ATELIER 5th April 2019

MUSIC AND MUSICOTHERAPY IN PERINATAL PERIOD

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Clinica Neurologica

UNIVERSITÀ DEGLI STUDI DI FERRARA
- EX LABORE FRUCTUS -

Ferrara, Este castle

- **Enrico Granieri,**

-Eminent Professor of Neurology, Ferrara University, Italy

- past full Professor of Neurology

- past director of the Department of Neurology

- director of the Multiple Sclerosis Research Center

-director of the Advanced Course of Music, Musico-Therapy and Neurology

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UNIVERSITÀ DEGLI STUDI DI FERRARA
- EX LABORE FRUCTUS -

SETTIMA EDIZIONE del

CORSO DI PERFEZIONAMENTO

IN MUSICA E MUSICOTERAPIA IN NEUROLOGIA

Anno Accademico 2018- 2019

Dipartimento di Scienze Biomediche e Chirurgiche Specialistiche.

Sezione di Scienze Neurologiche, Psichiatriche e Psicologiche

Direttori: MAURA PUGLIATTI e ENRICO GRANIERI

Comitato Scientifico *ENRICO GRANIERI, GIORGIO FABBRI, ALFREDO RAGLIO*

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SOCIETÀ ITALIANA DI NEUROLOGIA

Patrocinio della Società Italiana di Neurologia

http://www.unife.it/studenti/pfm/perfez/2018-2019/mus-in-neur

LEZIONI IN AULA OPEN, 1C2, Chirurgia, Ospedale di Cona, Ferrara

Coordinazione scientifica e organizzativa: Prof. Enrico Granieri

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Brain and Music

- Perception and musical production are peculiar functions of the human brain.
  Music is not just an artistic activity, but **a language to communicate**, which
  - evokes and strengthens emotions,
- induces feelings, reactions of the vegetative system, changes in heart rhythm and breath, language to communicate.

- In the fetus, music already plays motivation to movement.

Leonardo da Vinci

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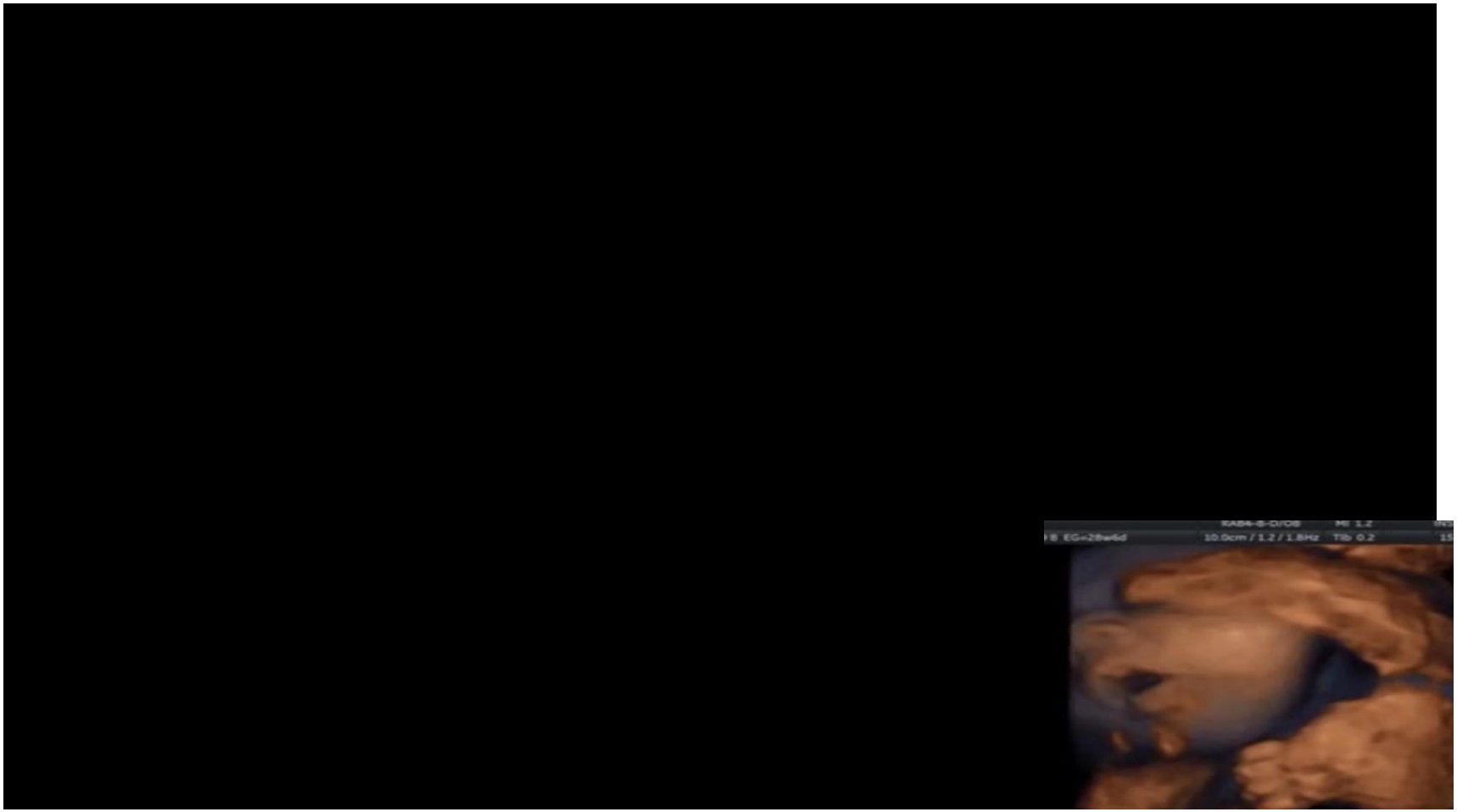
Music during pregnancy
Insitut Marquèz, Barcelona



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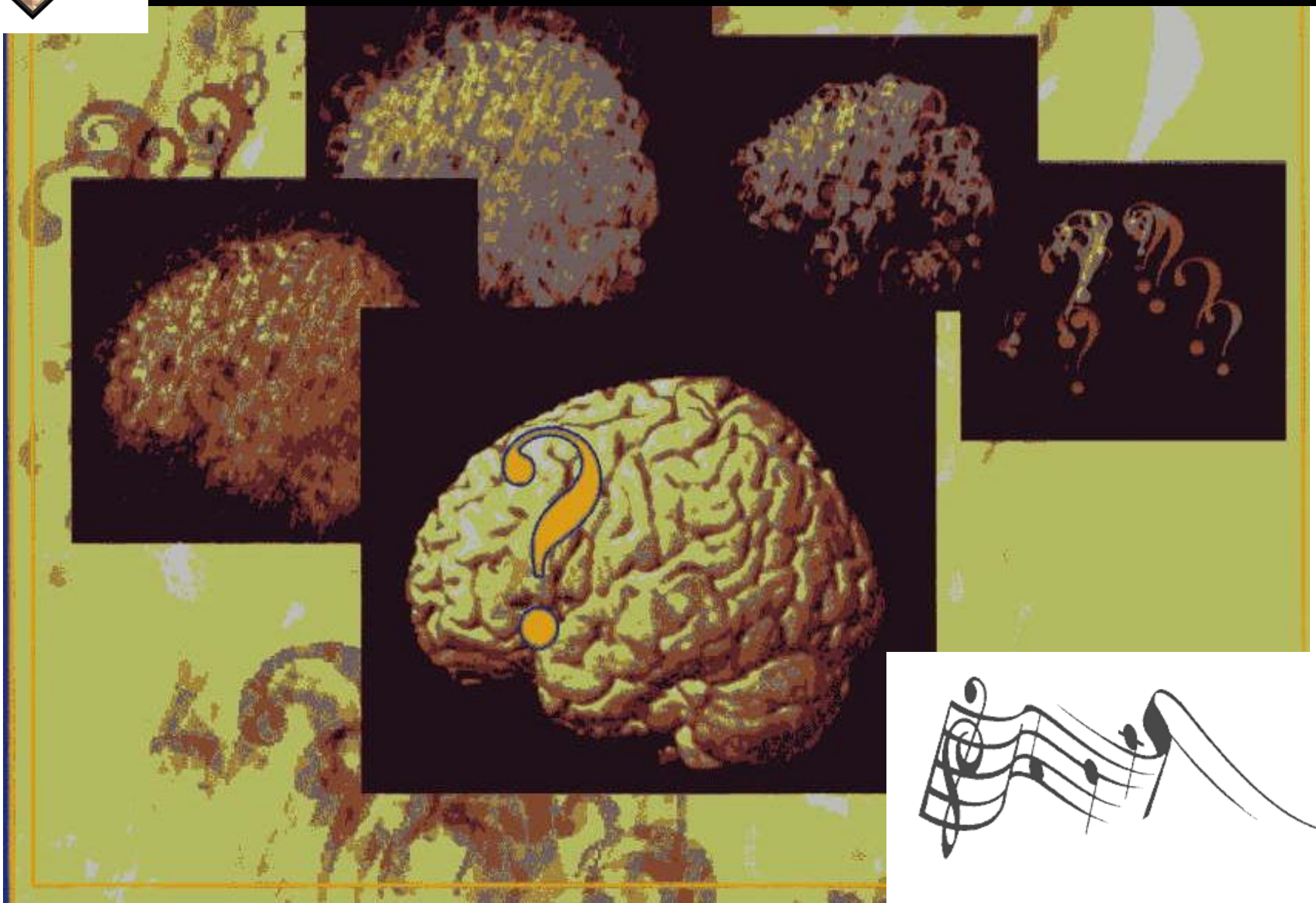
Music: particularly representative artistic expression of the sensory-motor, cognitive, emotional, neurovegetative, endocrine and neurochemical functions.



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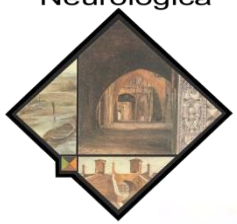
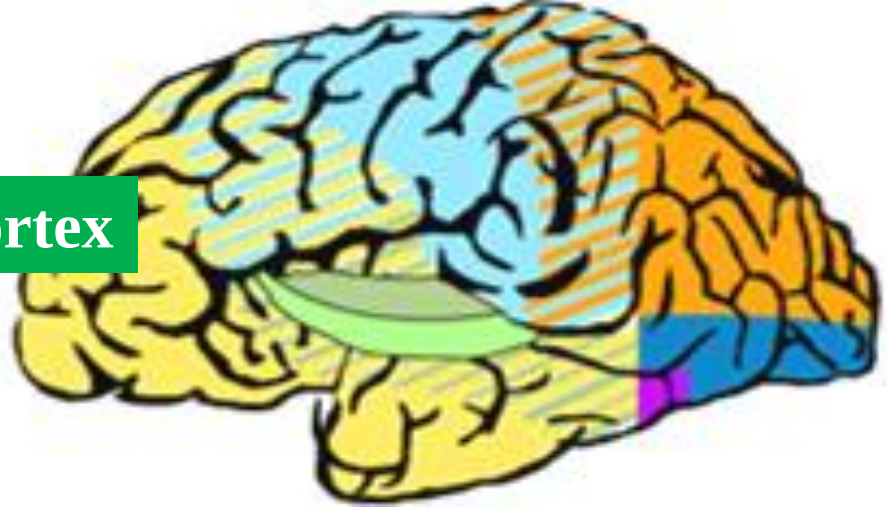


Auditory Cortex



some main peculiarities of music

ACOUSTIC ANALYSIS AND REPRESENTATION
Tonality, melody, harmony, rhythm, dynamics, timbre, voice, lyric, equivalence of octaves, equivalence in transposition, scales, keys, ways, metric, arrangements, mix,..

EXPETANCY GENERATION, VIOLATION, SATISFATION
Repetition, rewind, resolution, downbeats and offbeats, cadence, key change, time change,

KINETICS AND KINAESTETICS
Beat feet, dance, beat time, Instrumental and vocal performances, sinkinesia, synaesthesia

PERSONALITY & PREFERENCE
Style, Taste, Culture, Generation, Individuality

EMOTIONAL and VISCERAL CONCOMITANT ASPECTS
Excitement, Heart rate, Vascular tone, Endorphins, Hormones, "goose bumps", chills, ...

(Medial Temporal Lobe, Limbic Brain, Midbrain Hyothalamus)

VISUAL PERCEPTION
Facial expression, Language of the Body, Expression in dance, Reading of music, Synaesthesia,..

ASSOCIATIONS with PEOPLE, CULTURES and EVENTS
Festivities, Weddings, Funerals, Personal Histories,..

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Music and perinatal life

- Musical experience during pregnancy can have **positive effects on the pregnant woman in reducing anxiety and stress**. *(Chang & Chen, 2005; Chang et al., 2008; Raglio&Oasi, 2009; Koelsch, 2009, 2010);…).*
- From the 70s to today studies have shown that **fetuses from the 28th week of gestational age are able to respond to listening to music.**
- Fetal responses could be influenced by the effects of music on the mother *(Kafali et al., 2011; Miyuki et al., 2010; Yang et al., 2009,..).*
- The sound as early organizer and regulator of communication and emotions (relationship between mother and futur infant)

da Marta Bellu, 2017

Leonardo da Vinci

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Music and Medicine

- In ancient Greece the God Apollo was the divinity of Music and Medicine.

  In the healing temples for physical and mental illnesses, **music was proposed as a fundamental energy to harmonize the soul and the body.**

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MUSIC AND MEDICINE

Brain areas involved in listening and in musical performance
Effects of music on the brain

MUSICOTHERAPY

"The use of music and / or its elements (sound, rhythm, melody and harmony) by a qualified music therapist, in an individual or group relationship, within a defined process, to facilitate and promote communication, relationships, learning, mobilization, expression, organization and other noteworthy therapeutic goals, with a view to fulfilling physical, emotional, mental, social and cognitive needs. Musicotherapy aims to develop potential and / or rehabilitate the individual's functions so that he can achieve better integration on the intrapersonal and / or interpersonal level and, consequently, a better quality of life through **prevention**, **rehabilitation** or **therapy**"

(8th World Congress of Music Therapy, Hamburg, 1966).

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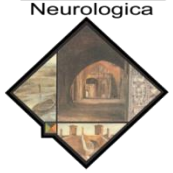
Why music?

1.) Music is a universal part of our life
2.) Music involves us and coordinates motor actions
4.) Music promotes social cohesion
5.) Music gives peace and meaning
6.) Music makes us active
7.) Music is strongly linked to memories
8.) Music promotes neurophysiological and biological effects in the brain:

a) Sensitive-auditory-motor integration through timing
b) Connections between cortical and subcortical areas
c) Plastic modifications in cortical and subcortical structures
d) Modulation of neurovegetative functions
e) Release of dopamine and serotonin, endorphins, hormones, ..
f) Improvement of the immune system (IgA)

E. Altenmueller 2017

Gustav Klimt (1903) Speranza I



Music and brain.
Music is psychologically holistic

- **Music is an auditory stimulus articulated in a complex way. Many perceptual processes take place simultaneously in different brain areas.**
- **The brain thus processes music in a hierarchical and distributed manner.**

First hierarchical elaborations of the perception of music also occur in the developing fetal brain.

- **Music involves the whole brain as its different components are processed through different circuits.**
  Computations that occur in one area of the brain are potentially capable of influencing any other computation, even in the absence of logical or rational connections.

  - Like an orchestra, the brain stimulated by music activates practically all its main functions.

- ***HOLISTIC involvement also in the fetal life compatibly with the phases of brain development.***

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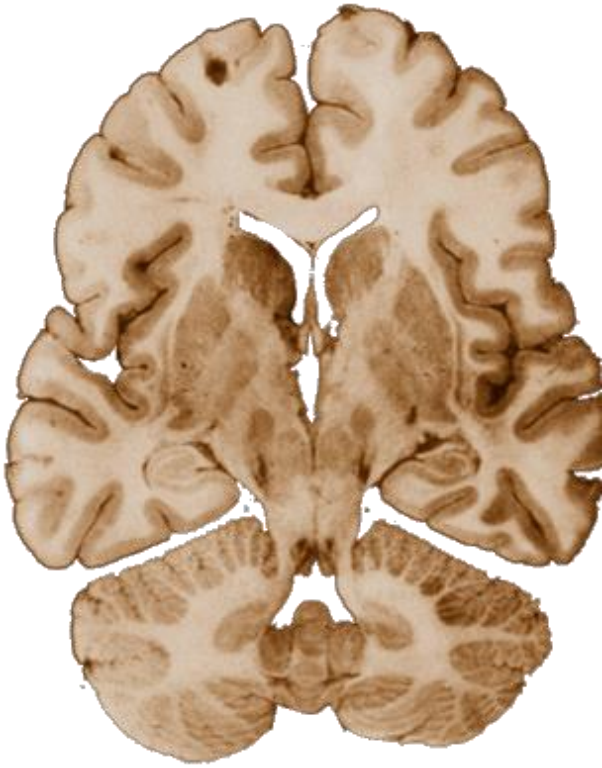
20 weeks



After birth

Prof. Dr. Birgit Arabin

Many studies
Many researches
.....

Music devices for the fetus? An evaluation of pregnancy music belts.
J Perinat Med. 2016 Aug 1;44(6):637-43.
Jahn M, Müller-Mazzotta J, **Arabin B.**

Need for interventional studies on the impact of music in the perinatal period: results of a pilot study on women's preferences and review of the literature. *J Matern Fetal Neonatal Med.* 2013 Mar;26(4):357-62.
Arabin B, Jahn M.

Music during pregnancy.
Ultrasound Obstet Gynecol. 2002 Nov;20 (5):425-30.
Arabin B.

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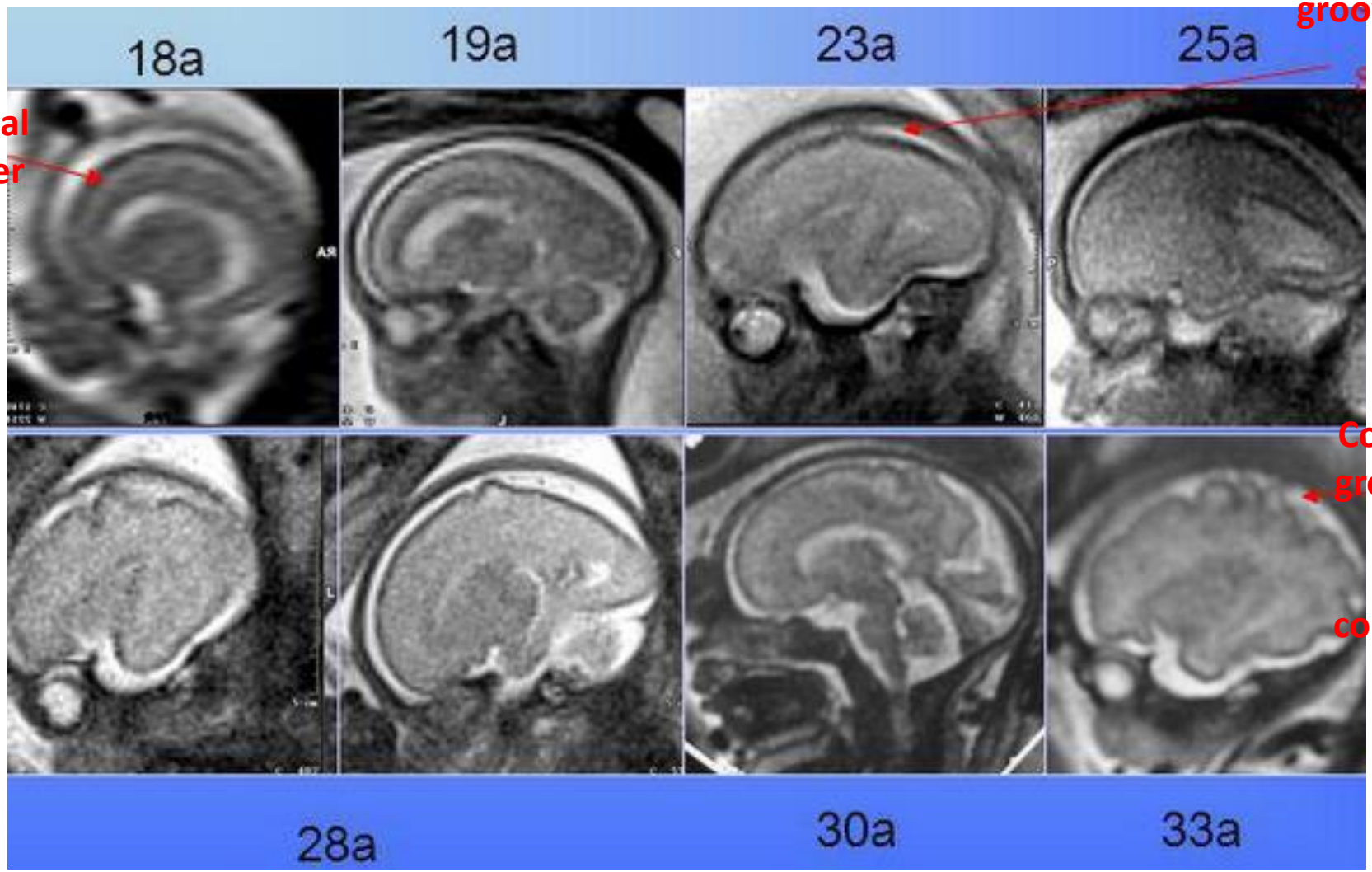
MRI fetal brain

(18th→33th week of gestational age)

