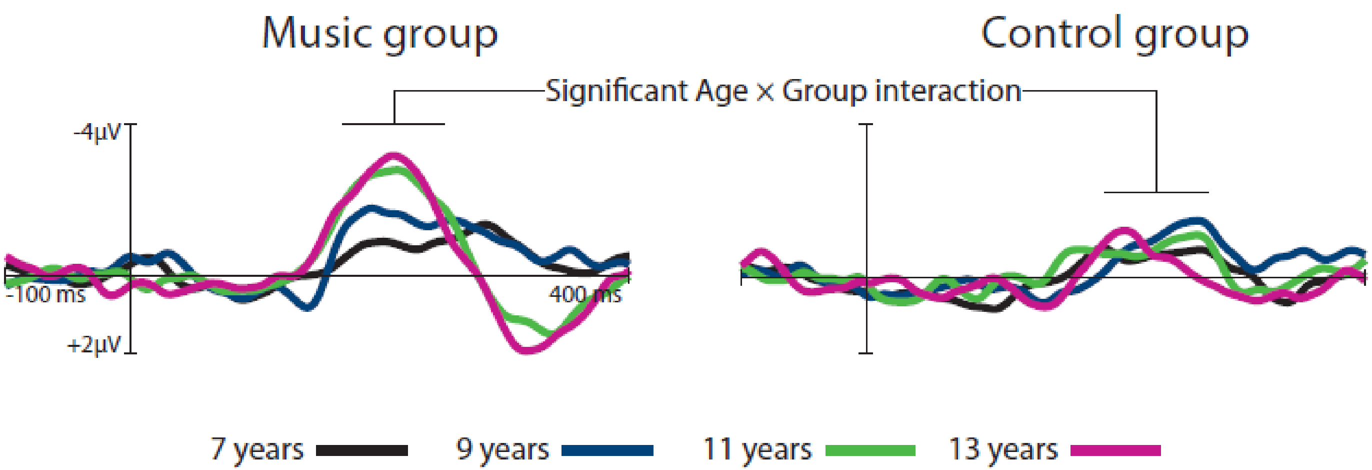
Both at birth and at the age of 4 months, the newborns exposed to the melody had stronger neural responses to unchanged notes.

The responses were larger the more often fetuses were exposed to the melody before birth.

Partanen et al. (2013) PLOS ONE
See also Partanen et al. (2013) PNAS for speech sound learning

Egg and Chicken – Chicken and Egg: when does brain plasticity play a role in musical development?

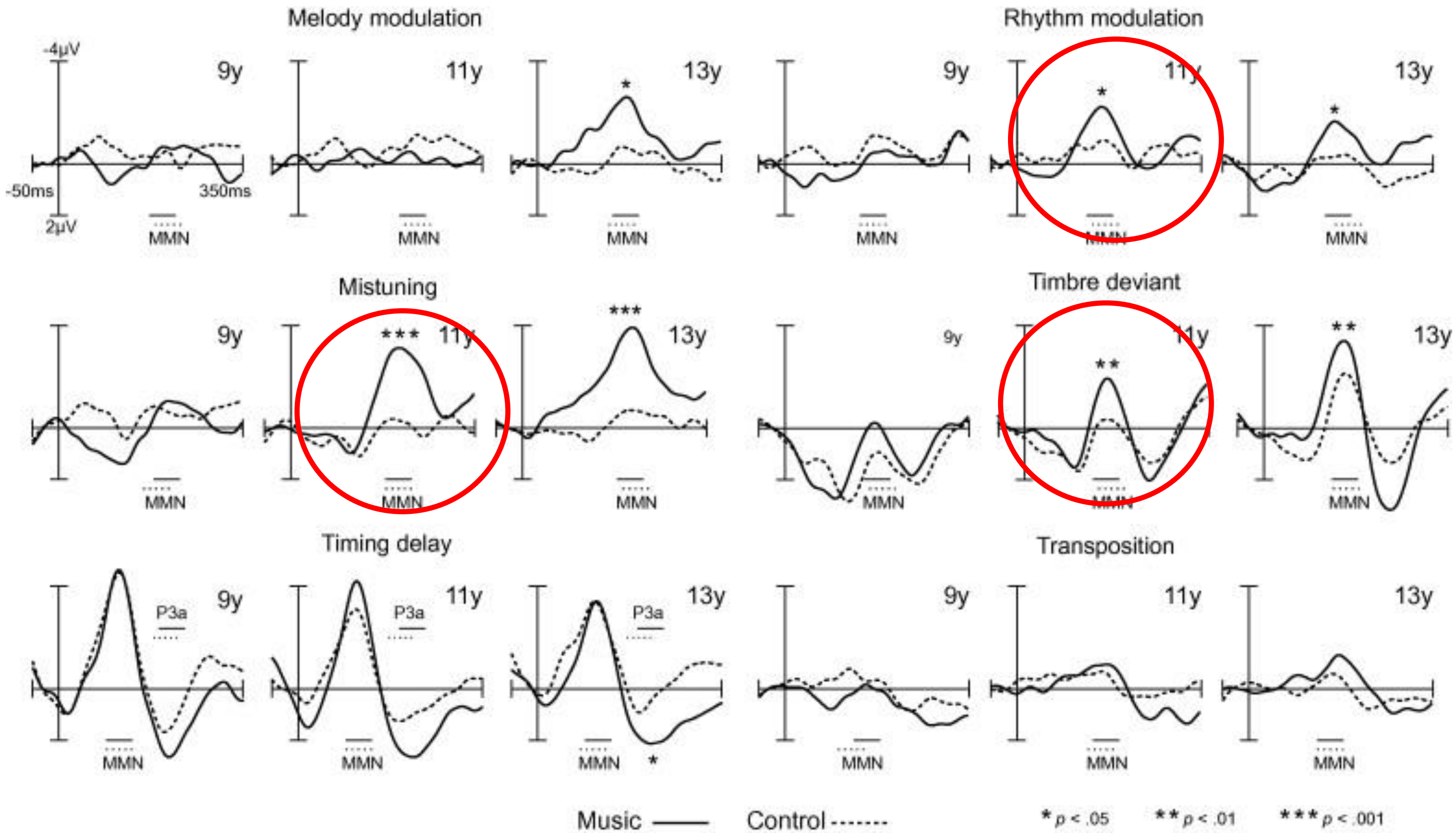
Learning of sound discrimination by music training?



No group differences prior to music training
No group differences when non-musical (sinusoidal) sounds were used

Putkinen et al. (2014)
Developmental Science

Discrimination of melodic ”mistakes” – different time courses



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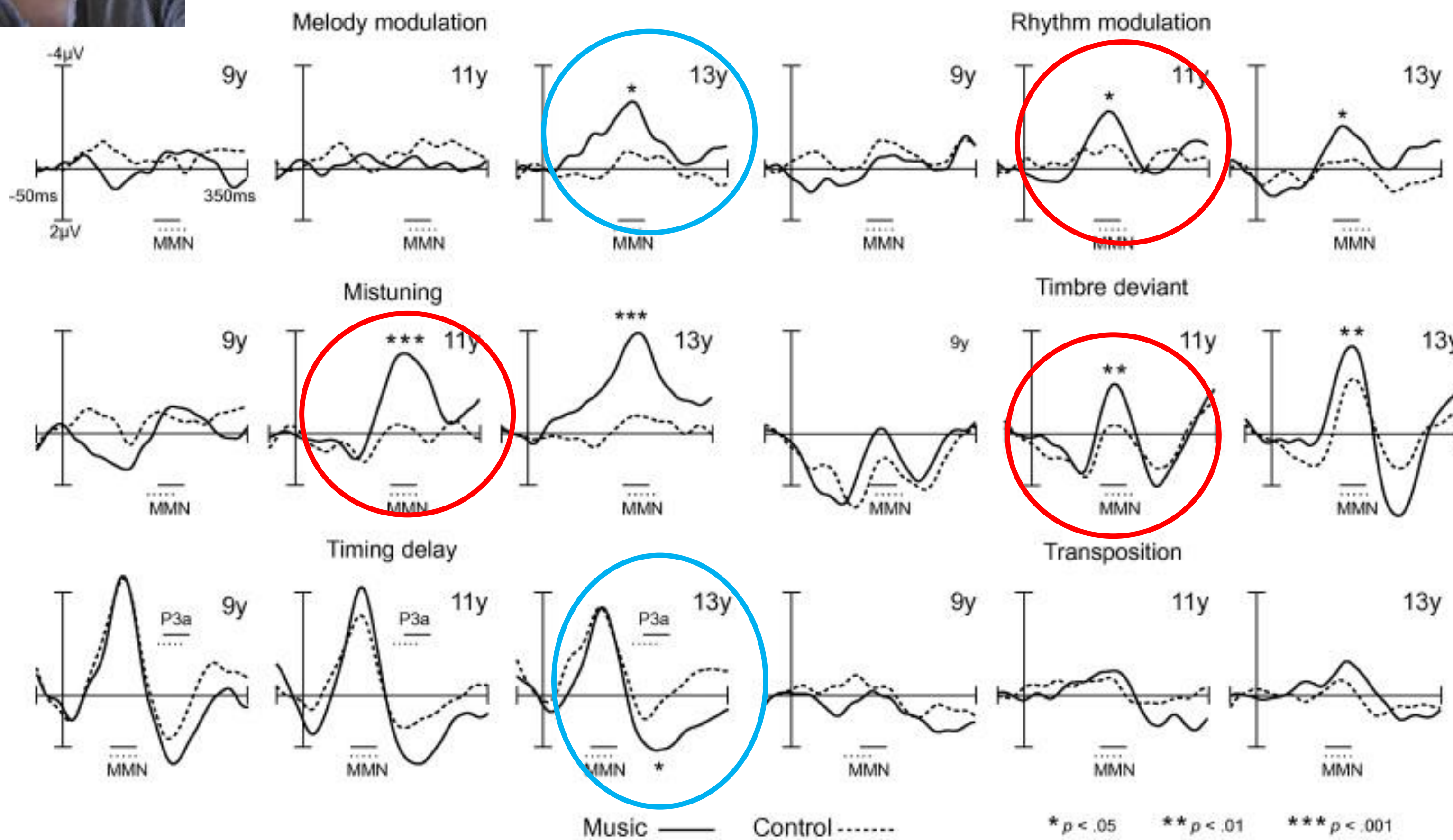
Putkinen et al. (2014)
Neurobiology of Learning and Memory