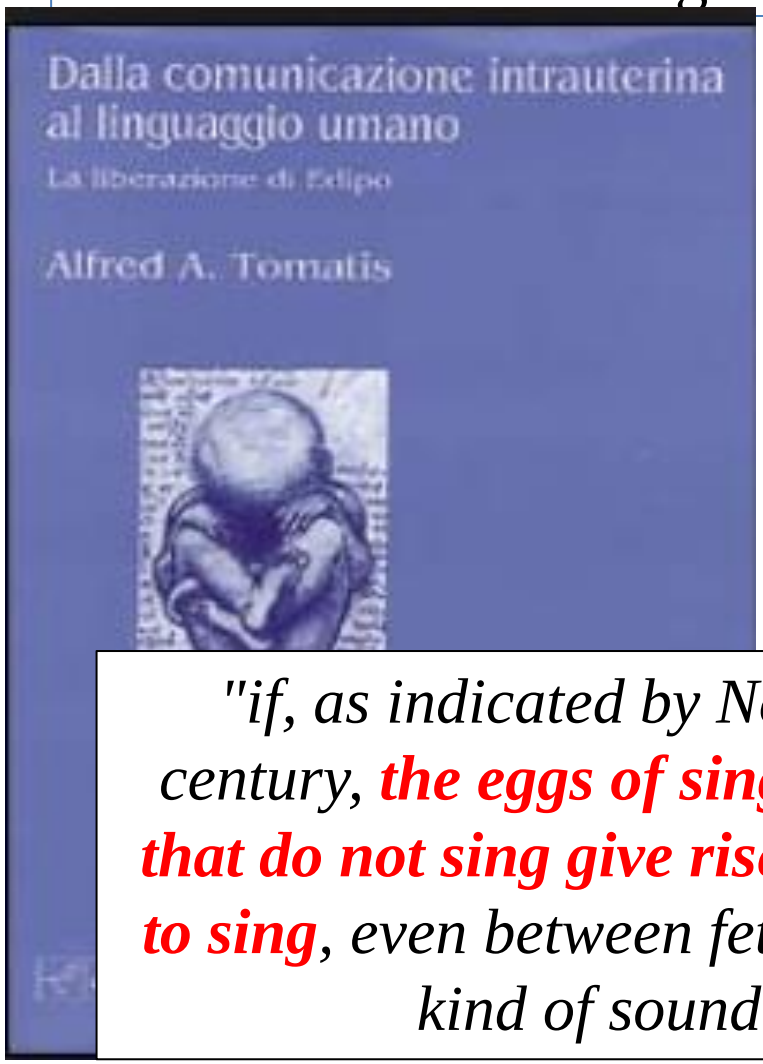


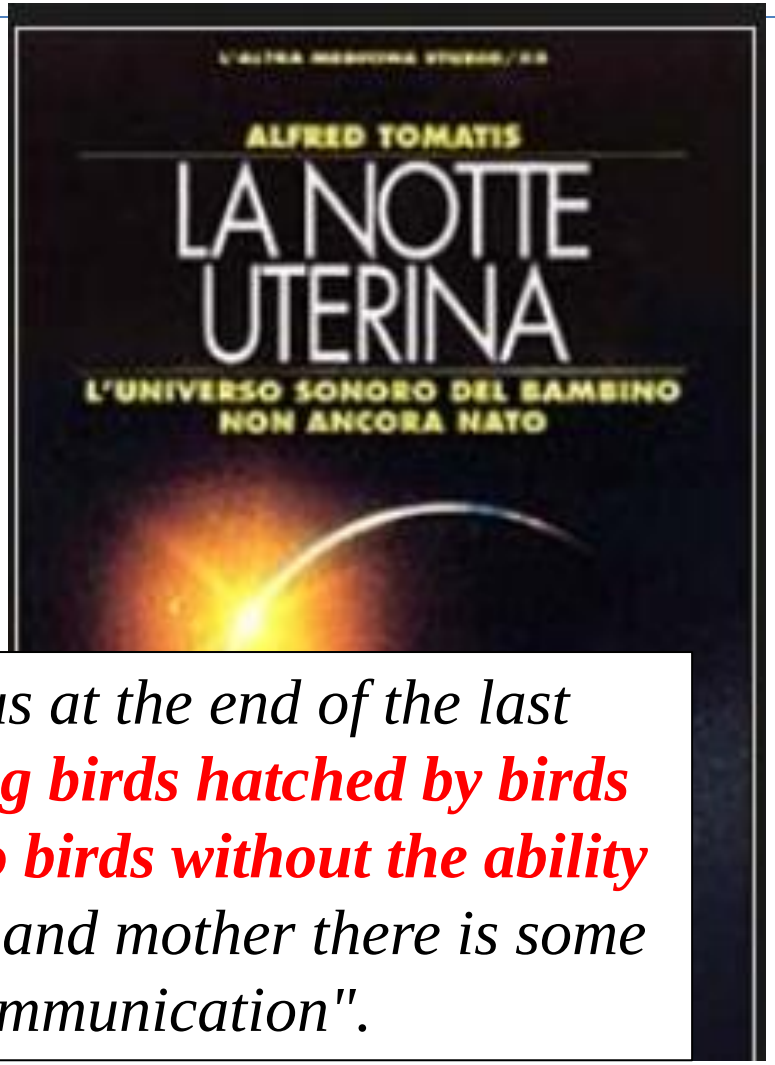
T2 weighted images, sagittal sections

Alfred Tomatis 1920-2001

(French otolaryngologist, music therapy expert in perinatal age)

As the fetus perceives the various sounds through the amniotic fluid





*"if, as indicated by Negus at the end of the last century, **the eggs of singing birds hatched by birds that do not sing give rise to birds without the ability to sing**, even between fetus and mother there is some kind of sound communication".*

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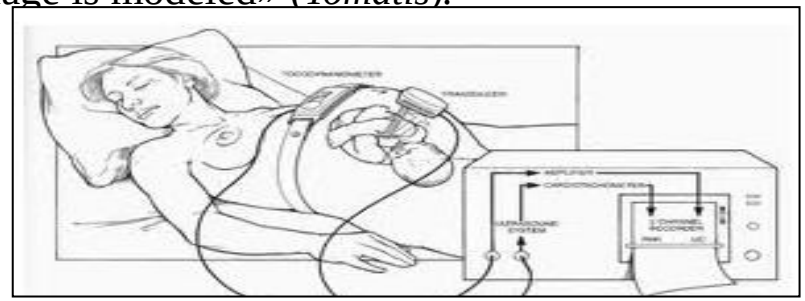
The sound-universe in prenatal life

- **Learning begins even before birth, especially the sonorous one.**
  Hearing: among the first of the five senses that develops in the fetus;
  Ear almost totally formed from the fourth month;
  The fetus begins to hear the voice of the mother, who will recognize at birth.
- **Around the 5th week the sounds that reach the child's hearing receptors are perceived through the vibration of the mother's womb,** then **filtered by the amniotic fluid and stripped of the serious frequencies.**
- **The vibrations, varying the pressure of the amniotic fluid, generate in the fetus at the same time auditory and tactile and proprioceptive stimulations.**

- The hearing of the fetus is related to the frequencies filtered by the amniotic fluid which transmits only specific frequencies coming from the external world, which go, in large part, over 8000 Hz.
Among the sounds audible to the fetus there are those very grave and acute some; the fetus does not like loud sounds.

"The embryo is subject to sound influences" that permanently influence the basic acoustic structures and the rhythm of the future language.

Communication skills arise from the special communication between mother and child. The very first language is **"the intimate communication between mother and fetus" that begins with empathy in the womb.** «The maternal voice undoubtedly constitutes the" sound mix "on which the language is modeled» *(Tomatis).*



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frontiers in Systems Neuroscience

Front Syst Neurosci. 2013; 7: 48.
Published online 2013 Sep 3. doi: 10.3389/fnsys.2013.00048
PMCID: PMC3759965

Linking prenatal experience to the emerging musical mind

Sangeeta Ullal-Gupta,[1] Christina M. Vanden Bosch der Nederlanden,[1] Parker Tichko,[1] Amir Lahav,[2,3,*] and Erin E. Hannon[1,*]

- The **musical brain** is built over time through experience with a multitude of sounds in the auditory environment.
- However, **learning** the melodies, timbres, and rhythms unique to the music and language of one's culture **begins already within the mother's womb** during the third trimester of human development.
- We review evidence that **the intrauterine auditory environment plays a key role** in shaping later auditory development and musical preferences.
- We describe evidence that **externally and internally generated sounds influence the developing fetus**. Such prenatal auditory experience may set the trajectory for the development of the musical mind.

P. Di Camillo

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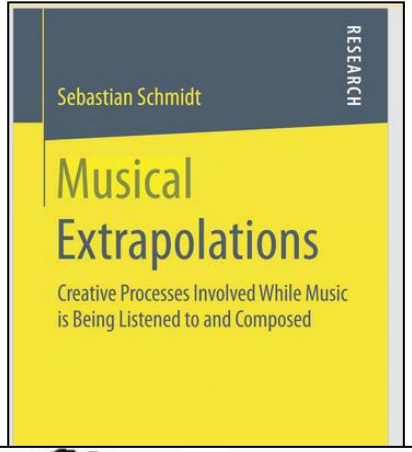
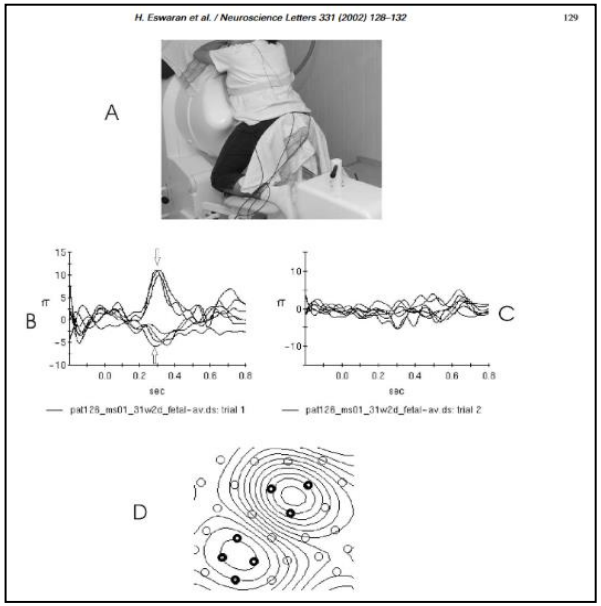
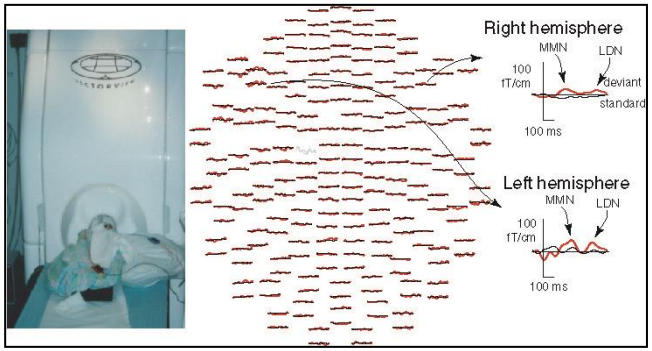
Ontogenesis of musical abilities during fetal life. Auditory learning.

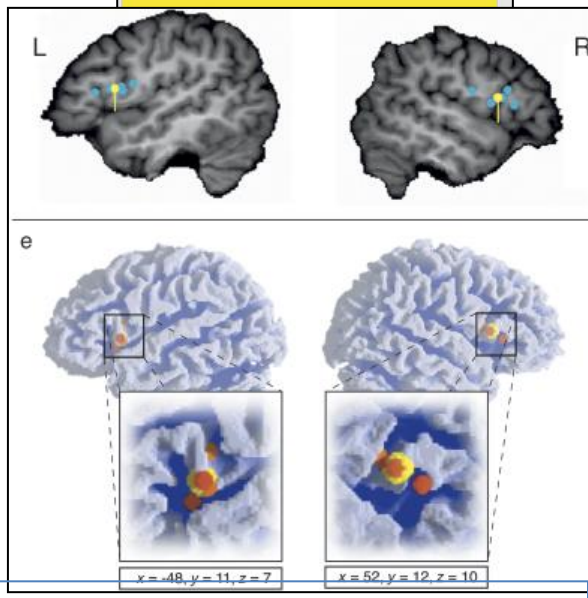




Magnetoencephalography (MEG). Recent studies on evoked auditory magnetic responses show that the brain of the fetus responds to the onset of sound.



Mismatch Negativity Paradigm (MMN):
violation of expectations. response to a deviant stimulus within an otherwise regular stimulus sequence.



Early Right anterior Negativity (ERAN)
Relatively early electrical brain response. Considered a specific reflection of the violation of the expectation of a musical and linguistic sound.

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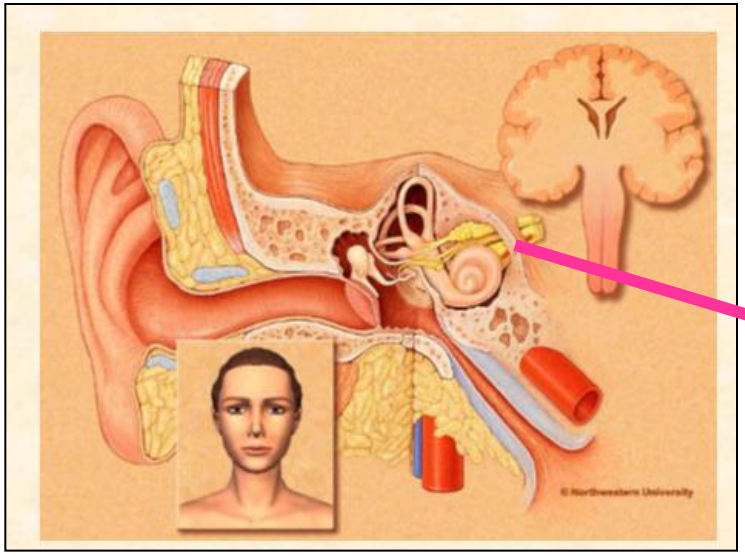
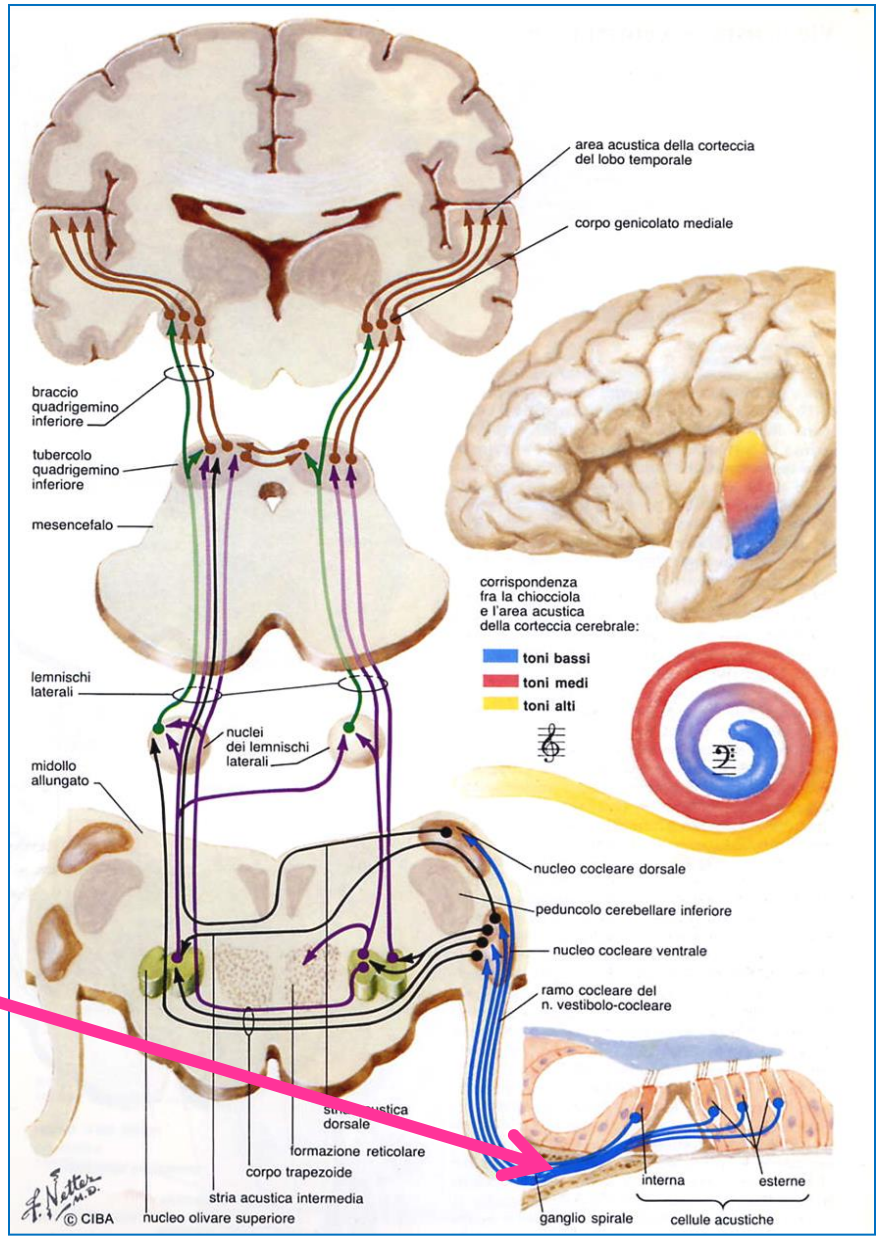
EAR and ACOUSTIC SYSTEM





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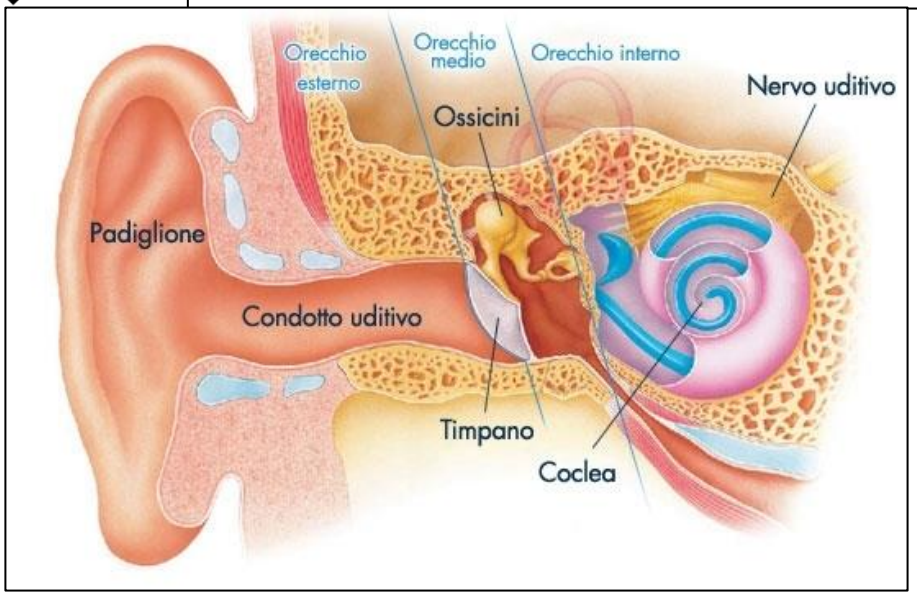
THE FETUS PERCEIVES THE SOUNDS



Although around the 8th week of pregnancy the cochlea is already formed and the receptors begin to differentiate around the 10th week, **only starting from 24th -28th week it can be said with certainty that the unborn child is able to listen to auditory stimuli external to the maternal body.**

- Initially the sounds, especially the mother's voice, are transmitted to the fetus through waves from the amniotic fluid and perceived by the touch receptors that are on the skin. They can be defined as a ***vibrational caress***, these first sounds perceived by the fetus.
- Starting **from the 6th month the music and the external sounds passing through the amniotic fluid are transmitted to the three bones of the middle ear**: hammer, anvil and **stirrup.**
- **The sound waves reach the cochlea**, a small snail-shaped structure that transforms the waves into electrical signals and transmits them to the brain through the acoustic nerve. The process of hearing development can be considered complete, and so will the perception of sound.
- **At the end of the 8th and the beginning of the 9th month, the auditory system can be said to be very well developed.**

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What does the fetus feel inside the mother's belly

American Journal of Obstetrics and Ginecology

FETAL AUDITION. Myth or reality. *Chelli D, Chanoufi B*

J Gynecol Obstet Biol Reprod (Paris) 2008 Oct;37(6):554-8.

Fetal sensory abilities have been considered for a long time as a philosophical question. The aim of this review is to investigate the scientifically proven knowledge about fetal audition.
Fetal audition seems to depend on gestational age and sound characteristics.
The onset of human fetal hearing is observed at about 26-28 weeks gestational age.

Noises from the placenta, the maternal organs and the maternal voice play a major role as current in utero auditory stimuli.
Many studies demonstrate that the fetus forms memories of his hearing experiences allowing some authors to use the term "fetal learning".
The fetus can memorize not only his mother's voice but also more complex acoustic external sounds with a big ability of discrimination. (fetal learning).

Moreover, most studies strengthen the hypothesis of an implicit musical ability of the human brain.

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ULTRASOUND

Ultrasound. 2015 Nov; 23(4): 216–223.
Published online 2015 Sep 29. doi: 10.1177/1742271X15609367
PMCID: PMC46

Fetal facial expression in response to intravaginal music emission

Marisa López-Teijón,[✉1] Álex García-Faura,[1] and Alberto Prats-Galino[2]

- **https://www.nostrofiglio.it/gravidanza/musica-in-gravidanza/gravidanza-il-feto-nel-pancione-canta-e-balla-se-sente-la-musica**
  The fetus listens, responds and reacts to musical stimuli.
  "Singing" and "Dancing" to the rhythm of what it perceives: paraverbal communication.

- Already at the 16th week you can record **movements of the body and mouth of the fetus while listening to the music.** This is what emerges from a study performed at the Institute Marques' in Barcelona by Marisa López-Teijón and coll. (*Ultrasound et al, 2015*).

106 women from the 14th to the 39th week. The cubs were stimulated with **Bach (Partita in A minor for flute solo-BWV 1013).** They listened to the sound.
A) directly with a maternal belly player
B) transvaginal with an instrument specially designed for this study.

Device on belly: **45% of fetuses move arms, legs and mouth.**
Transvaginal way: **87% of fetuses move, especially shaking the mouth**.

In 50% of cases, the fetus pulls out the tongue and extends it to the fullest and opens its mouth, as if it were singing.

- According to the researchers through the device the music comes to the ears of the fetus in a better way.

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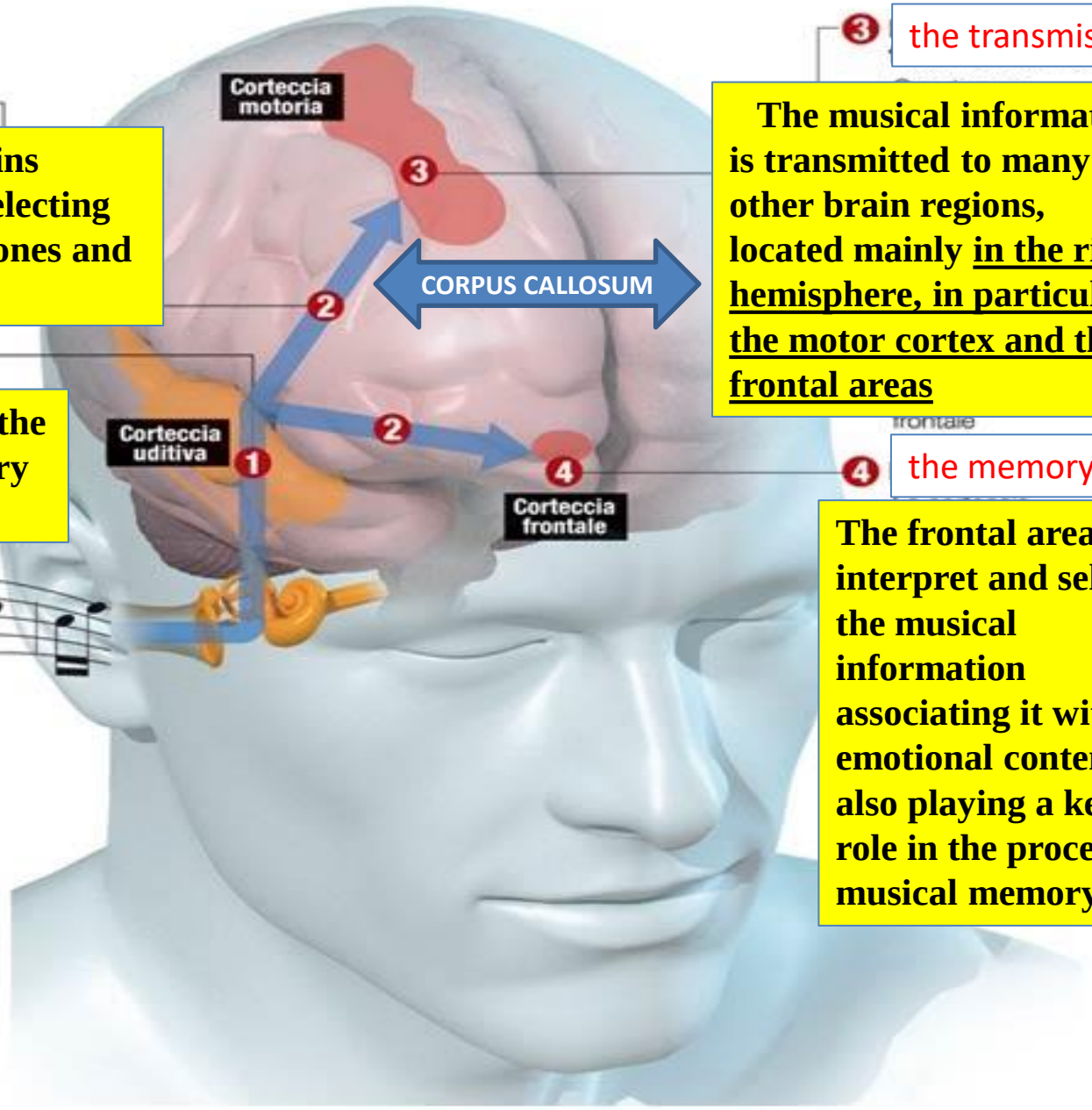
MUSIC AND BRAIN IN ADULT

1 Source

The musical sound reaches the ear, and through the auditory path reaches the cortex

2 Decoding

The auditory cortex contains distinct areas capable of selecting the various components (tones and frequencies).



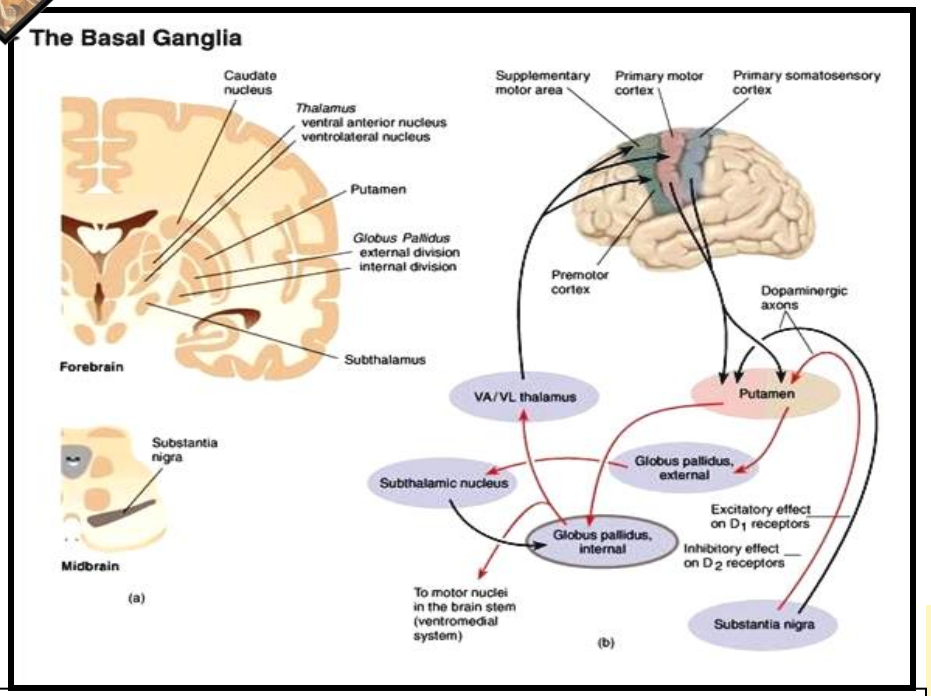
3 the transmission

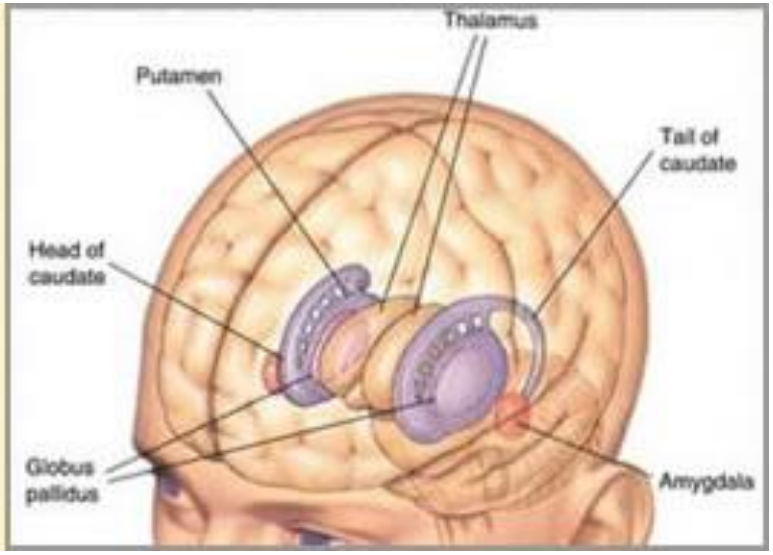
The musical information is transmitted to many other brain regions, located mainly <u>in the right hemisphere, in particular the motor cortex and the frontal areas</u>

4 the memory

The frontal areas interpret and select the musical information associating it with emotional contents, also playing a key role in the process of musical memory.

EXTRA-PIRAMIDAL-CEREBELLAR CONTROL





Cerebellum

Basal Ganglia are implicated in:

- synchronization of musical rythms, automatisms, ….

- and in synchronization and coordination of movements.

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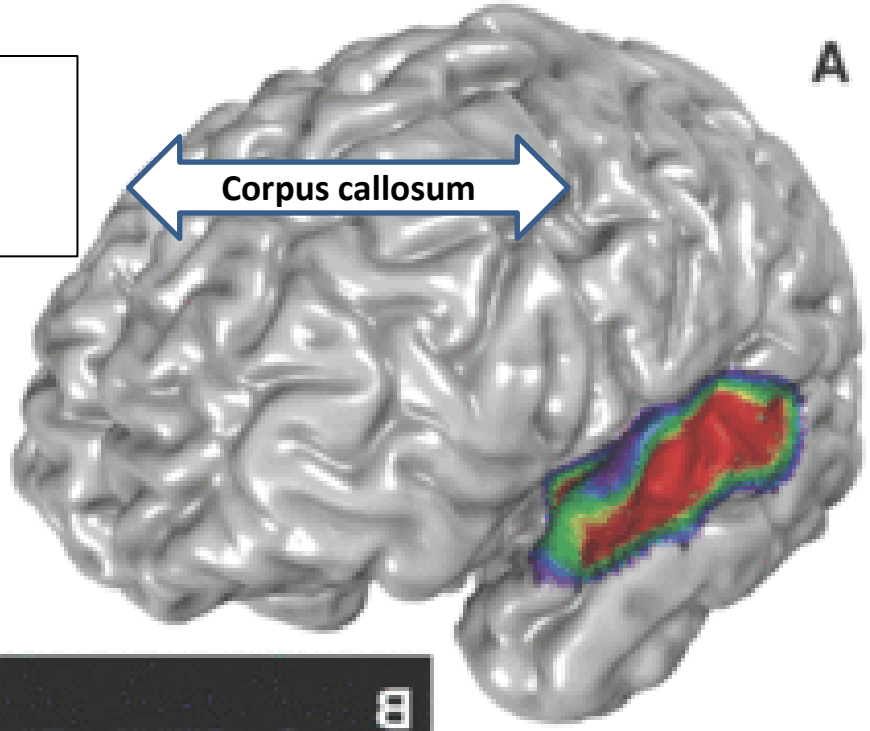
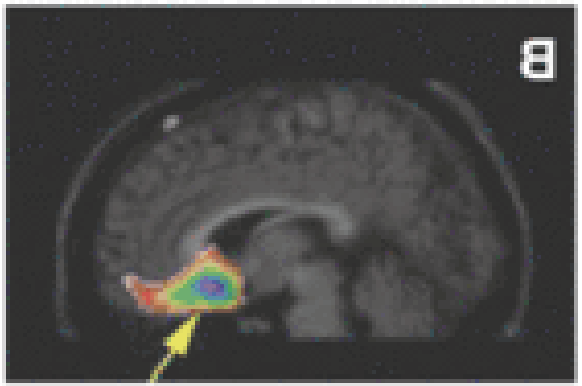
Neuronal mechanisms of musical perception.



ADULTS



Frontal cortical areas related to the recognition of harmony. Hearing areas recognize the musical time and from there the synchronization of the movements with the different musical rhythms is realized.

Peretz, I., and Zatorre, R. J. (2005). *Brain organization for music processing*. Annu. Rev. Psychol. 2005;56:89–114.

The frontal areas interpret and select the musical information and associate it with emotional contents, playing a key role in the process of musical memory.

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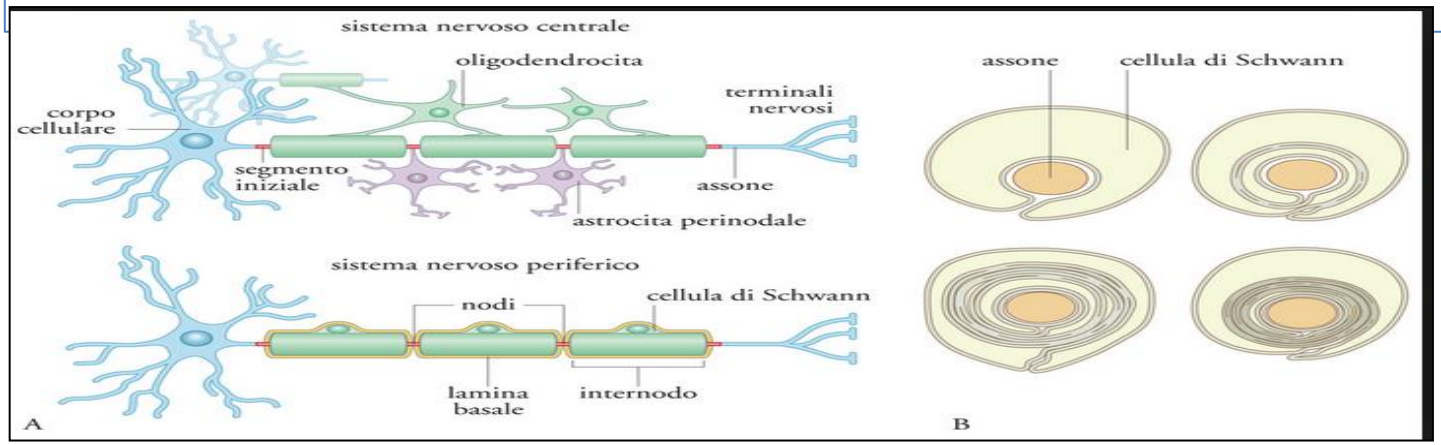
THE FETUS BRAIN DEVELOPS EXTERNAL AUDITIVE INFORMATIONS



The first areas of the brain to mature are those responsible for the perception and processing of external stimuli and the structure of the brain mass also varies.

- As well as anatomically, the brain also matures from the functional point of view.

- At the 5th month the hearing is already working and the fetus reacts to noises by increasing the heart rate or exhibiting spontaneous movements.

- In the last three months of pregnancy the nervous fibers, the white substance, the important connections between brain areas, also develop: communication takes place on a regular basis. Axons (prolongations of neurons) and myelin sheath allow a rapid transmission of electrical signals.

- **In the last three months if sounds and music are transmitted to the child in gestation, his/her brain activity in the temporal lobe also increases, the most important area for the processing of linguistic stimuli** *(Frenaud Jardri, Lille University, Franch neuro scientist, 2008)*

NeuroImage 42 (2008) 10–18

Neuroimage. 2008

Contents lists available at ScienceDirect

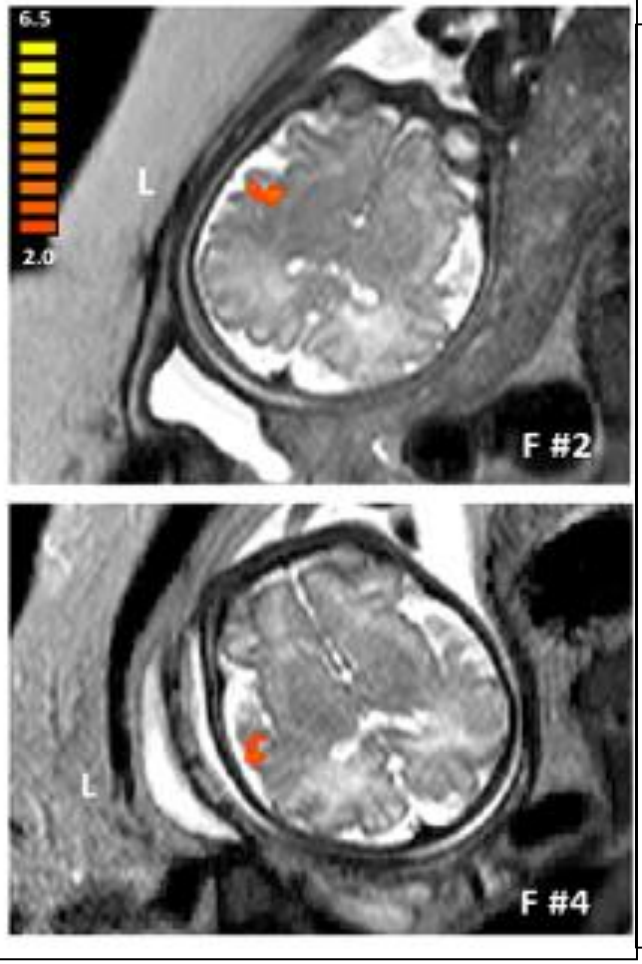
NeuroImage

journal homepage: www.elsevier.com/locate/ynimg

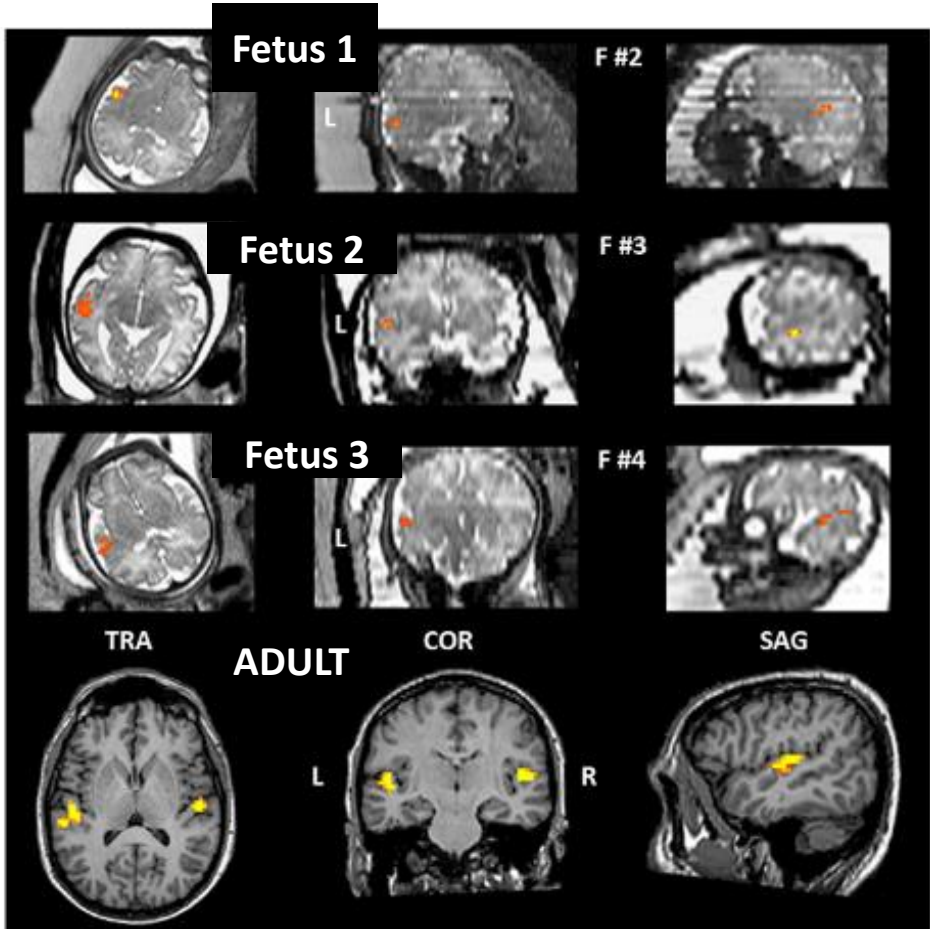
Activation of the left temporal lobe with acoustic stimuli

Fetal cortical activation to sound at 33 weeks of gestation: A functional MRI study

Renaud Jardri [a,b,*], Delphine Pins [a], Véronique Houfflin-Debarge [c], Caroline Chaffiotte [d], Nathalie Rocourt [d], Jean-Pierre Pruvo [d,e], Marc Steinling [f], Pierre Delion [b], Pierre Thomas [a,g]



The study indicates that it is possible to use fMRI to detect the early functionality of acoustic systems in the fetal brain, but also that the processing of sound occurs beyond the level sub-cortical, at the beginning of the 3rd trimester of pregnancy.



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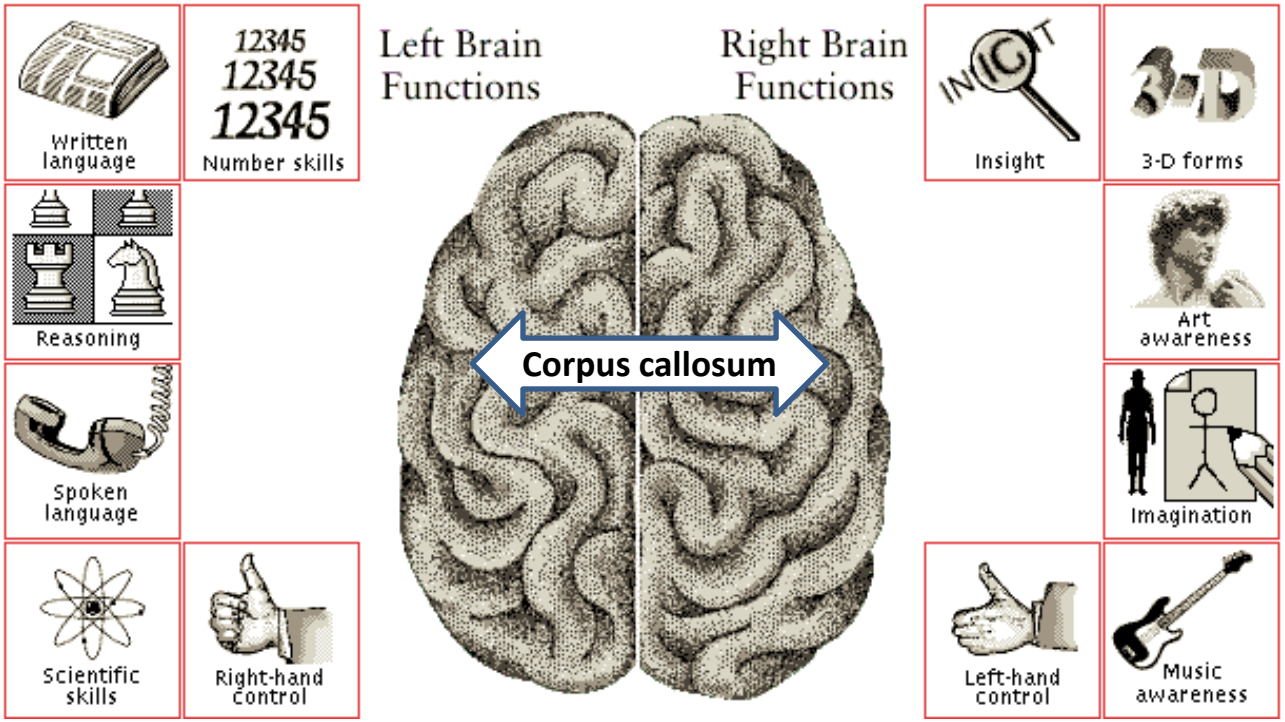
EMISPHERIC DOMINANCE AND MUSIC



ADULTS

Left: analytical and rational functions

Right: innate and intuitive functions

– ***The right hemisphere at first recognizes / captures the melody as a whole (the most complex characteristics of time and the melodic line).***

– ***subsequently the left hemisphere performs a more precise analysis.***

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Perception of music

Since the duration of the musical pieces varies from a few seconds to several minutes, **the perception of music implies a substantial capacity of memorizing.**

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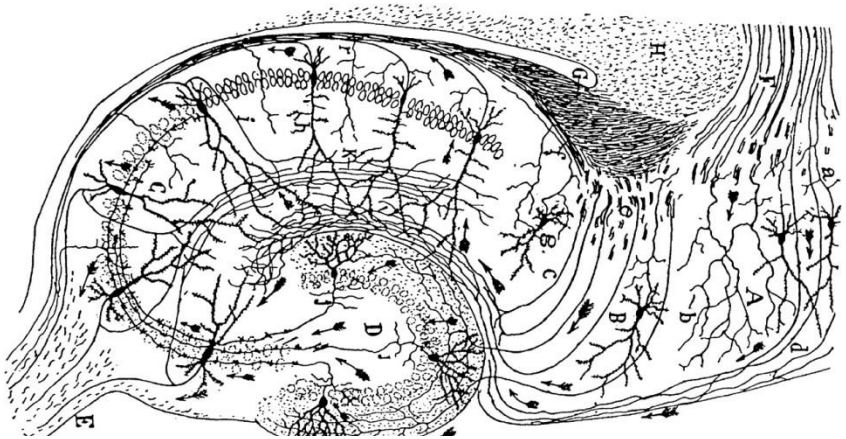
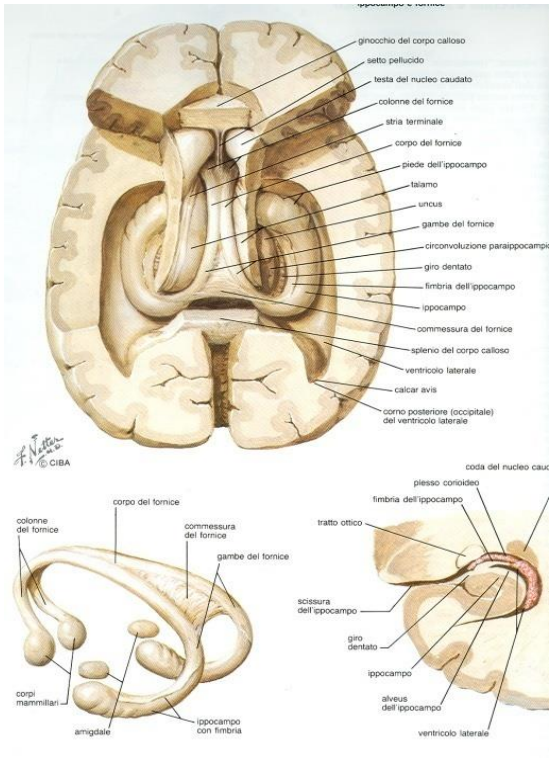
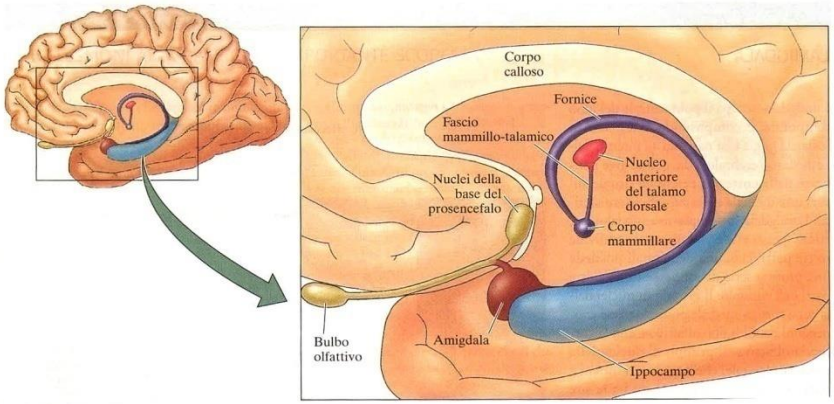
ROLE OF THE CIRCUIT OF PAPEZ AND THE



Neuronal network of the hippocampus drawn by Ramon y Cajal (1901)





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HOW THE FETAL BRAIN DEVELOPS EXTERNAL UDITIVE INFORMATION: Melodies, musical phrases, fairy tales ..

frontiers in Human Neuroscience

Front Hum Neurosci. 2015; 9: 127.
Published online 2015 Mar 11. doi: 10.3389/fnhum.2015.00127

PMCID: PMC43

Editorial on emerging neuroimaging tools for studying normal and abnormal human brain development

Christos Papadelis,[1,2,*] P. Ellen Grant,[1,2,3] Yoshio Okada,[1,2] and Hubert Preissl[4,5]

- **At the 28th week** fetuses are not limited to perceiving general noises outside the belly, **but distinguish the different noises and learn to filter the stimuli,** important to learn how to process information in a sensible way.