Discrimination of melodic ”mistakes” – different time courses



7 yrs: no data – no need for that
Same paradigm used for adult musicians

Putkinen et al. (2014)
Neurobiology of Learning and Memory

Adult musicians – same or different?

Adult musicians more accurate than non-musicians in sound encoding:

> Rock, jazz, classical, folk: MMN or P3a larger in musicians than in non-musicians in some but not all sound features

Adult musicians differ from each other in their neural accuracy in encoding some but not all musical parameters

=> Musicianship: not one but many different profiles, shaped by the demands of music style and instrument

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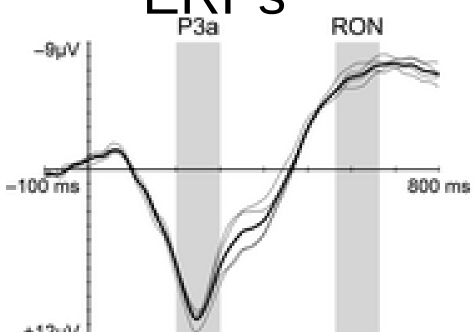
Vuust et al. (2012)
Tervaniemi et al. (2014, 2016)
Kliuchko et al. (in review)

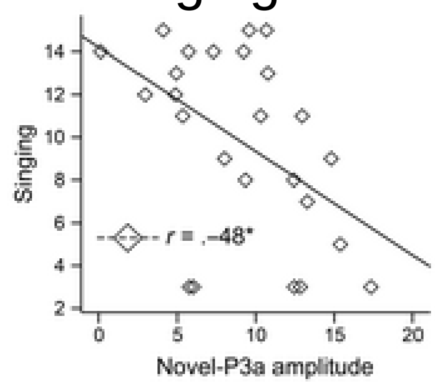
Correspondence between informal music activities and brain function

- 25 children, 3 yrs of age
- Participants of music play school
- Singing and Music activities at home associated with less distractability – more music, better attention

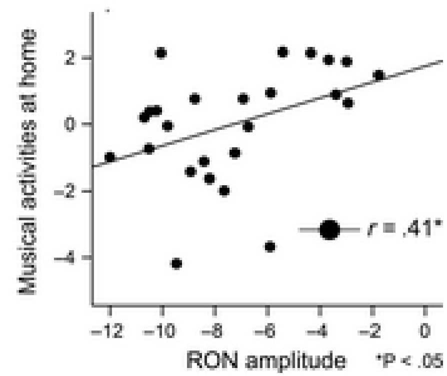
ERPs



Singing vs. P3a



Music activities vs. RON



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Putkinen et al. (2013)
Eur J Neuroscience