- The fetuses, in addition to modifying their motor and cardiac activity in response to auditory stimulations, also know how to recognize and memorize the proposed auditory stimuli.
  It has been found that after hearing the same sound several times, for which heart and motor responses have been noticed, the fetus, recognizing the sound and no longer being alarmed by it, does not react anymore. These statements show that the brain of the fetus **can process external stimuli and is capable of a rudimentary learning.**

- **Numerous tests have been carried out on newborns about their ability to recognize melodies, musical phrases and even fairy tales read by their mother in the last weeks of pregnancy**.*(Huebert Preissl- Tuebingen University, Germany).*

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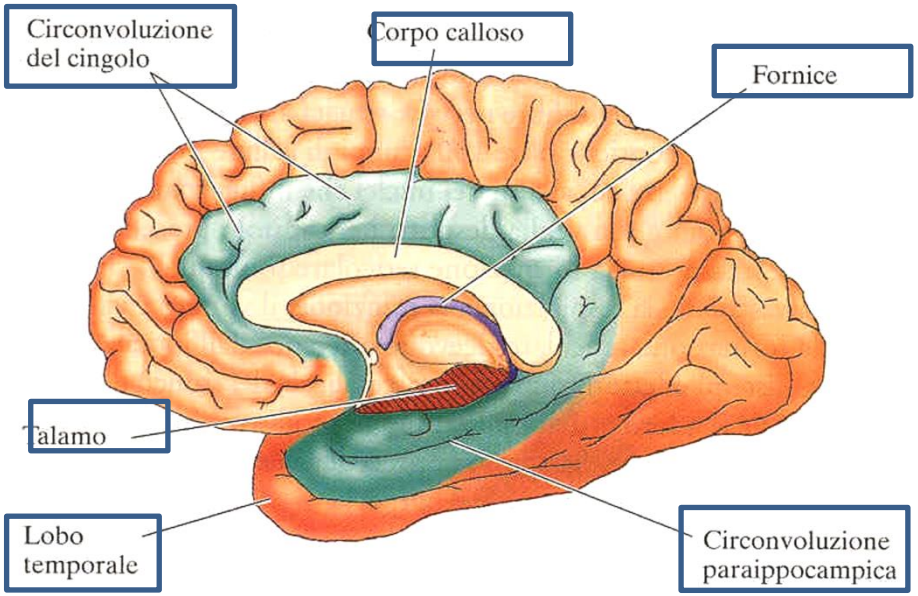
Limbic System: in charge of affective processing

- **Limbic System:** set of regions of the diencephalon and telencephalon that "coordinate sensory afferences with bodily reactions and visceral needs" (Papez) and which "represent the place of origin of emotions" *(Fulton 1951).* This portion of the Central Nervous System intervenes in **the elaboration of the whole set of behaviors correlated with the survival of the species**:

Limbic system processes emotions and the vegetative reactions that to them they are accompanied and is involved in the memorization processes.



SUBCORTICAL COMPONENTS : **Hypothalamus** and various adjacent structures, including the septum, *part of the nuclei of the basal ganglia* and of the anterior thalamus . **Hippocampus and amygdala. Hypothalamus:** role of integration and control of vegetative functions, of physiological needs, of "instinctive" behaviors. **The amygdala attributes the emotional meaning of stimuli**

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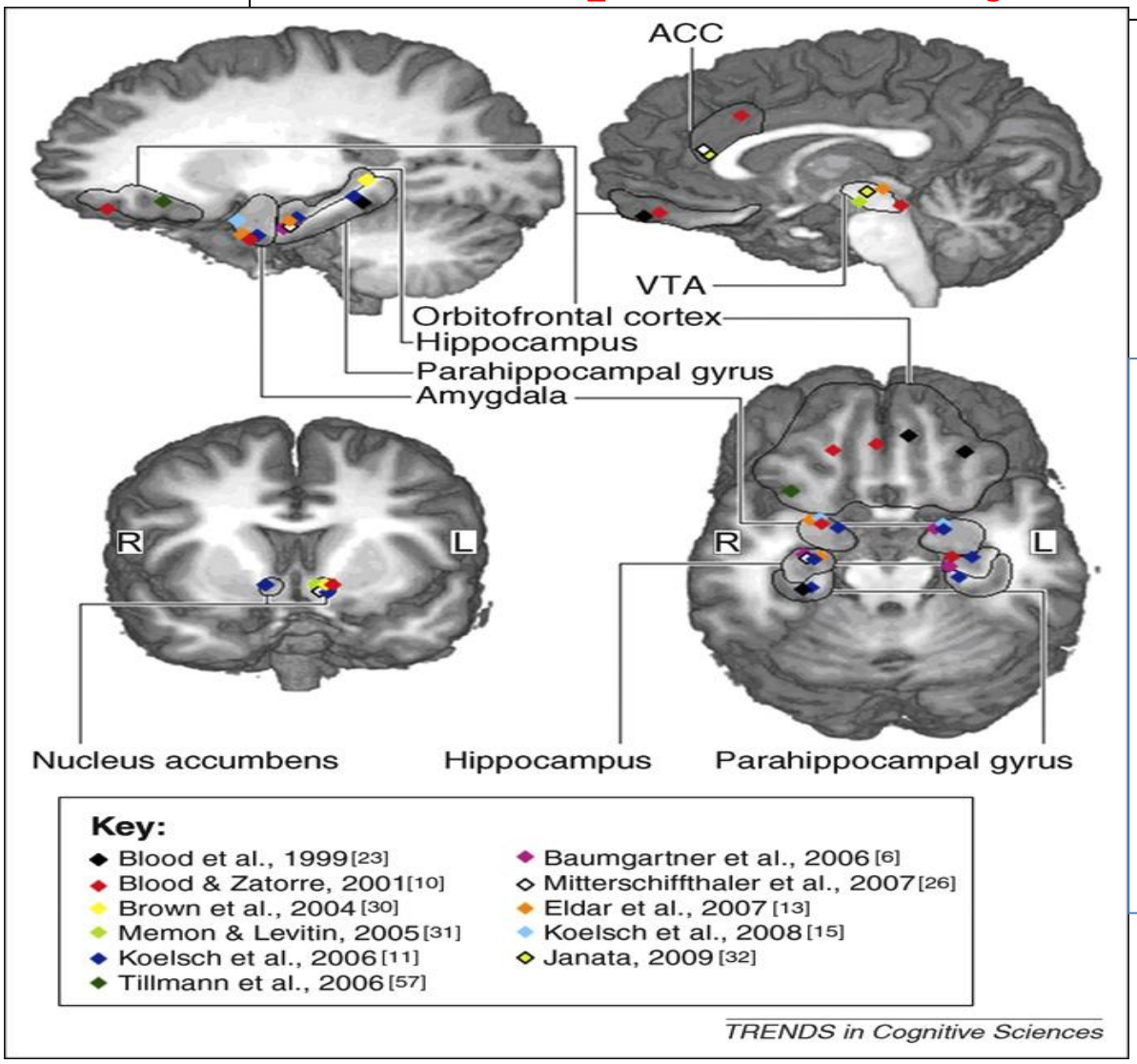
Some structures belonging to the limbic/paralimbic system *(Koelsch, 2010)*



Music is capable of modulating activity in core structures of emotion.

Listening to efficacius music in decreasing anxiety, depression, pain (also during pregnancy)

Cassileth et al., 2003
Cepeda et al., 2006
Siedliecki and Good, 2006

The diamonds represent music-evoked activity changes in these structures

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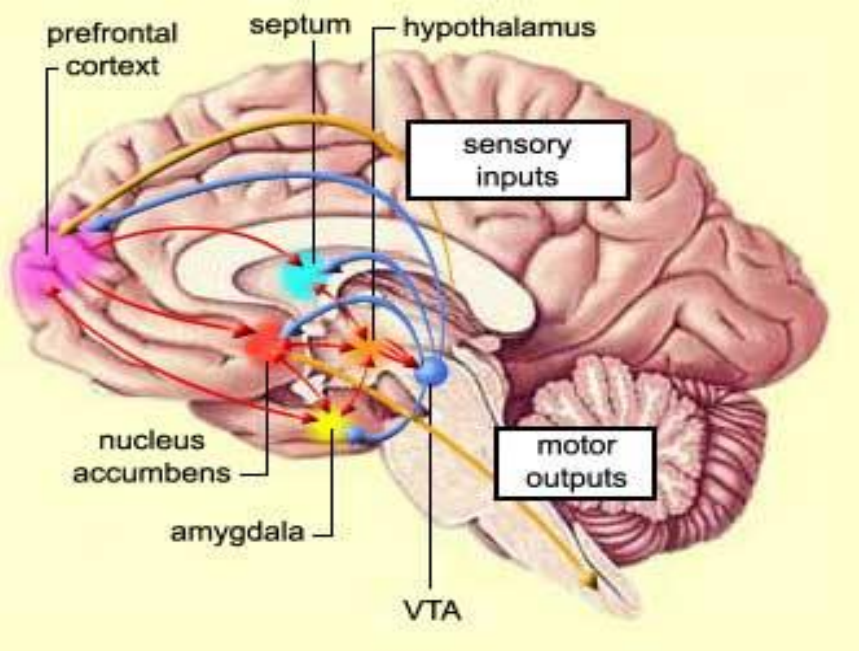
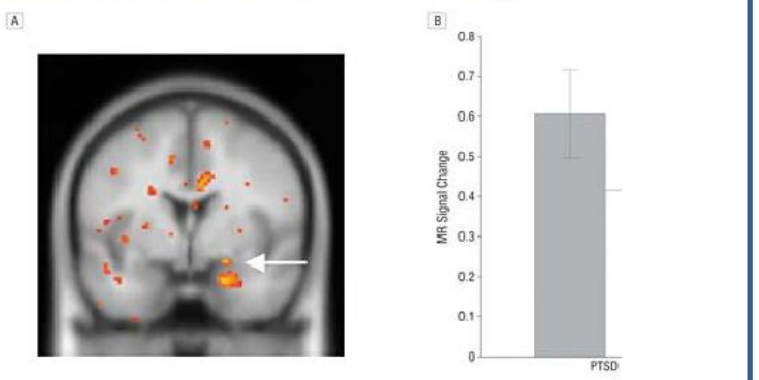
LIMBIC and MESOLIMBIC SYSTEMS, MUSIC EMOTION and *REWARD*

- The emotions induced by music activate ***reward circuits of the mesolimbic system***, the cerebral hemispheres, the midbrain and the orbito-frontal regions and the amygdala
- **MESOLIMBIC SYSTEM:** **Dopaminergic neurons** that originate from the midbrain and innervate different areas of the limbic system, including the nucleus accumbens (NA).
- The mesolimbic reward circuit (gratification) whose activation makes it pleasant to eat, drink, sexual behavior and social interactions essential for the survival of the species.
  -- **This circuit is also activated by other pleasant experiences like listening to music, playing,..** sports, sexual intercourse, drinking water when you are thirsty, .. **is linked to the release of dopamine.**
- - Music induces feelings, reactions of the vegetative system, changes in heart rhythm and breathing, **but also motivations for movement.**



fMRI: increased activity of the amygdala



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PERINATAL SCIENCE OF EMOTIONS AND AFFECTIONS

The emotional involvement of the mother towards the first fetus and the newborn then, **activates neuroendocrine modifications**.

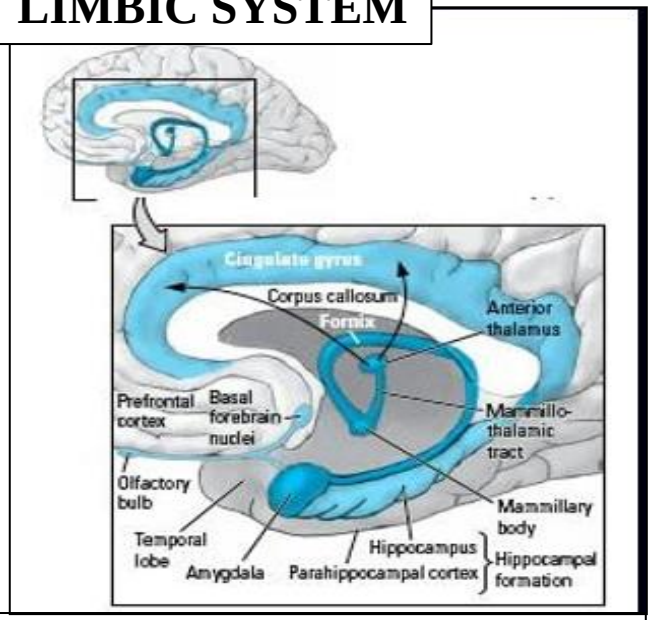
Throughout the perinatal period **the mother produces neuromodulators** capable of increasing the efficacy of the synaptic connections of the child.
Activate production of **endogenous opioids, analgesic and excitatory endorphins.**

One of these is **Oxytocin** , a neuro-modulator that promotes tenderness and devotion by reinforcing the tendency to bind to others. By absorbing oxytocin the fetus in turn develops and fixes forever the desire of the affective relationship. *Studies in progress*

The maternal psychological state therefore becomes biological first and then psychological in the small**.**

- Parents but also all those who deal with small children must be aware of how basic the relationships are in brain building, and how much the caresses or lack of them can nourish the limbic area: **the structures limbs in the depths of the brain collect and process all emotions.**

LIMBIC SYSTEM



Music releases endorfins and Dopamine (pleasure).

Serotonin is under control of limbic system and is responsible of **modulation of mood tone** and increases the **analgesic processes in the body**.

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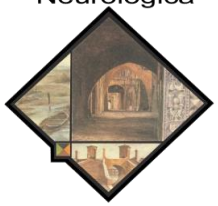

The neurochemistry of music

Mona Lisa Chanda and Daniel J. Levitin

Trends in Cognitive Sciences, 2013, Vol. 17, No. 4

Department of Psychology, McGill University, Montreal, Quebec, QC H3A 1B1, Canada

Music releases endorphins (body's natural pain killers) **and dopamine** (pleasure) into the body. **Serotonin** is also controlled by the limbic system; it is responsible for regulating mood and enhancing the effects of analgesics.

- Music is used to regulate mood and arousal in everyday life and to promote physical and psychological health and well-being in clinical settings.
- However, scientific inquiry into the neurochemical effects of music is still in its infancy. In this review, we evaluate the evidence that music improves health and well-being through the engagement of neurochemical systems for
- (1) **reward, motivation**, and **pleasure**;
  (2) **stress and arousal**;
  (3) **immunity;** *and*
  (4) **social affiliation…**

1. **Dopamine and opioids**
2. **Cortisol, corticotrophin-releasing hormone (CRH), adernocorticotropic hormone (ACTH)**
3. **Serotonin and the peptide derivatides of proopriomelanocortin (POMC), including alphamelanocyte stimulating hormone and beta-endorphin**
4. **Oxytocin**

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MAIN EFFECTS OF MUSIC ON THE FETUS

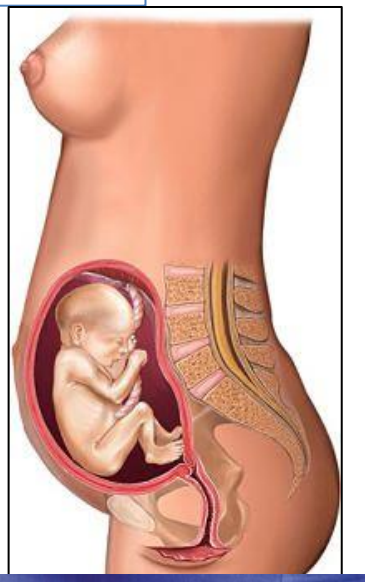
- Several studies have shown that **children between two and five years of age, exposed in prenatal life to musical stimulation**, are able to make more organized and articulate speeches, to know how to memorize long songs and they sing in an expressive way.

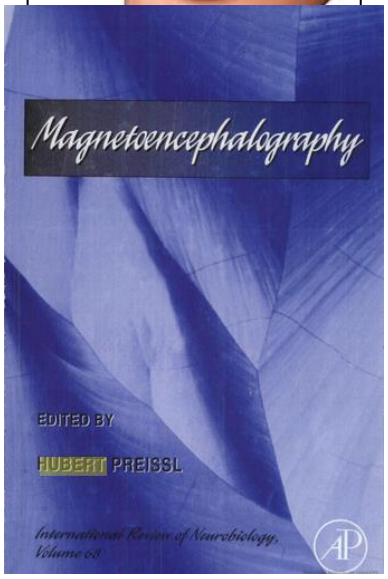
Music and singing also help the **production of endorphins**, which have an anti-stress function and cause general well-being.

- **During pregnancy this well-being is useful both to the future mother and the child:** relaxation resulting from listening to music or singing helps to lower tensions, to regularize the heartbeat and blood pressure. Thanks to the production of endorphins, fatigue and moodiness are counteracted and we are helped to live the pregnancy more serenely

Singing also plays **an important role in building and strengthening the mother-child bond through intrauterine communication.**

- The uterine environment, in fact, is not a silent place but, on the contrary, a real resonance box thanks to which the child begins to compose his own "soundtrack".





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J Physiol Sci (2010) 60:213–220
DOI 10.1007/s12576-010-0087-x

ORIGINAL PAPER

Fetal response to induced maternal emotions

Miyuki Araki · Shota Nishitani · Keisho Ushimaru · Hideaki Masuzaki · Kazuyo Oishi · Kazuyuki Shinohara

THE MATERNAL EMOTIONS ARE ABLE TO INFLUENCE THE FETUS

Università di Nagasaki

Research on **the effects of mother's joy during pregnancy**. Analysis of the correlation between positive emotions experienced during pregnancy and growth of the baby.

Experiment: **3 different groups of pregnant women** are provided with **cheerful, sad and neutral videoclips.** Women were put on headphones to ensure that only the effect of their emotions was measured, not the sounds.

- **Experiment:** 3 different groups of pregnant women are provided with cheerful, sad and neutral videoclips. Women were put on headphones to ensure that only the effect of their emotions was measured, not the sounds.

Results:

- **the emotions induced in pregnant women modify above all the movements of the arms of their children**: the number of movements of the fetal arms was higher when the pregnant women looked at a funny videoclip with little musics,
- the number and the duration of the movements **decreased progressively during the viewing of neutral and sad videos.**

Conclusion:The sadness increases in the fetuses the levels of catecholamines, hormones released in response to stress suffered. These hormones direct the blood out of the uterus, reducing the supply to the brain of the fetus.

- A correlation could therefore be found between the happiness of the mother and a better brain development.

G Klimt (1903) Speranza I

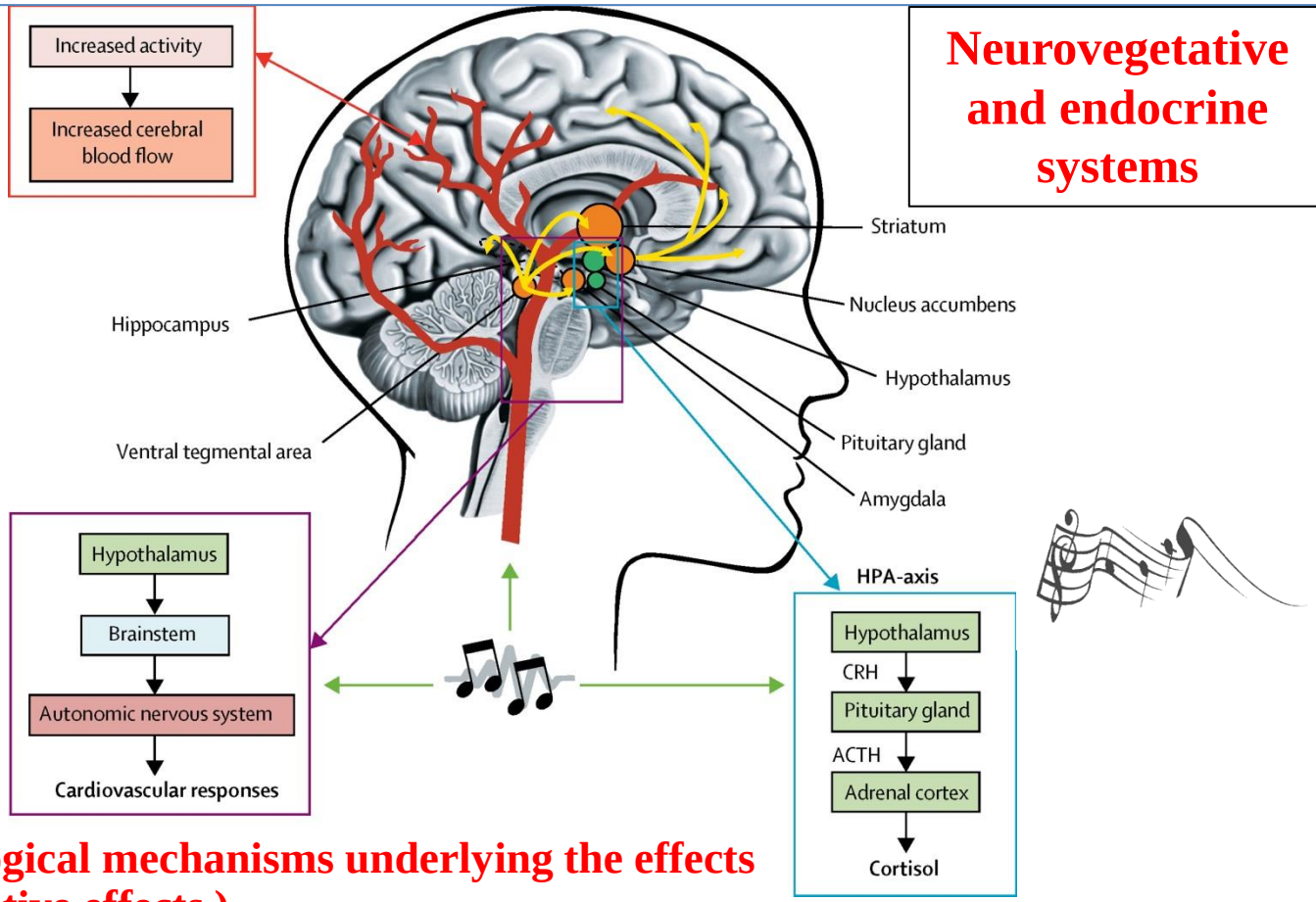
Music-based interventions in neurological rehabilitation

Aleksi J Sihvonen, Teppo Särkämö, Vera Leo, Mari Tervaniemi, Eckart Altenmüller, Seppo Soinila

Lancet Neurol 2017;

Neurovegetative and endocrine systems

Limbic/ mesolimbic system

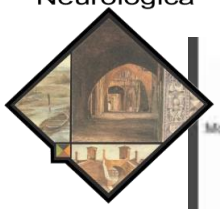


Possible neurobiological mechanisms underlying the effects of music (rehabilitative effects)

The orange circles and the yellow arrows represent the mesolimbic system, while the green circles represent the **HPA axis.**

ACTH=adrenocorticotropic hormone. CRH=corticotropin-releasing hormone.

HPA axis=hypothalamic-pituitary-adrenal axis.



Music, the food of neuroscience?

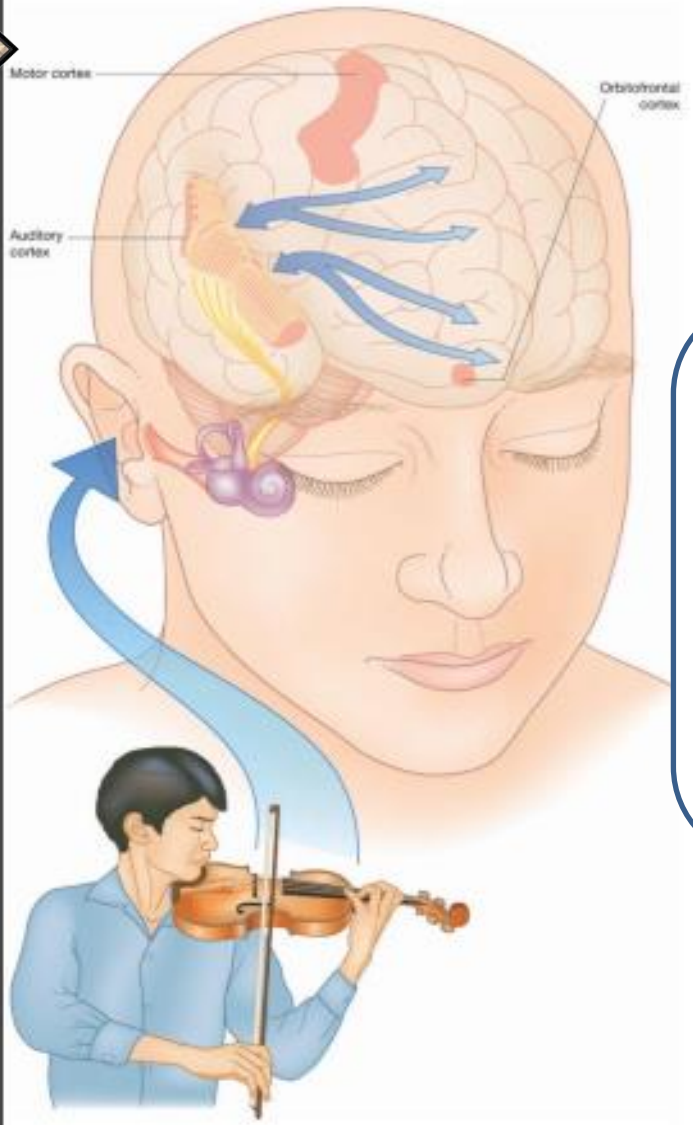


Figure 1 The processing of sound waves from a musical instrument. After being transduced into neural impulses by the inner ear, information travels through several waystations in the brainstem and midbrain to reach the auditory cortex. The auditory cortex contains distinct subregions that are important for decoding and representing the various aspects of the complex sound. In turn, information from the auditory cortex interacts with many other brain areas, especially the frontal lobe, for memory formation and interpretation. The orbitofrontal region is one of many involved in emotional evaluation. The motor cortex is involved in sensory–motor feedback circuits, and in controlling the movements needed to produce music using an instrument.

Playing, listening and creating music involve practically every cognitive and behavioral and emotional-affective function.
Robert Zatorre explains how music can teach us about language, brain plasticity and also the origin of emotions.

Robert Zatorre is a cognitive neuroscientist and James McGill professor of neuroscience at the Montreal Neurological Institute.

NATURE | VOL 434 | 17 MARCH 2005

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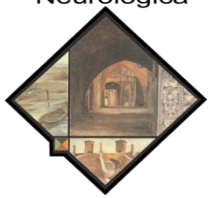

Neurogenesis and Plasticity

Schlaug, 2009,Ann. N.Y. Acad. Sci, 1169: 372-373,

- … long-term music training and skill learning can be a strong stimulator for **neuroplastic changes** **in the developing brain *(and neurogenesis)*** as well as adult brain.

- **Making music** places unique demands on the nervous system, leading to **strong coupling of perception and action** mediated by sensory, motor, and multimodal integrative regions distributed throughout the brain.

- … **listening to music and making music ("musicking") provoke motion, improves and increases between-subject communication and interaction, and is considered to be and experienced as a joyous and rewarding activity.**

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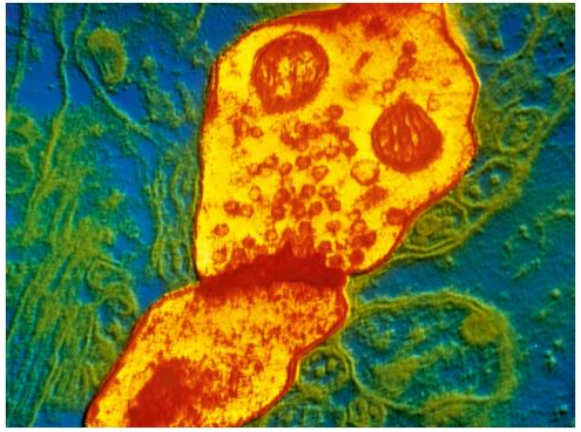
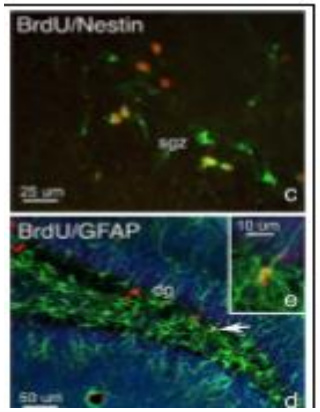
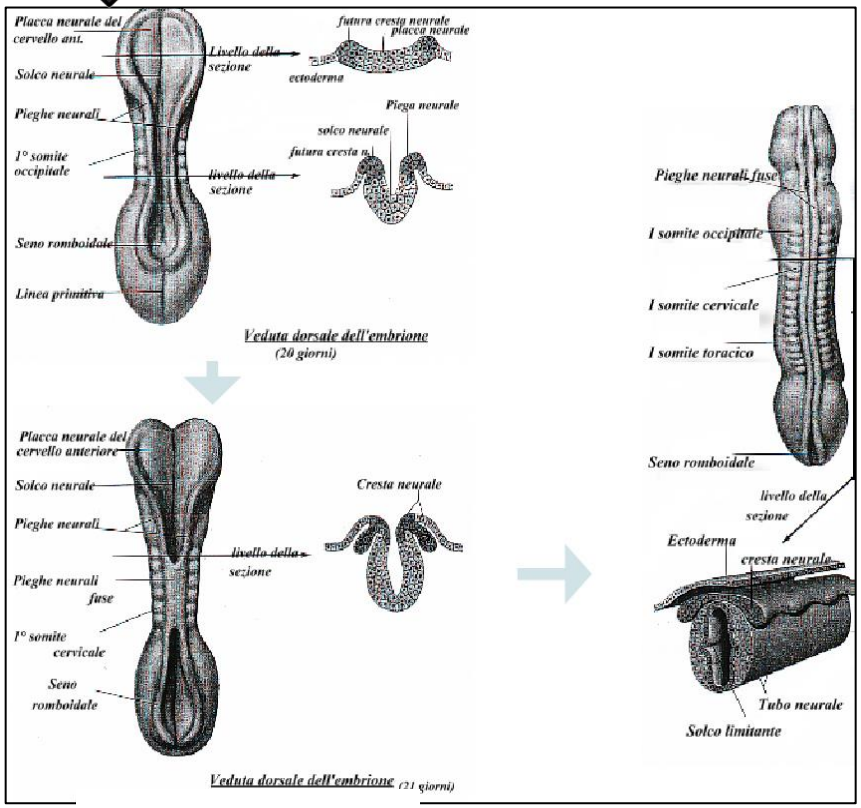
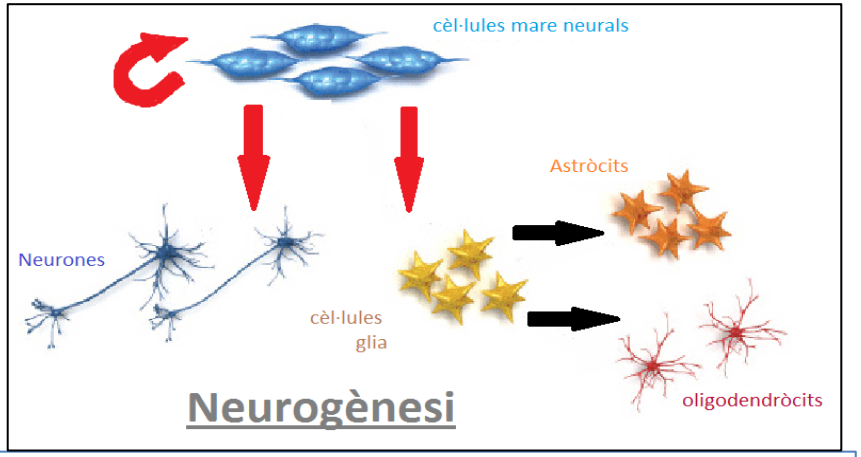
Neurogenesis









- **New neurons and glial cells are generated by progenitor cells. Process through which the central and peripheral nervous system (brain and other nerve structures) are formed.**
- *Recently neurogenesis has also been demonstrated in the adult brain, mammals and humans, in sub-ventricular areas and in the hippocampus.*

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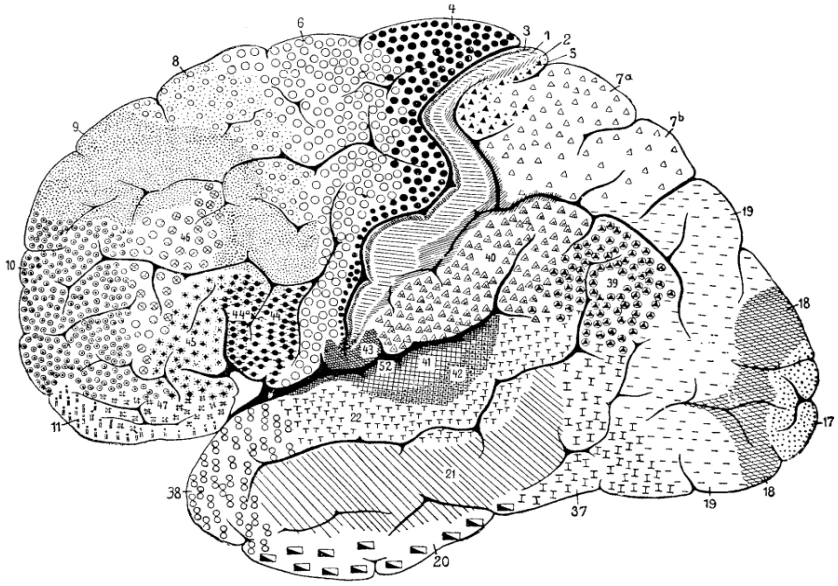
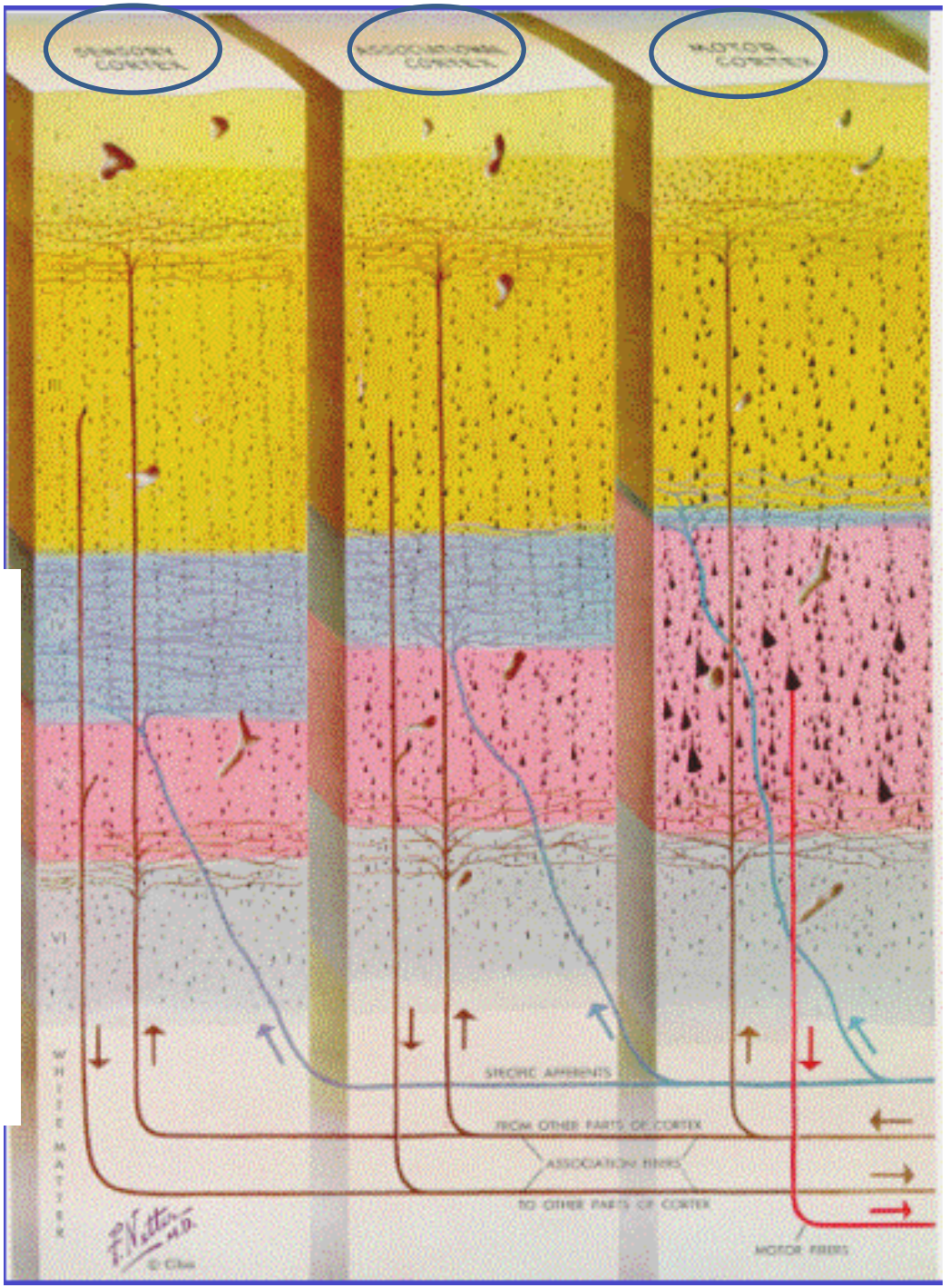
Cell differentiation in the brain





MUSIC: STRONG MODEL OF STRONG STIMULUS OF PLASTICITY

- **Plasticity:** functional and structural adaptation of the Nervous System addressed to (extensive) processes of relevant (more complex)

(Eckart Altenmüller, 2015)

secondi minuti giorni settimane mesi

1) Efficiency of synapses

2) Recruitment of neurons

3) Amount of synapses

4) Amount and heights of neurons

5) Level of myelinization

6) Interaction with glial cells and processes of capillarization of brain tissue

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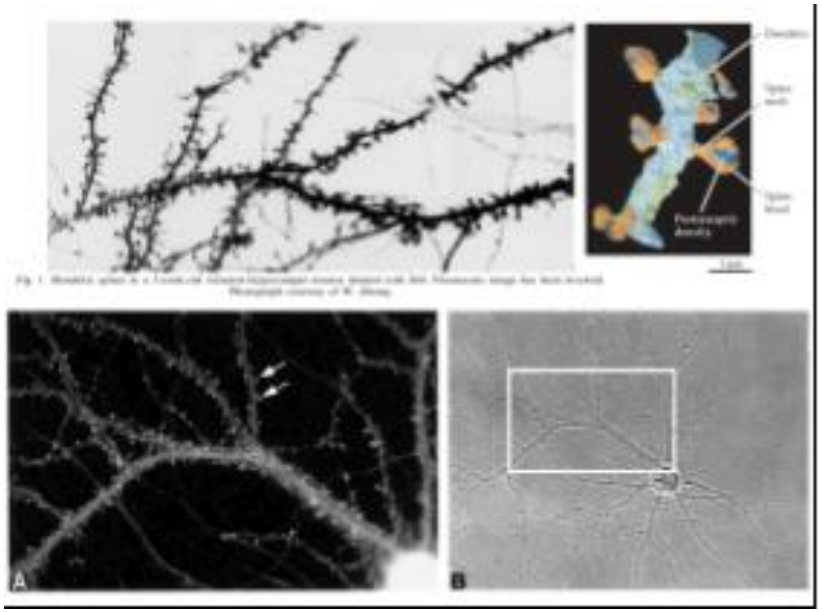
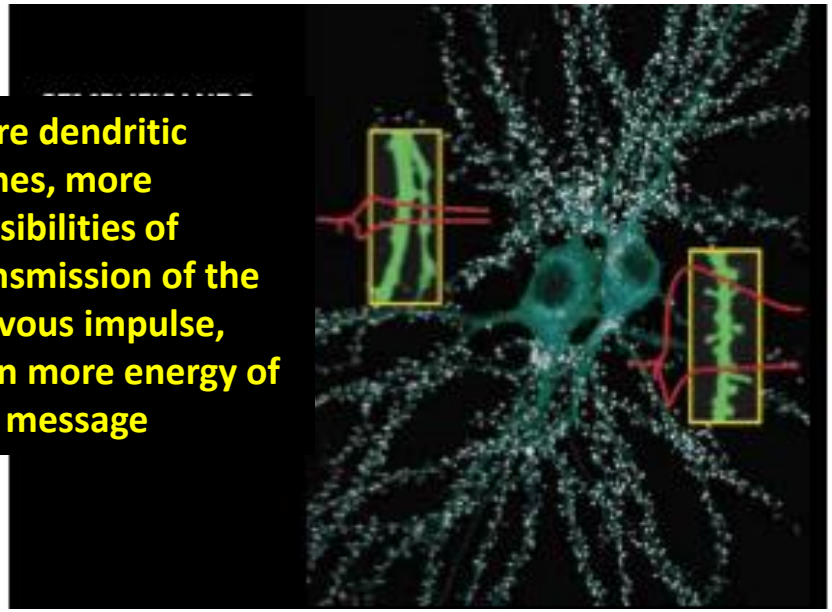
Neural Plasticity

new dendrites, spines and synapses enriched environment, es. music

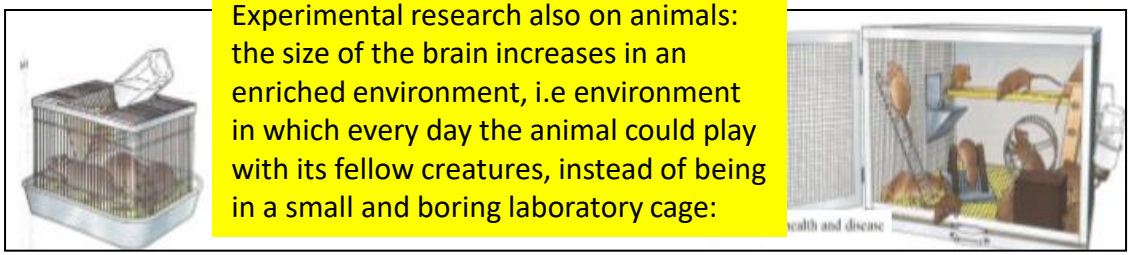


more dendritic spines, more possibilities of transmission of the nervous impulse, then more energy of the message

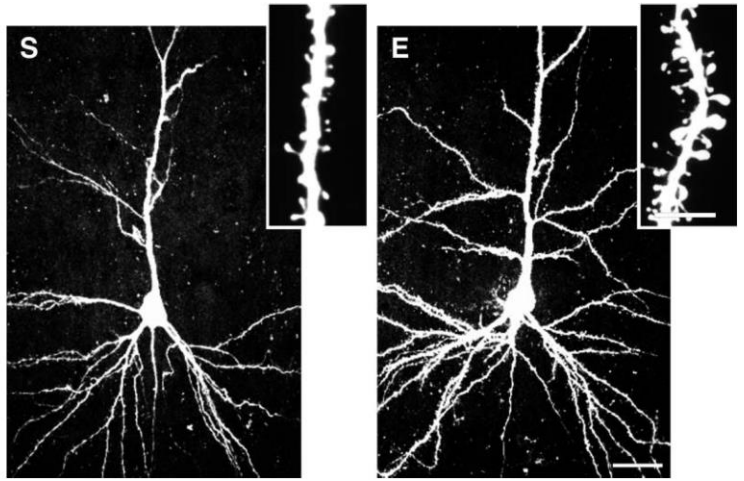


232 Johansson BB: Brain plasticity in health and disease

The environment enriched by stimuli induces trophic changes continuously



Experimental research also on animals: the size of the brain increases in an enriched environment, i.e environment in which every day the animal could play with its fellow creatures, instead of being in a small and boring laboratory cage:



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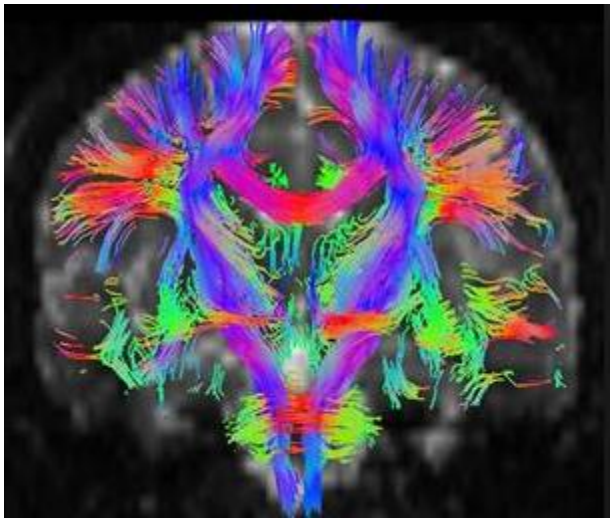
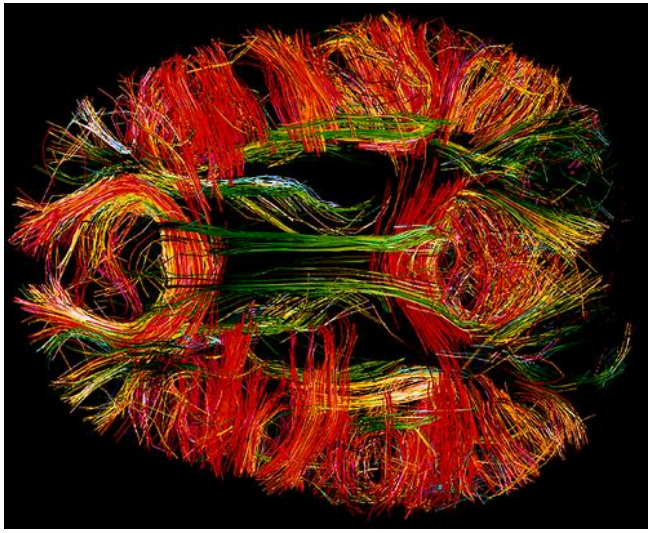
Tractography studies the myelinated connection routes of cortical regions

- **Tractography:** neuroimaging technique of two-dimensional modeling: visually represents the neural ways , using data collected from **diffusion tensor imaging (DTI),** special MRI techniques and computer image analysis.
  The results are presented in two- or three-dimensional images.
  First studies also on the brains of the fetus.