Correspondence between informal music activities and brain function

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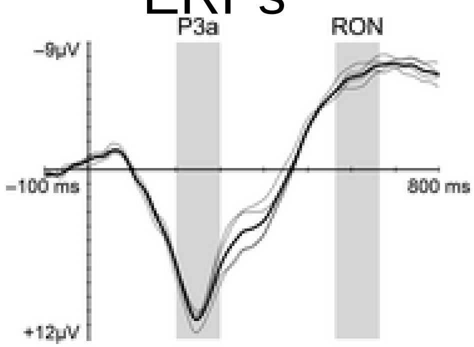
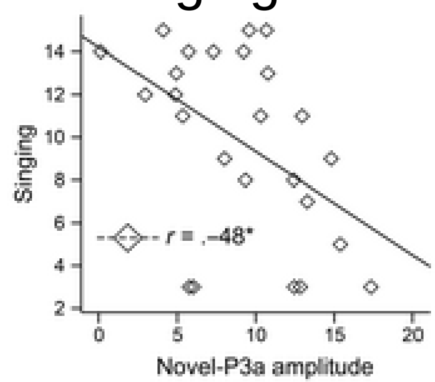
- NOTE: correlational data

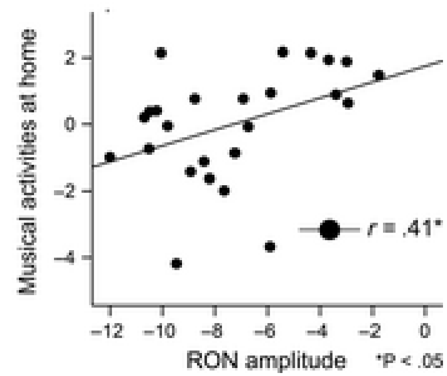
ERPs



Singing vs. P3a



Music activities vs. RON



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Putkinen et al. (2013)
Eur J Neuroscience

Longitudinal project on children in music play school

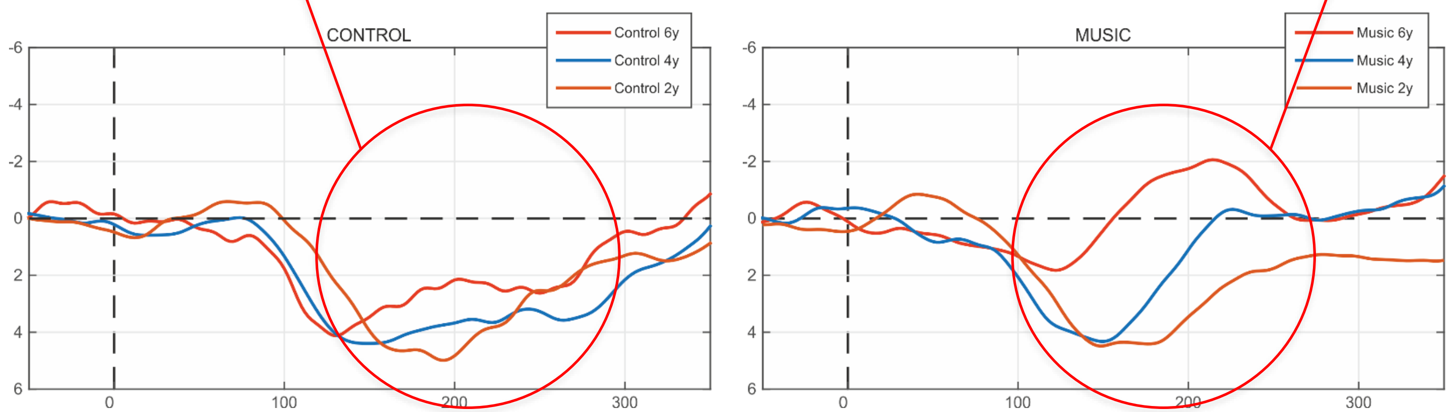
- EEG measurements at ages 2-3, 4-5, and 6-7 years.
- **Music group**: children who had attended a musical playschool throughout the follow-up period.
- **Control group**: children who had attended the playschool for a shorter period.
- The 45-min weekly playschool sessions (max 30/year) consisted of singing in group, moving to music, playing percussive instruments etc.

	2-3Y	4-5Y	6-7Y
Music	16	16	9
Control	17	17	9

Musical playschool & Timbre MMR maturation

Positive polarity MMRs in the Control group

Shift towards negative polarity in the Music group



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Putkinen, Tervaniemi, & Huotilainen (in preparation)
Putkinen et al.´(2015) Annals NY Sciences

Music interventions in neurological disorders

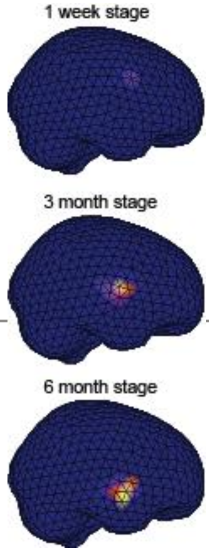
- Music can improve healthy brain – could it also reprogram neural functions if something went wrong?
- Emotionally rewarding (playing and listening)
- Easy to implement (listening)
  - Available immediately after the onset of the disease
  - Together with family members
  - Started early 2000

Music listening in stroke rehabilitation

- Stroke patients randomly allocated into three groups: Music listening, Audio book listening, Control (N=60)
- Music/Audio book listening hour/day, 2 months
  - Music therapists provided the patients with their favorite music or audio books
- Data collection at acute stage as well as 3 and 6 months post-stroke onset
- Cognitive and emotional recovery was helped by music:
  - verbal memory and attention - faster recovery in the Music group than in other groups
  - patients in the Music group were less depressed and confused than in the control group

Särkämö et al. (2008) Brain

And brain data…



- MEG findings: Särkämö et al. (2010) J Cogn. Neurosci.:
  role of the right hemisphere in recovery (MMNm)

- MRI findings: Särkämö et al. (2014) Front. Hum. Neurosci.:

  role of the frontal and limbic areas in recovery -

  correlation between gray matter reorganization in superior frontal gyrus and enhanced cognitive abilities;

  correlation between anterior cingulate cortex and reduced negative mood

And brain data…

- Follow-up study in the University of Turku, Finland, to compare the effects of instrumental music and songs with lyrics in stroke recovery
  - Neuropsychological tests, hormonal analyses, MRI and (brief) fMRI
  - Now data of about 50 patients recruited, follow-up ended and analyses in progress
- Data on anatomical basis of acquired amusia (combined Helsinki and Turku) by Sihvonen et al. (2016) J Neurosci 24 August

Can regular musical leisure activities (singing, music listening) support cognitive and emotional well-being in early dementia?

- Yes, both singing and listening of familiar songs enhanced cognitive skills (attention, memory) and mood in patients with memory disorders
- Well-being of family members improved
- Effects not related to the musical background of the patient

Särkämö et al. (2014) The Gerontologist; Särkämö et al. (2016) J Alzh Dis

Music – why?

- For fun and enjoyment
- For social cohesion and bonding
- For emotion regulation
- For regulation of vigilance
- For neurocognitive benefits of music in learning and re-learning

Music – why?

- Ongoing projects to further investigate the benefits of music in cognitive, social, and emotional functions

- Learning: Not only in children already enrolled in music training but also with musically naïve children as part of their school curriculum or activities offered for free
  - Large longitudinal projects by profs. Besson, Damasio, Kraus, and Tervaniemi

Music – why?

- Ongoing projects to further investigate the benefits of music in cognitive, social, and emotional functions

- Re-learning: traditional means of therapist-driven music therapy appended by patient-driven techniques using special music instruments and e.g music apps in mobile phones
  - Two special issues in Frontiers
    - Dialogues in music therapy and music neuroscience: collaborative understanding driving clinical advances
    - Music, brain, and rehabilitation: Emerging therapeutic applications and potential neural mechanisms