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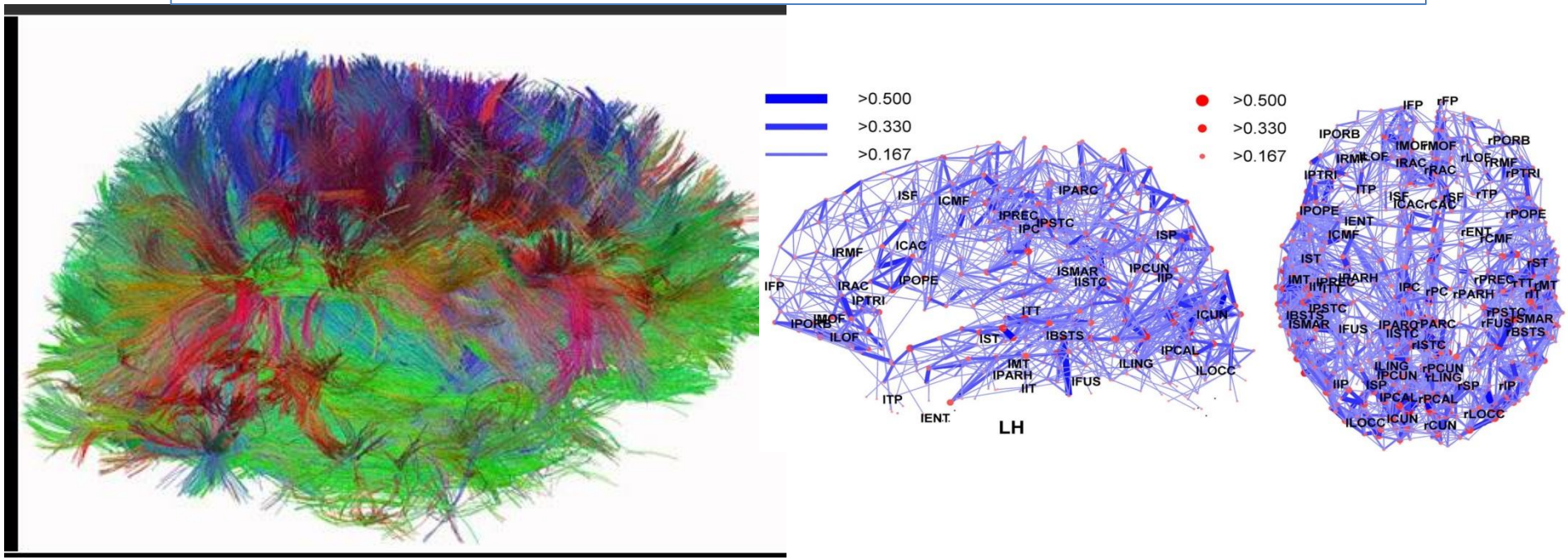
Processes of neural connectivity of the nervous ways



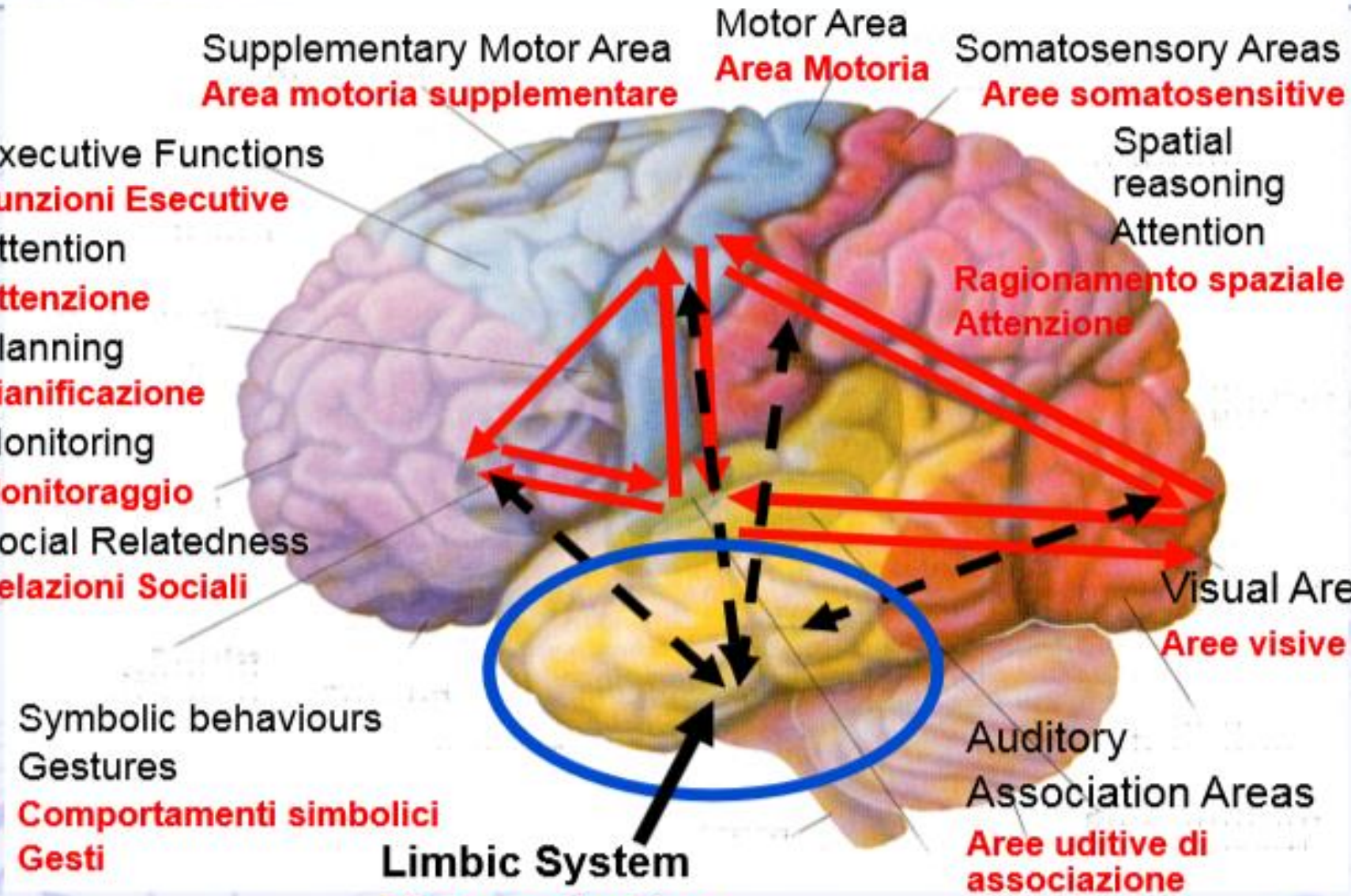
. Intricate brain architecture presented in all its **"connectivity"** and beauty thanks to a reinforcement of the MRI.

The new neuroimaging systems allow to map the neural circuits with extreme precision: each fiber, characterized by a different color, represents hundreds of thousands of neurons.

Listening to Music as „Networking Art“

ODOLOGY

Ascoltare la musica come Arte di Networking



Ekart Altenmüller, 2017

nature REVIEWS NEUROSCIENCE

Scuola di Hannover

Perspectives

Nature Reviews Neuroscience **3**, 473-478 (June 2002) | doi:10.1038/nrn843

The musician's brain as a model of neuroplasticity

Thomas F. Münte, Eckart Altenmüller & Lutz Jäncke

Studies of experience-driven neuroplasticity at the behavioural, ensemble, cellular and molecular levels have shown that the structure and significance of the eliciting stimulus can determine the neural changes that result. Studying such effects in humans is difficult, but professional musicians represent an ideal model in which to investigate plastic changes in the human brain. There are two advantages to studying plasticity in musicians: the complexity of the eliciting stimulus — music — and the extent of their exposure to this stimulus. Here, we focus on the functional and anatomical differences that have been detected in musicians by modern neuroimaging methods.

Neuron

Cell PRESS

Volume 76, Issue 3, 8 November 2012, Pages 486–502

Review

Musical Training as a Framework for Brain Plasticity: Behavior, Function, and Structure

Sibylle C. Herholz[1], Robert J. Zatorre[1,]

Show more

doi:10.1016/j.neuron.2012.10.011

Musical training has emerged as a useful framework for the investigation of training-related plasticity in the human brain. Learning to play an instrument is a highly complex task that involves the interaction of several modalities and higher-order cognitive functions and that results in behavioral, structural, and functional changes on time scales ranging from days to years. While early work focused on comparison of musical experts and novices, more recently an increasing number of controlled training studies provide clear experimental evidence for training effects. Here, we review research investigating brain plasticity induced by musical training, highlight common patterns and possible underlying mechanisms of such plasticity, and integrate these studies with findings and models for mechanisms of plasticity in other domains.

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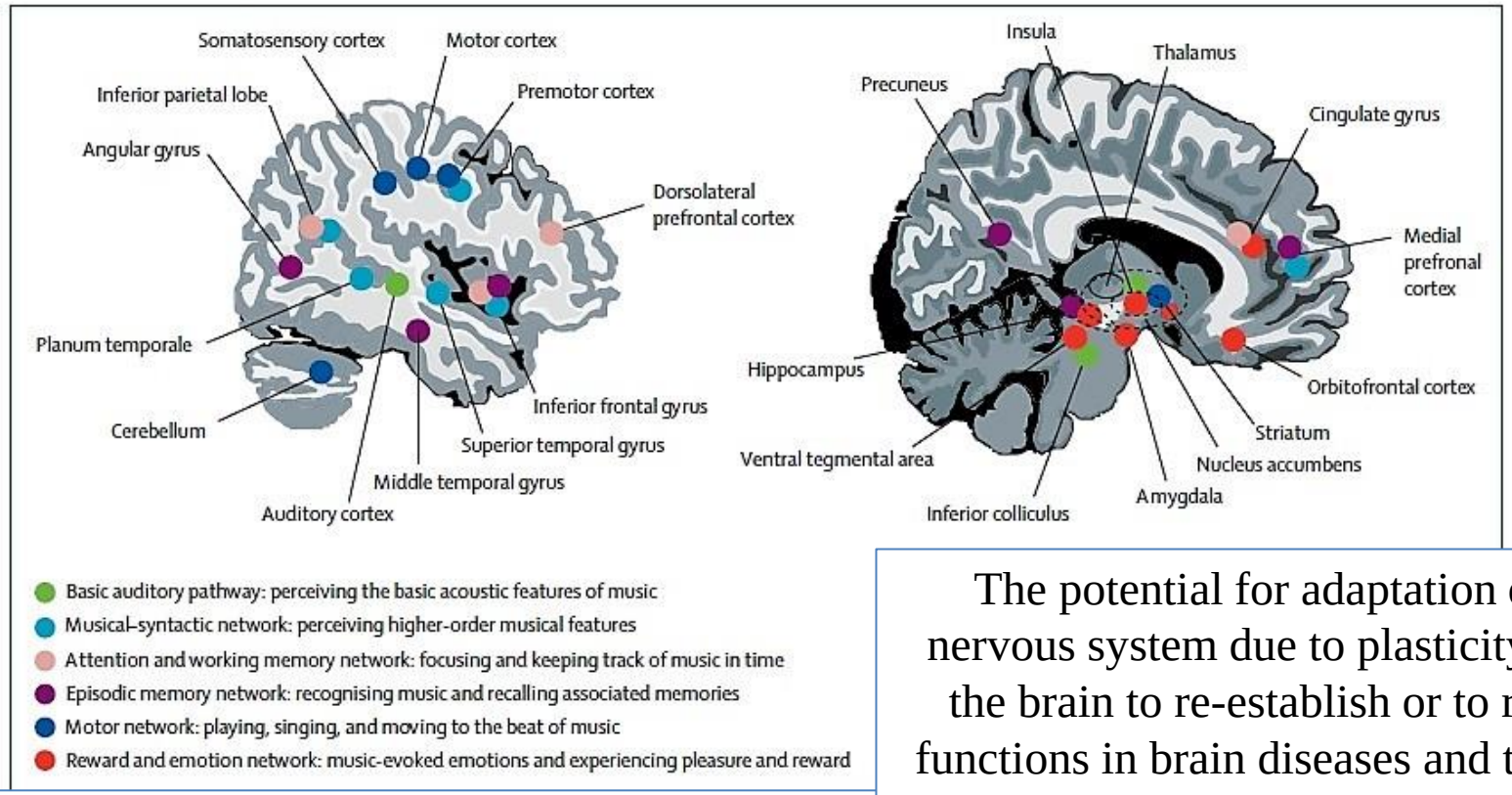
Music-based interventions in neurological rehabilitation

Aleksi J Sihvonen, Teppo Särkämö, Vera Leo, Mari Tervaniemi, Eckart Altenmüller, Seppo Soinila

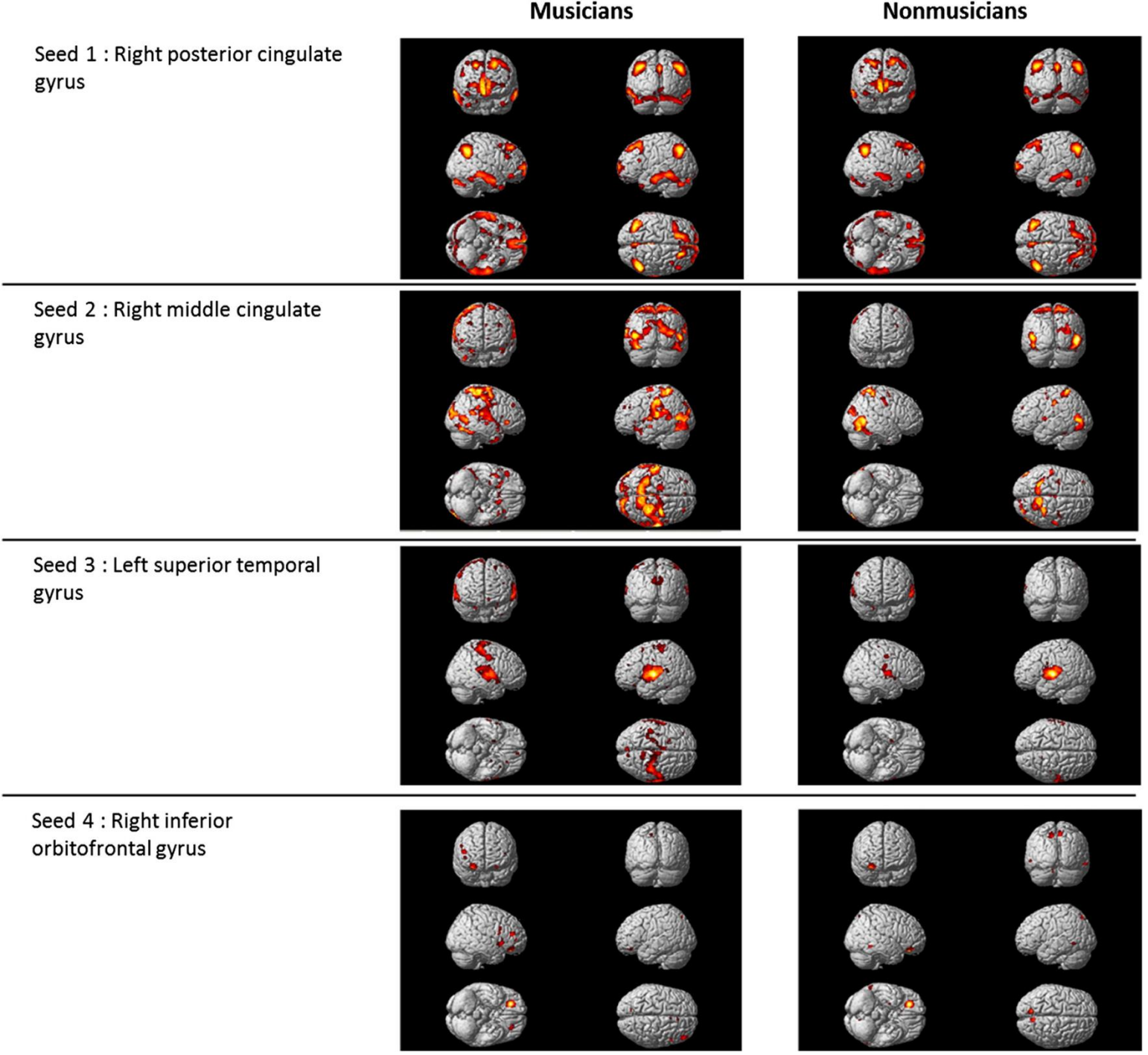
Lancet Neurol 2017; 16: 648–60

Key areas of the brain associated with music processing
Areas identified by neuroimaging studies of healthy people.



The potential for adaptation of the nervous system due to plasticity allows the brain to re-establish or to recover functions in brain diseases and to reduce the effects of structural alterations.

Although the figure shows the lateral and medial parts of the right hemisphere, many processes induced by music are largely bilateral (with the exception of the processing of intonation and melody, which are lateralized: in the right hemisphere the activity is dominant).



fMRI during listening of music

Brain plasticity in musical *expertise*

the four resting-state functional connectivity maps for **musically-experienced group** and **nonmusicians group.** p(fwe) ≤ 0001.

(Fauvel B,et al, 2014)

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Proc Natl Acad Sci U S A. 2013 Sep 10; 110(37): 15145–15150.
Published online 2013 Aug 26. doi: 10.1073/pnas.1302159110
Psychological and Cognitive Sciences

Effects of fetal exposure to changes in tone and pseudowords on neural responses: **tatota** *instead of* **tatata**

Learning-induced neural plasticity of speech processing before birth

Eino Partanen,[a,b,1] Teija Kujala,[a,c] Risto Näätänen,[a,d,e] Auli Liitola,[a] Anke Sambeth,[f] and Minna Huotilainen[a,b,g]

- **Abstract**

Learning, the foundation of adaptive and intelligent behavior, is based on plastic changes in neural assemblies, reflected by the modulation of electric brain responses.

In infancy, auditory learning implicates the **formation and strengthening of neural long-term memory traces, improving discrimination skills, in particular those forming the prerequisites for speech perception and understanding.**

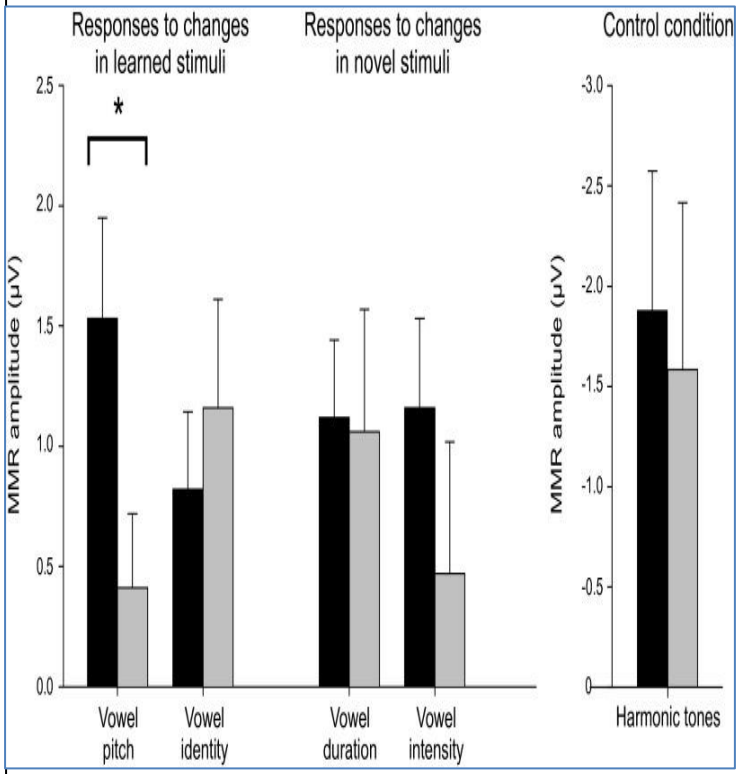
Although previous behavioral observations show that **newborns react differentially to unfamiliar sounds vs. familiar sound material that they were exposed to as fetuses, the neural basis of fetal learning has not thus far been investigated.**

Here we demonstrate direct neural correlates of human fetal learning of speech-like auditory stimuli. We presented **variants of words to fetuses :PSEUDOWORDS** ; unlike infants with no exposure to these stimuli, **the exposed fetuses showed enhanced brain activity (mismatch responses) in response to pitch changes for the trained variants after birth.**

……..

Furthermore, a significant correlation existed between the amount of prenatal exposure and brain activity, with greater activity being associated with a higher amount of prenatal speech exposure. Moreover, the learning effect was generalized to other types of similar speech sounds not included in the training material.

Consequently, our results indicate **neural commitment specifically tuned to the speech features heard before birth and their memory representations.**



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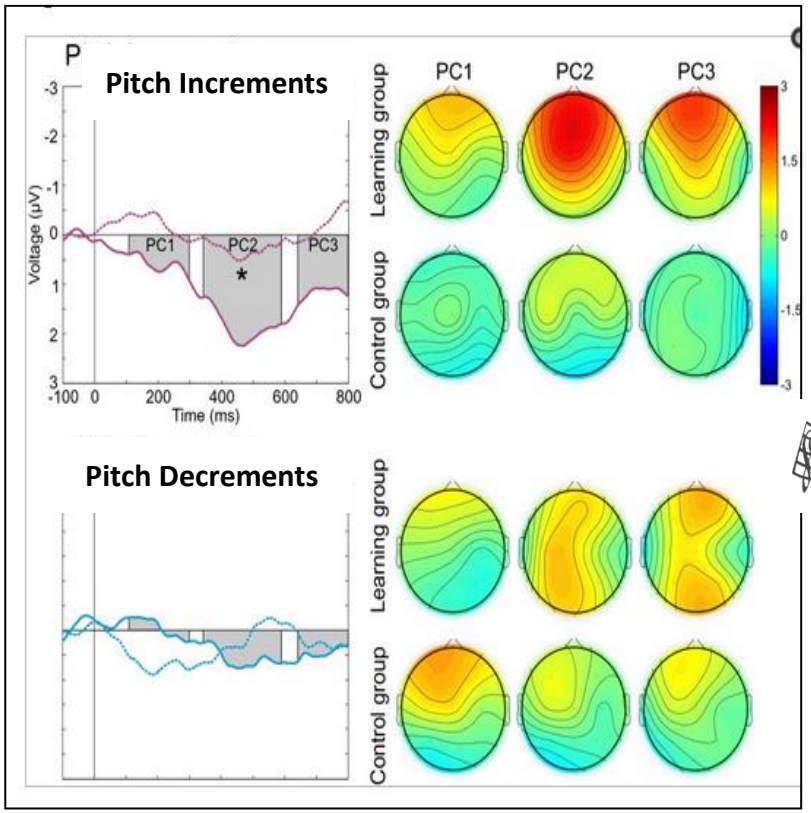
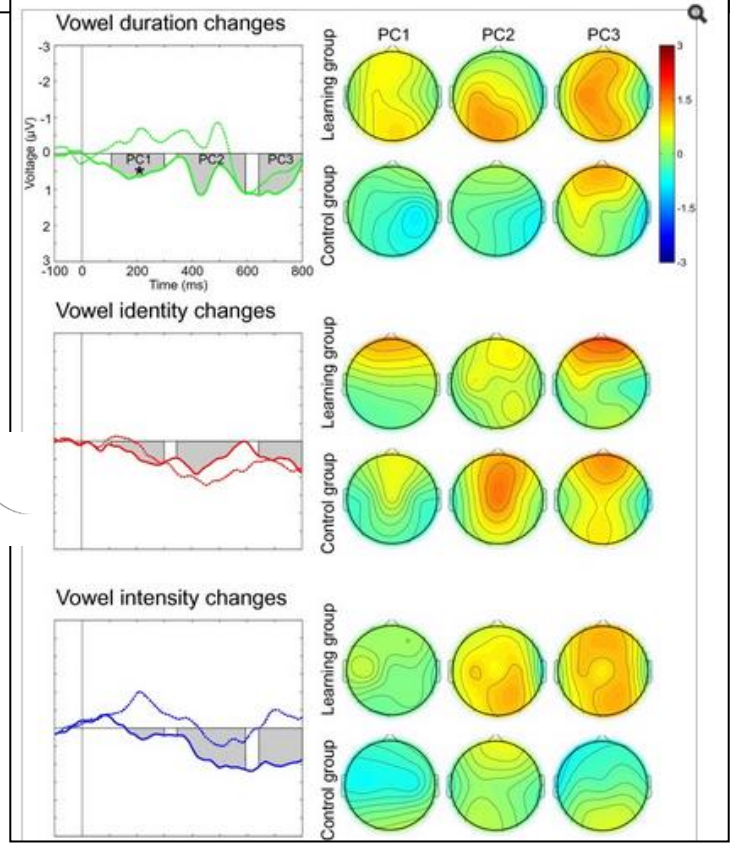
Published online 2013 Aug 26. doi: 10.1073/pnas.1302159110
Psychological and Cognitive Sciences

Learning-induced neural plasticity of speech processing before birth

Eino Partanen,[a,b,1] Teija Kujala,[a,c] Risto Näätänen,[a,d,e] Auli Liitola,[a] Anke Sambeth,[f] and Minna Huotilainen[a,b,g]

Effects of fetal exposures to pitch variations and to *pseudowords* on the neural responses: tatota *instead of* tatata





Effects of fetal exposure to pitch increments and decrements in the middle syllable of the pseudoword [tatata] on the neural responses. The responses of the learning group are shown with solid lines (n = 17), and those of the control group are shown with dotted lines (n = 16). Gray bars denote the latencies of interest indicated by the PCs of the tPCA. The right column shows the distribution of the neural activity across the scalp for each of the PCs. The neural activity was significantly stronger in the learning group than in the control group for pitch increments to which only the learning group had been exposed prenatally (*P < 0.05).

Effects of fetal exposure to pseudowords on the neural responses to vowel duration, vowel identity, and vowel intensity changes in the middle syllable of the pseudoword [tatata]. The responses of the learning group are shown with solid lines (n = 17), and those of the control group are shown with dotted lines (n = 16). Gray bars denote the latencies of interest indicated by the PCs of the tPCA. The right column shows the distribution of the neural activity across the scalp for each of the PCs. Neural activity for the vowel duration change was stronger in the learning group than in the control group (*P < 0.05).

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CELL JOURNAL (Yakhteh)
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Cell J. 2015 Winter; 16(4): 448–455.
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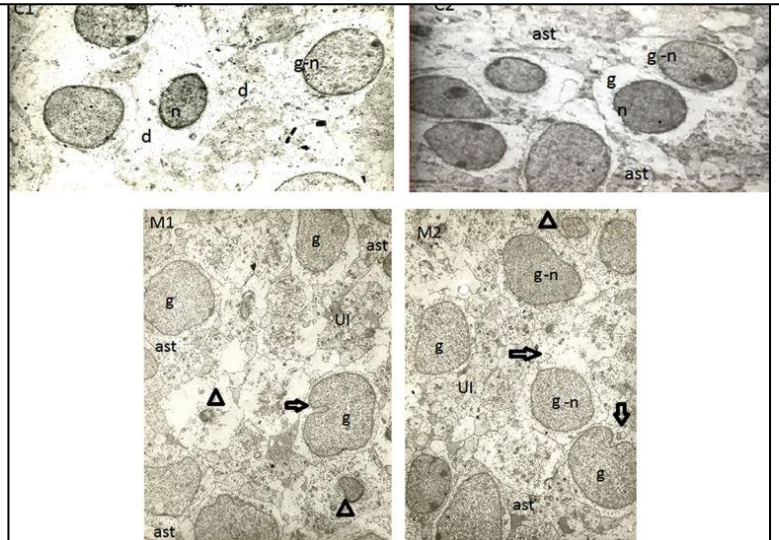
2015

PMCID: PMC

Neuroplasticity Changes of Rat Brain by Musical Stimuli during Fetal Period

Siamak Sheikhi, Ph.D[1] and Ehsan Saboory, Ph.D[2,3,*]

12 Wistar female rats were selected, assigned uniformly to control and musical groups. The music group was exposed to classical music with a power of 60 dB for 90 minutes twice a day from 2 (nd) to 20 (th) day of gestation. The control rats were managed similarly to the band, but they were not exposed to music. Before delivery, all mothers were anesthetized and their blood samples were obtained and used to measure corticosterone. The fetal brains were extracted intact and used for the preparation of the slices. Horizontal slices were made for the preparation of the electron microscope and the images were taken and analyzed in terms of cell density and morphological changes. The **fetal brains were extracted intact** and used for the preparation of the slices for electron microscope: analysis: cell density and morphological changes. **Significant morphological difference in cellular and intercellular spaces between the two groups. The fetuses treated with the music had a significantly higher cell density in the parietal cortex** and in the blood samples there was a lower cortisol level. Prenatal music would have a great impact on the neuro-plasticity of the fetal rat brain, at least indirectly. Although rat fetuses can not hear until birth, music-induced reduction in the maternal cortisol blood level may be the reason for fetal brain neuroplasticity.



Electron microscope (EM) photomicrographs of fetal parietal cortex in rats. Images C1 and C2 belong to two fetuses from control rats, Images M1 and M2 belong to a music-treated group. Shape of the cells was simpler and smoother in control rats, whereas the cell and nuclear membranes are more complex in the music-treated group. " g" indicates granular cell, " n" stands for nucleus, " ast" indicates astrocyte, " Ul" stands for unidentified cells, ⇨ indicates indentation in cell membrane and/or nucleus membrane, △ indicates nucleus of unknown cells, " d" stands for dendrite, and " ax" indicates axon.

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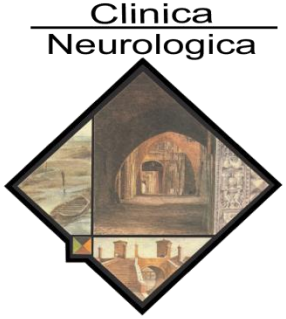
MUSIC AND LANGUAGE

Daniel Stern, *prominent American psychiatrist and psychoanalytic theorist, specializing in infant development, ...*

- "… When you talk to a baby you automatically do a whole bunch of things. You raise your pitch, you make it more melodic, the pauses are different, and they do that in every culture in the world, every place that we've looked. And the baby's nervous system's designed to that."



MUSIC and LANGUAGE

- **MUSIC IS PROTO-LANGUAGE?**

MUSIC AS AN APPROACH TO THE STUDY OF CEREBRAL FUNCTIONS

also in the fetus?

EVIDENCE OF RELATIONSHIPS BETWEEN MUSIC AND LANGUAGE !!

A SIMILAR SYNTAX IN MUSIC, LANGUAGE AND MOTOR PROGRAMMING?

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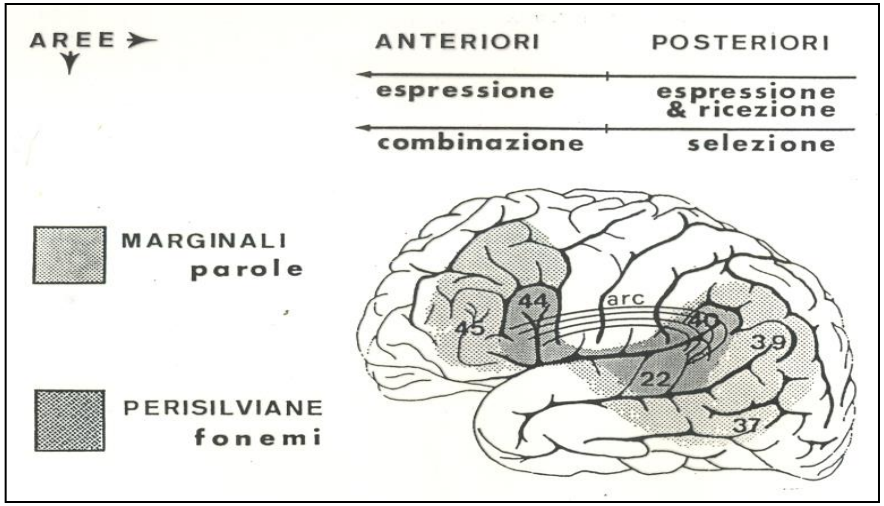
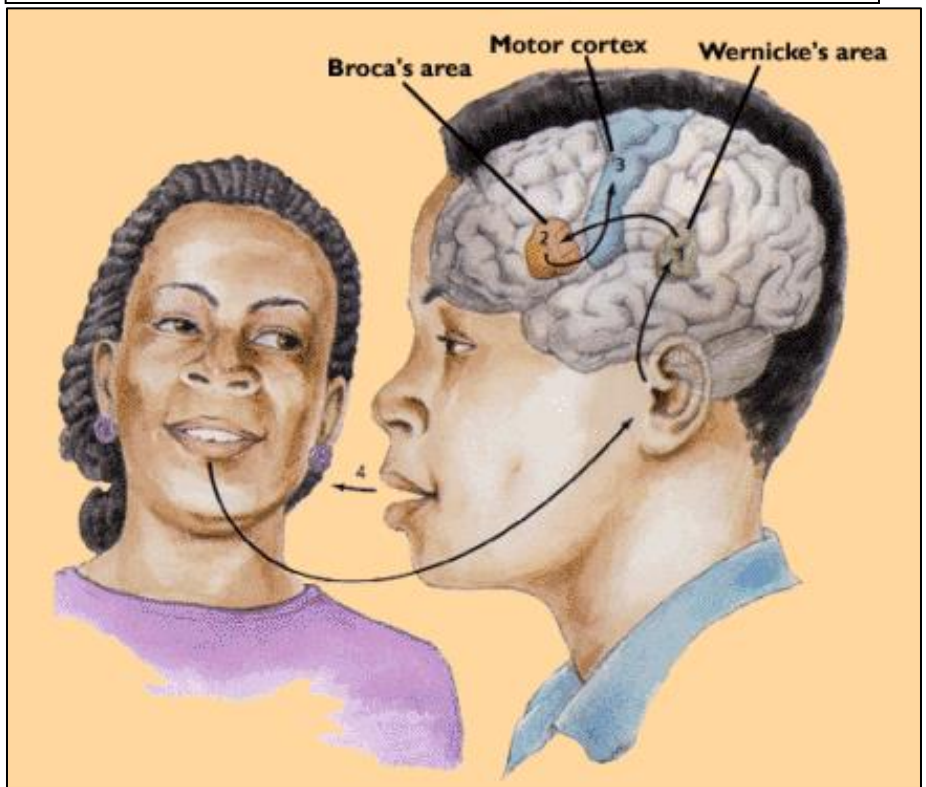
MUSICAL LANGUAGE

- **Language and music:**
  both languages basically use the same auditory-vocal channel; both can produce an unlimited number of sentences;
- ***- Children learn both languages, exposing themselves to the examples produced by adults;***

MUSICAL LANGUAGE AND SINGING





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Music and Language

- **The words of Music**

- **Rhythm**
  Harmony
  Melody
  Dynamics and
  Timbre
  Other variables ...

Listen to music:

activation of subcortical areas connected

- **to attention,**
- **to semantic and musical sintax,**
- **to memory,**
- **to motor functons**
- **to emotion**

Bhattacharya et al., 2001

- *Janata et al., 2002*
- *Koelsch et al., 2006*
- *Popescu et al., 2004*
- *Patel 2007, 2015 ……*

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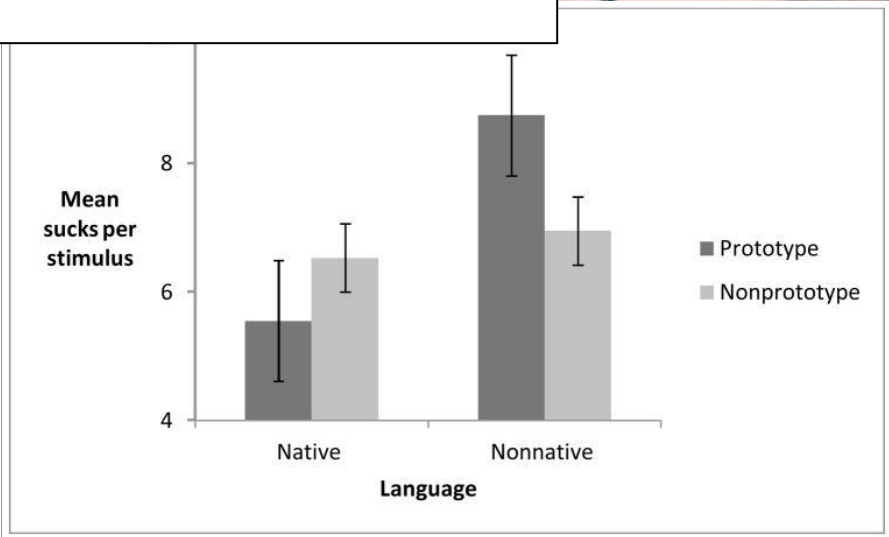
Acta Paediatr. Author manuscript; available in PMC 2014 Feb 1.
Published in final edited form as:
Acta Paediatr. 2013 Feb; 102(2): 156–160.
Published online 2013 Jan 9. doi: 10.1111/apa.12098

Results: babies born a few hours are able to distinguish the sounds of a language unknown from those belonging to the native one.

Language experienced *in utero* affects vowel perception after birth: a two-country study

Christine Moon,[1] Hugo Lagercrantz,[2] and Patricia K Kuhl[3]

- **METHOD:** experiment in Sweden (n = 40) and the USA (n = 40) **using Swedish and English vowel sounds.**
  The neonates (mean postnatal age = 33 h) controlled audio presentation of either native or non-native vowels by sucking on a pacifier, with **the number of times they sucked their pacifier being used to demonstrate what vowel sounds attracted their attention. …**
- **RESULTS:** The infants in the native and non-native groups responded differently. **As predicted, the infants responded to the unfamiliar non-native language with higher mean sucks. They also sucked more to the non-native prototype**. Time since birth (range: 7-75 h) did not affect the outcome.
- **CONCLUSION:** The ambient language to which foetuses are exposed in the womb starts to affect their perception of their native language at a phonetic level.
  This can be measured shortly after birth by differences in responding to familiar vs. unfamiliar vowels.



The neonates (mean postnatal age = 33 hrs) controlled audio presentation of either native or nonnative vowels by sucking on a pacifier, with the number of times they sucked their pacifier being used to demonstrate what vowel sounds attracted their attention. The infants responded to the unfamiliar non-native language with higher mean sucks. They also sucked more to the non-native prototype. Time since birth (range: 7-75 h) did not affect the outcome.

THE CHILD LEARNS THE LANGUAGE ALREADY IN UTERO.

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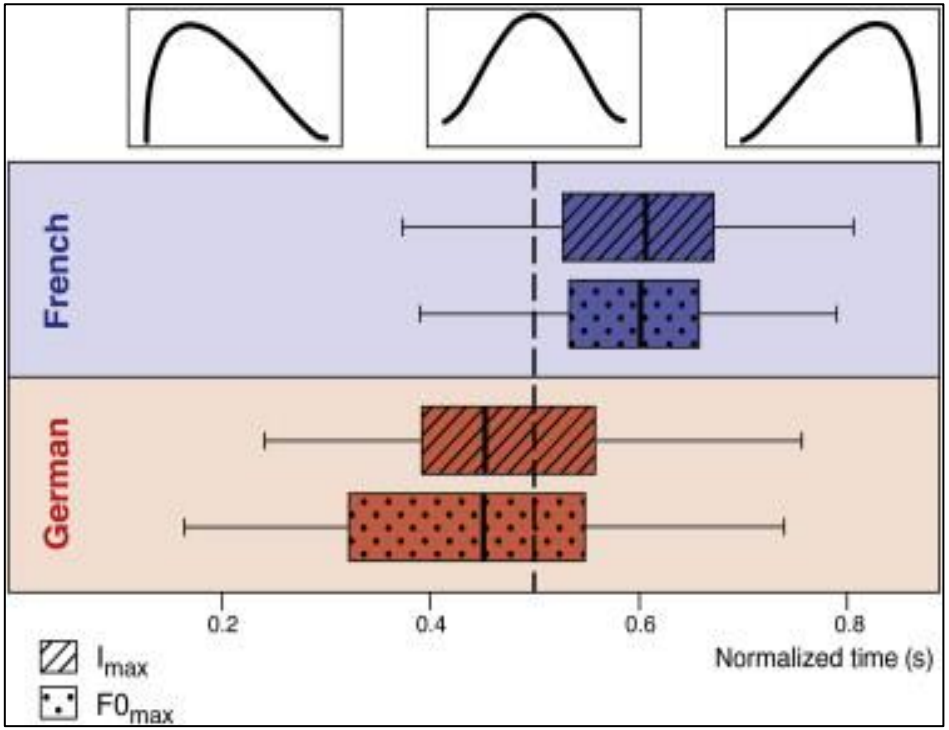
Volume 19, Issue 23, p1994–1997, 15 December 2009

REPORT

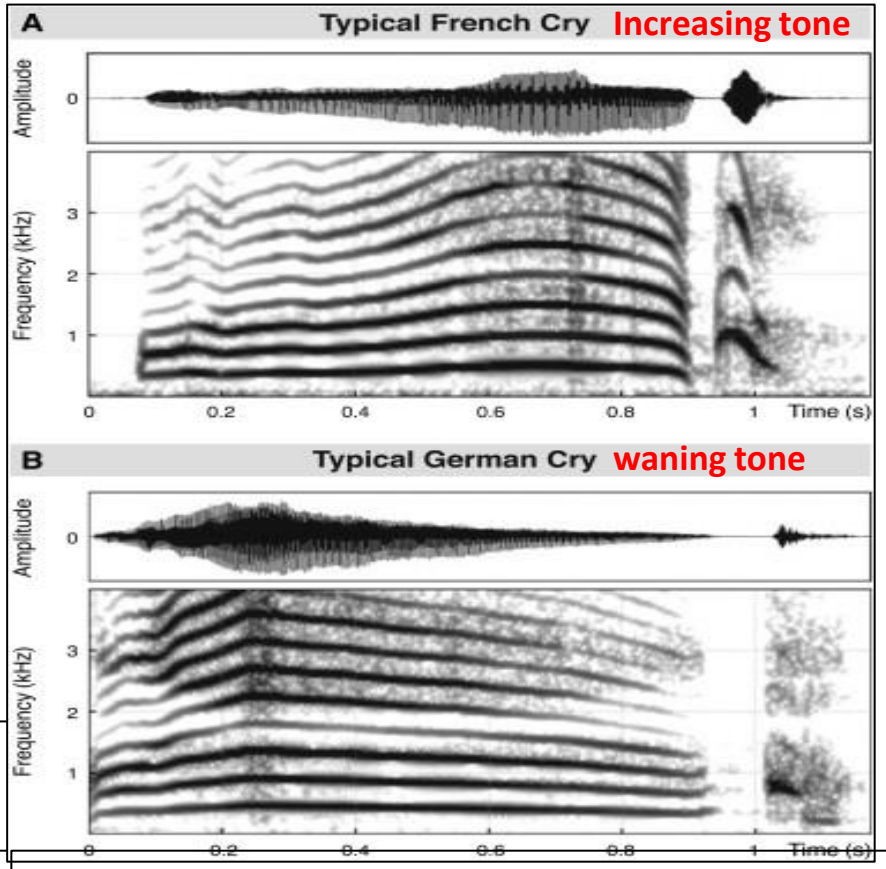
Newborns' Cry Melody Is Shaped by Their Native Language

Birgit Mampe, Angela D. Friederici, Anne Christophe, Kathleen Wermke

Published Online: November 05, 2009



Distribution of all observed melody and intensity contours in German and French newborns' crying.