Warmest thanks to you and to …

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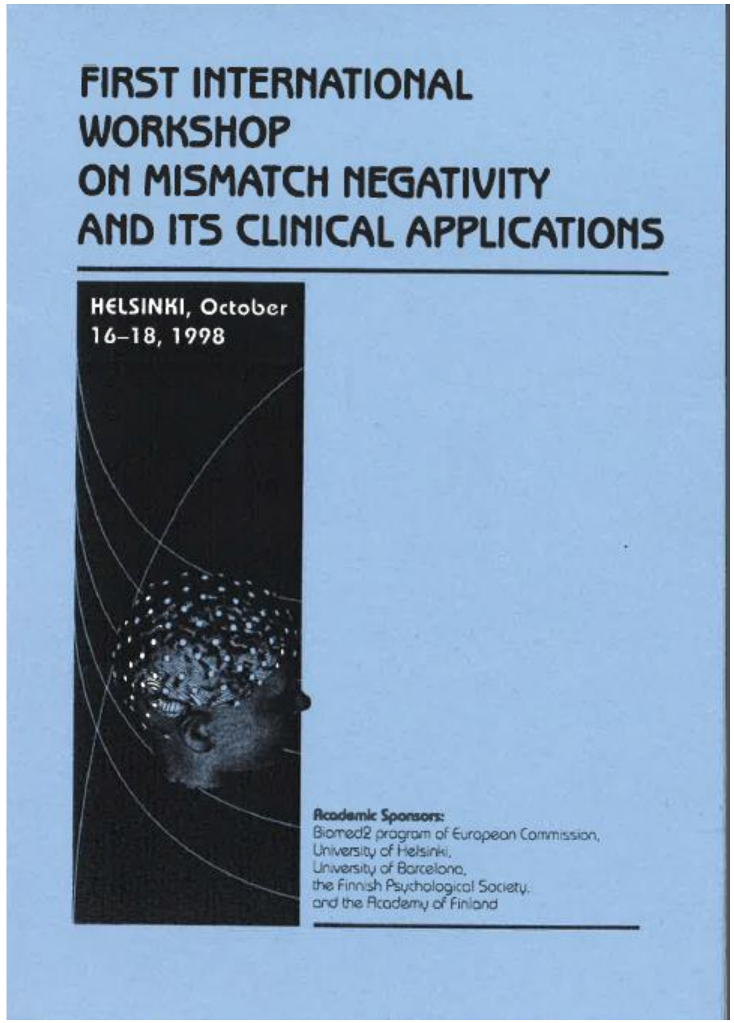
Welcome to
MMN2018 in Helsinki!

1998



MMN congresses
2000 Barcelona
2003 Lyon
2006 Cambridge
2009 Budapest
2012 New York
2015 Leipzig

1978

Acta Psychologica 42 (1978) 313–329

EARLY SELECTIVE-ATTENTION EFFECT ON EVOKED POTENTIAL REINTERPRETED*

R. NÄÄTÄNEN,** A. W. K. GAILLARD and S. MÄNTYSALO**

Institute for Perception, TNO, Soesterberg, The Netherlands

Received April 1977

In a dichotic listening situation stimuli were presented one at a time and at random to either ear of the subject at constant inter-stimulus intervals of 800 msec. The subject's task was to detect and count occasional slightly different stimuli in one ear. In Experiment 1, these 'signal' stimuli were slightly louder, and in Experiment 2 they had a slightly higher pitch, than the much more frequent, 'standard', stimuli. In both experiments signals occurred randomly at either ear. Separate evoked potentials from three different locations were recorded for each of the four kinds of stimuli (attended signals, unattended signals, attended standards, unattended standards). Contrary to Hillyard et al. (1973), no early (N_1 component) evoked-potential enhancement was observed to stimuli to the attended ear as compared with those to the unattended ear, but there was a later negative shift superimposed on potentials elicited by the former stimuli. This negative shift was considered identical to the N_1 enhancement of Hillyard and his colleagues which in the present study was forced, by the longer inter-stimulus interval used, to demonstrate temporal dissociation with the N_1 component. The 'Hillyard effect' was, consequently, explained as being caused by a superimposition of a CNV kind of negative shift on the evoked potential to the attended stimuli rather than by a growth of the 'real' N_1 component of the evoked potential.

In an impressive series of experiments, Hillyard and his colleagues (for a comprehensive review, see Hillyard and Picton 1978) have shown that all stimuli within an attended channel (one ear, certain pitch easily

* The experiments were carried out in the Institute for Perception TNO, Soesterberg, in the summer of 1975 when S. Mäntysalo worked there as a visiting scholar, supported by Suomen Tiedeakatemia (The Finnish Academy of Science and Letters). Please send requests for reprints to A. W. K. Gaillard, Institute for Perception TNO, Kampweg 5, Soesterberg, The Netherlands.

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