Time Waveform and Narrow-Band Spectrograms of a Typical French Cry and a Typical German Cry

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Fundamental Frequency Variation in Crying of Mandarin and German Neonates

Journal of Voice, 2017

*Kathleen Wermke, †Yufang Ruan, *Yun Feng, *Daniela Dobnig, *Sophia Stephan, ‡Peter Wermke, §Li Ma, ¶Hongyu Chang, †Youyi Liu, **·††Volker Hesse, and †Hua Shu, *‡**Lindenhof, and ††Berlin,Germany, and †§¶Beijing, China*

Does prenatal exposure to a tonal or non-tonal mother speech influence the **fundamental properties of frequency (fo)** in neonatal crying?

Prospective study: 102 newborns in the first week of Chinese and German life. Methods. Spontaneous cries (N = 6480) of **Chinese neonates (tonal language group)** and **Germans (non-tonal group)** were quantitatively analyzed.

.... Conclusions .... The results confirm the hypothesis that the mother , in particular regarding the characteristics based on fo, has already determined during pregnancy an early modeling on the crying characteristics of newborns..

Tonal Language Influence on Neonates' Crying

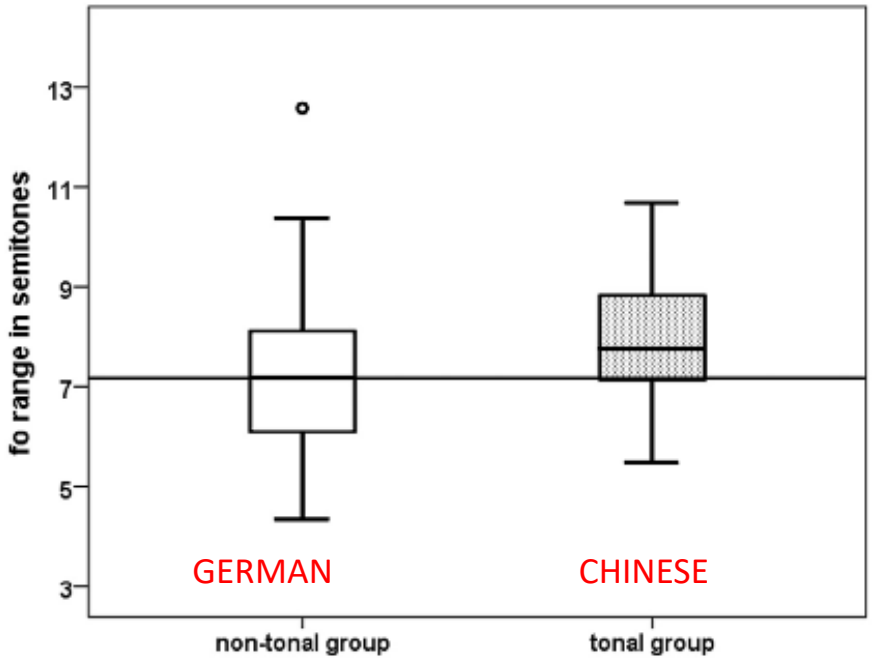

FIGURE 2. Boxplot diagram showing the fo range distribution in semitones for the two language groups. The Chinese neonates had a mean fo range in their crying that was one to two semitones higher than that of the German neonates.

fo: fundamental properties of frequency

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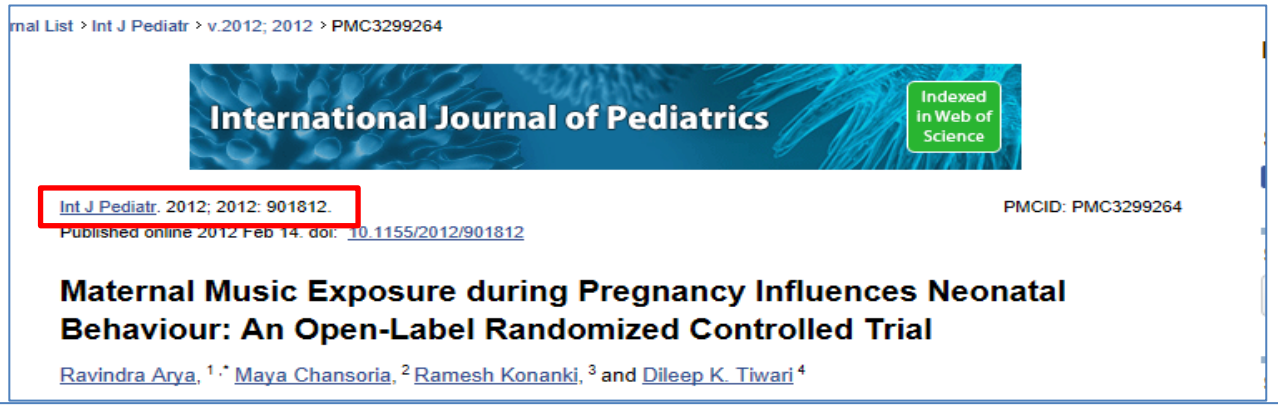

- **Music** stimulates brain development already within the uterus. **Controlled study**: the mothers, during the second half of the pregnancy, were made to listen to music for an hour a day,

  → **the children after birth presented:**

higher performance on a development scale, the Brazelton Neonatal Behavioral Assessment Scale

the orientation towards the auditory and visual stimuli of these children was much better.

higher scores also regarding the *habituation*, an elementary form of learning, the stages of behavior and autonomous stability; neonatal behavior regarding perception, sensory-sensorial conduction, integration, conscious decision and motor apparatus.

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Music and Newborn

Observing the children as they listen to music, one immediately notices how extraordinarily they are tuned to what they are listening to; they sway in time and it has been shown that already at 2 years they develop their own musical taste, creating their *"personal hit parade"*.

But they are also tuned with their inner music, which is probably genetically coded, and often they go through a period of "musical spluttering", which occurs well before the linguistic one.

Role of epigenetics also during fetal life?

Fig.12 – Interazioni mamme e bambini.

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Functional specializations for music processing in the human newborn brain

PNAS 2010

Daniela Perani[a,b,c,d,1,2], Maria Cristina Saccuman[a,b,1], Paola Scifo[b,c,d], Danilo Spada[e], Guido Andreolli[a], Rosanna Rovelli[f], Cristina Baldoli[c,g], and Stefan Koelsch[h,i]

[a]Faculty of Psychology, Vita-Salute San Raffaele University, 20132 Milan, Italy; [b]Division of Neuroscience, San Raffaele Scientific Institute, 20132 Milan, Italy; [c]Center of Excellence for High-Field Magnetic Resonance Imaging (CERMAC), San Raffaele Scientific Institute, 20132 Milan, Italy; [d]Department of Nuclear Medicine, San Raffaele Scientific Institute, 20132 Milan, Italy; [e]Psychology Section, Department of Biomedical Sciences and Technologies, School of Medicine, Universita'degli Studi, 20134 Milan, Italy; [f]Department of Neonatology, San Raffaele Scientific Institute, 20132 Milan, Italy; [g]Department of Neuroradiology, San Raffaele Scientific Institute, 20132 Milan, Italy; [h]Cluster of Excellence "Languages of Emotion," Freie Universität Berlin, 14195 Berlin, Germany; and [i]Max-Planck-Institute for Human Cognitive and Brain Science, 04103 Leipzig, Germany

Edited* by Dale Purves, Duke University Medical Center, Durham, NC, and approved January 26, 2010 (received for review August 28, 2009)

In adults, specific neural systems with right-hemisphere weighting are needed to process tone, melody and harmony, as well as the structure and meaning that emerge from the musical sequences. It is not known to what extent **the specialization of these systems derives from long-term exposure to music or neurobiological constraints.** One way to address this question is to examine how these systems work at birth, when the hearing experience is minimal. We used functional magnetic resonance imaging to measure brain activity in infants aged 1 to 3 days while listening to western tonal music extracts and altered versions of the same extracts.

The altered versions also included changes to the tonal key or were permanently dissonant. **The music mainly evokes activations of the right hemisphere in the primary and upper auditory cortex**. During the presentation of the **altered extracts, the hemodynamic responses were significantly reduced in the auditory cortex right and the activations emerged in the left inferior frontal cortex and in the limbic structures**. These results demonstrate that **the child's brain shows a hemispheric specialization in processing music from the early post-natal hours. The results also indicate that the neural architecture behind musical processing in infants is sensitive to changes in tone and differences in consonance and dissonance**.

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Original Music: Temporal activation in right hemisphere and in left amigdala – hippocampus complex

Alterd music: No activation in right temporal hemisphere, activation in right amigdala - hippocampus complex and in left frontal gyrus

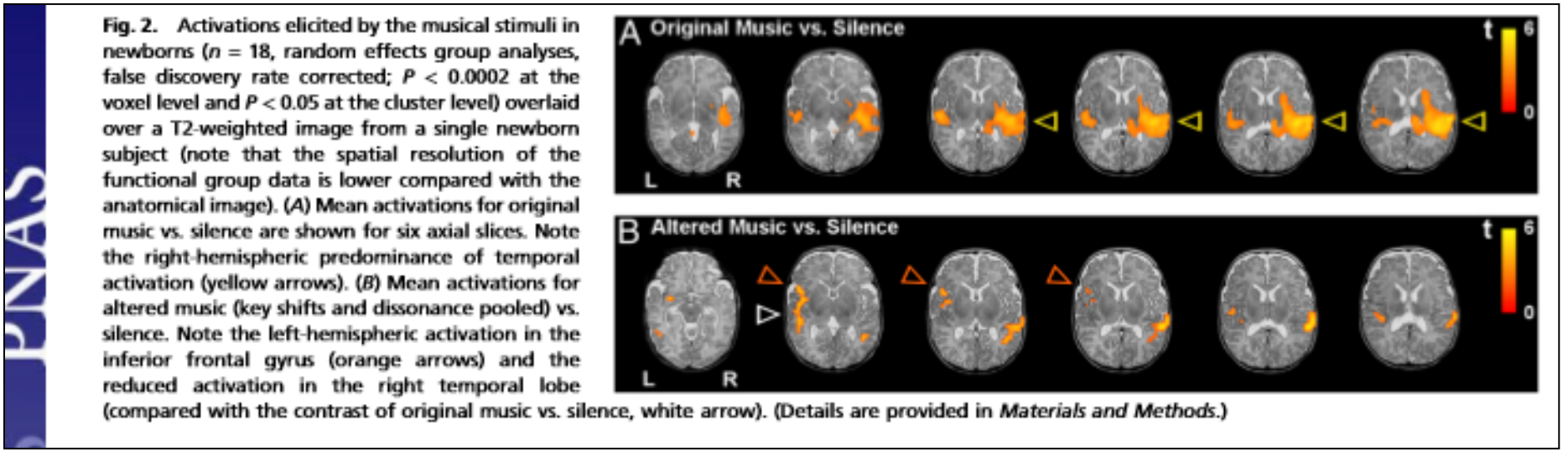

Fig. 2. Activations elicited by the musical stimuli in newborns (n = 18, random effects group analyses, false discovery rate corrected; $P < 0.0002$ at the voxel level and $P < 0.05$ at the cluster level) overlaid over a T2-weighted image from a single newborn subject (note that the spatial resolution of the functional group data is lower compared with the anatomical image). (*A*) Mean activations for original music vs. silence are shown for six axial slices. Note the right-hemispheric predominance of temporal activation (yellow arrows). (*B*) Mean activations for altered music (key shifts and dissonance pooled) vs. silence. Note the left-hemispheric activation in the inferior frontal gyrus (orange arrows) and the reduced activation in the right temporal lobe (compared with the contrast of original music vs. silence, white arrow). (Details are provided in *Materials and Methods*.)

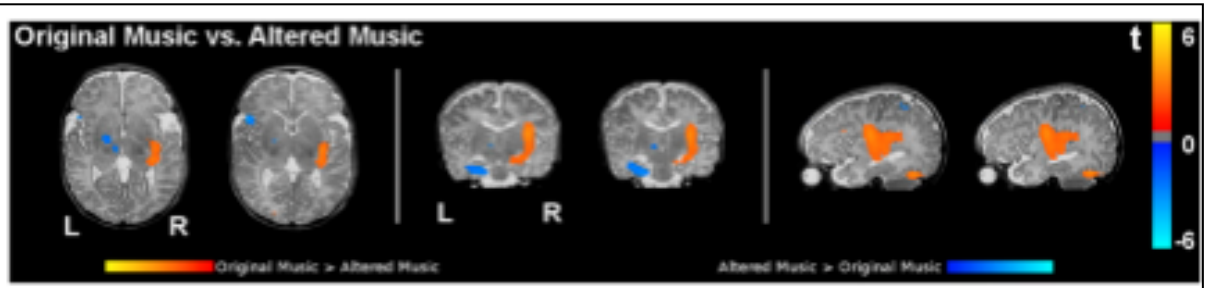

Fig. 3. Direct contrast of original music vs. altered music in healthy newborns (n = 18, random effects group analysis; $P < 0.05$ at the voxel level, uncorrected) overlaid on a T2-weighted image from a single newborn (note that the spatial resolution of the functional group data is lower compared with the anatomical image). Regions more active for original music are shown in orange/yellow, and regions more active for altered music are shown in blue. Two axial slices show a stronger activation of the left inferior frontal gyrus in response to altered music. The slices also show a stronger activation of (posterior) auditory cortex in response to original music. The two coronal slices show activation of the left amygdala-hippocampal complex (and of the ventral striatum) for altered music and activation of the right amygdala-hippocampal complex for original music. The two sagittal slices show the larger right superior temporal activation for original music.

The study demonstrates the skills of newborns for music processing by providing information on the neural origins of music, a universal human capacity.

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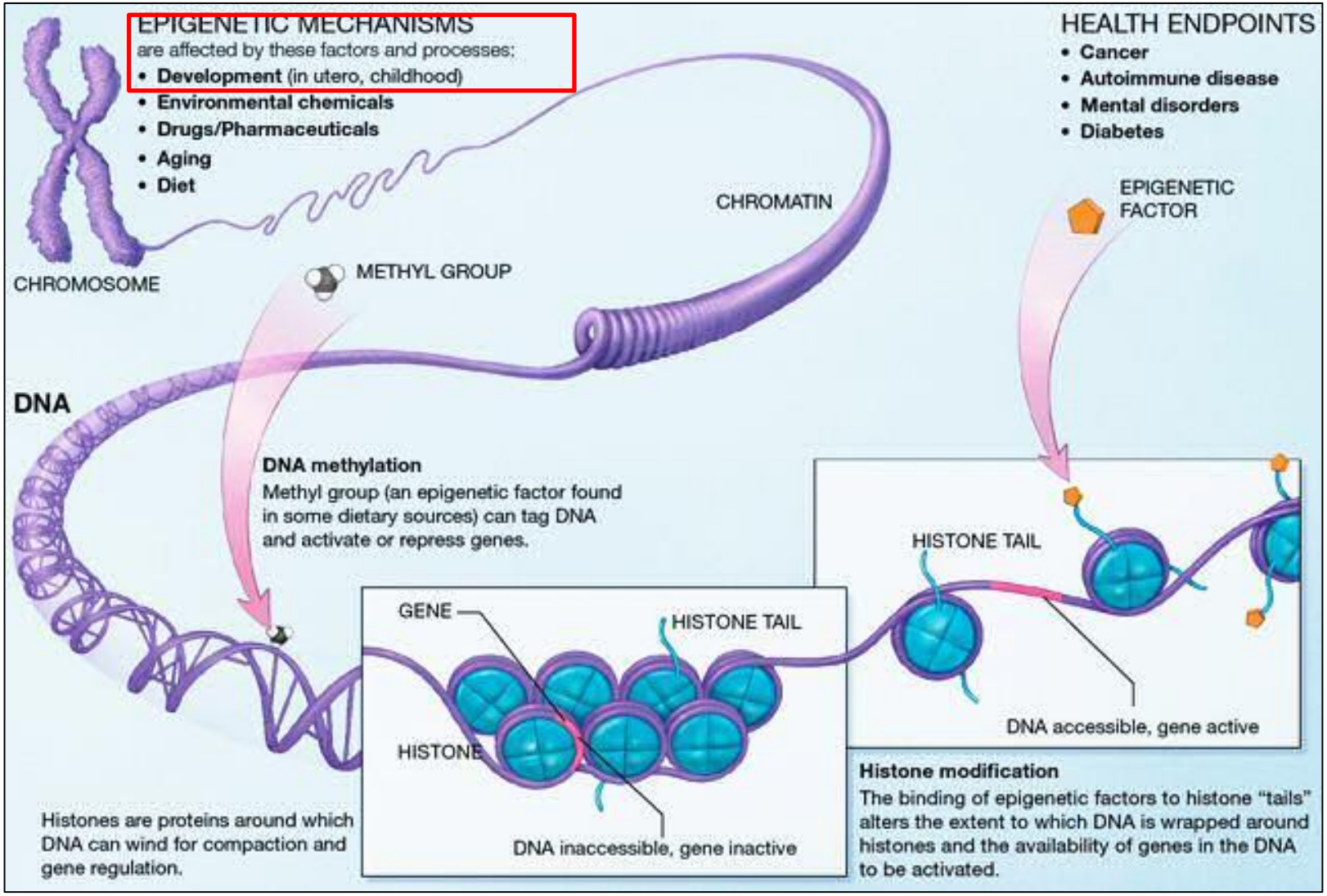
Epigenetic and Music?



Heritable phenotype changes that do not involve alterations in the DNA sequence.

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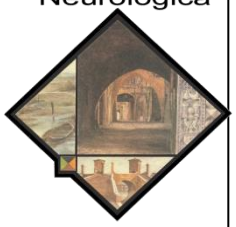

Scientific Perspectives on Music Therapy

THOMAS HILLECKE, ANNE NICKEL, AND HANS VOLKER BOLAY

Ann. N.Y. Acad. Sci. 1060: 271–282 (2005). © 2005 New York Academy of Sciences.
doi: 10.1196/annals.1360.020

A Neuroscientific Perspective on Music Therapy

Stefan Koelsch

The Neurosciences and Music III—Disorders and Plasticity: Ann. N.Y. Acad. Sci. 1169: 374–384 (2009).
doi: 10.1111/j.1749-6632.2009.04592.x © 2009 New York Academy of Sciences.

Heuristic working factor model for music therapy (Hillecke 2005)

...five modulating factors contribute to the effects of music therapy: attention, emotion, cognition, behavior, communication.

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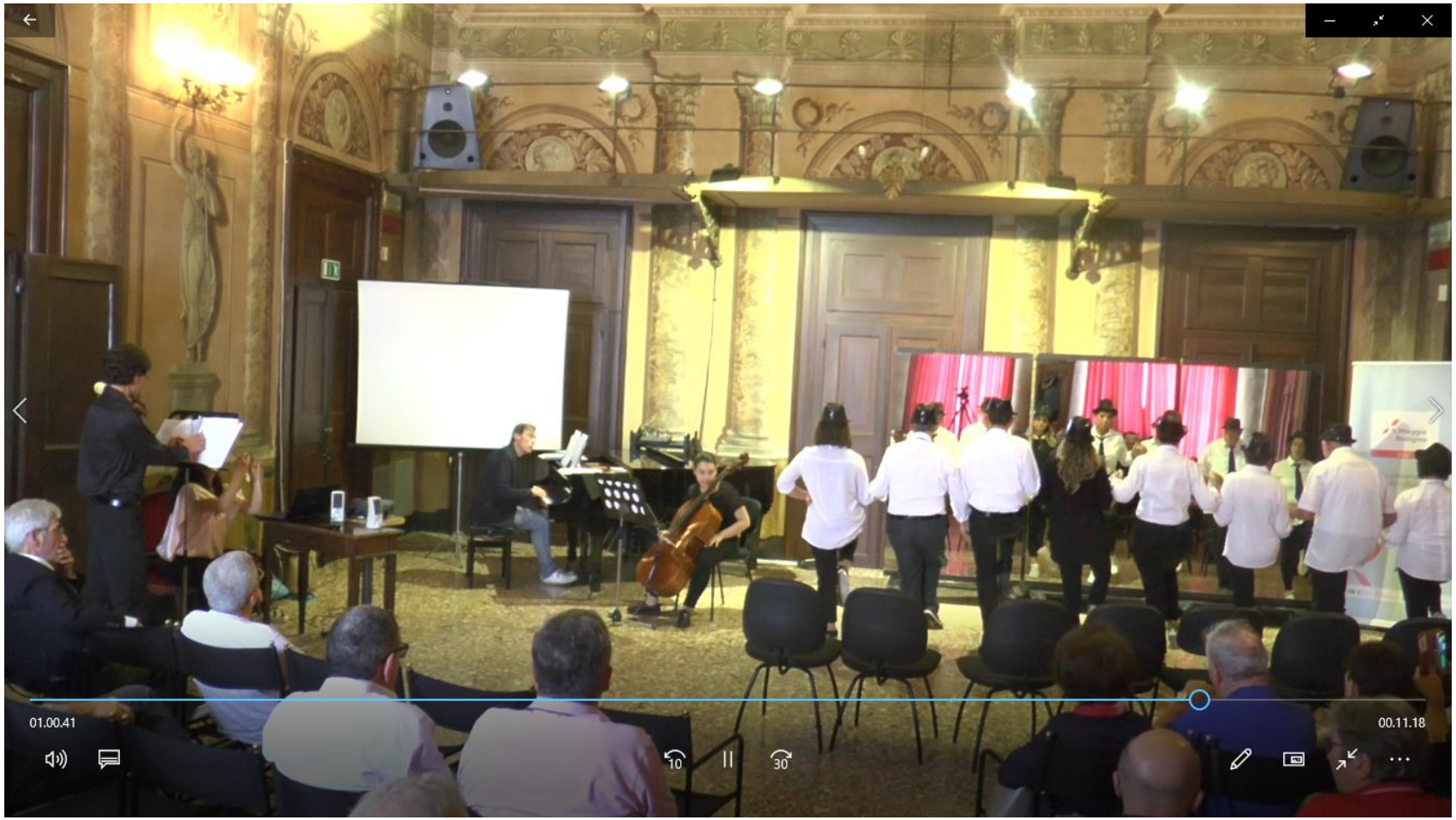
Musicotherapy. Parkinson in Ferrara



2 minutes of movie

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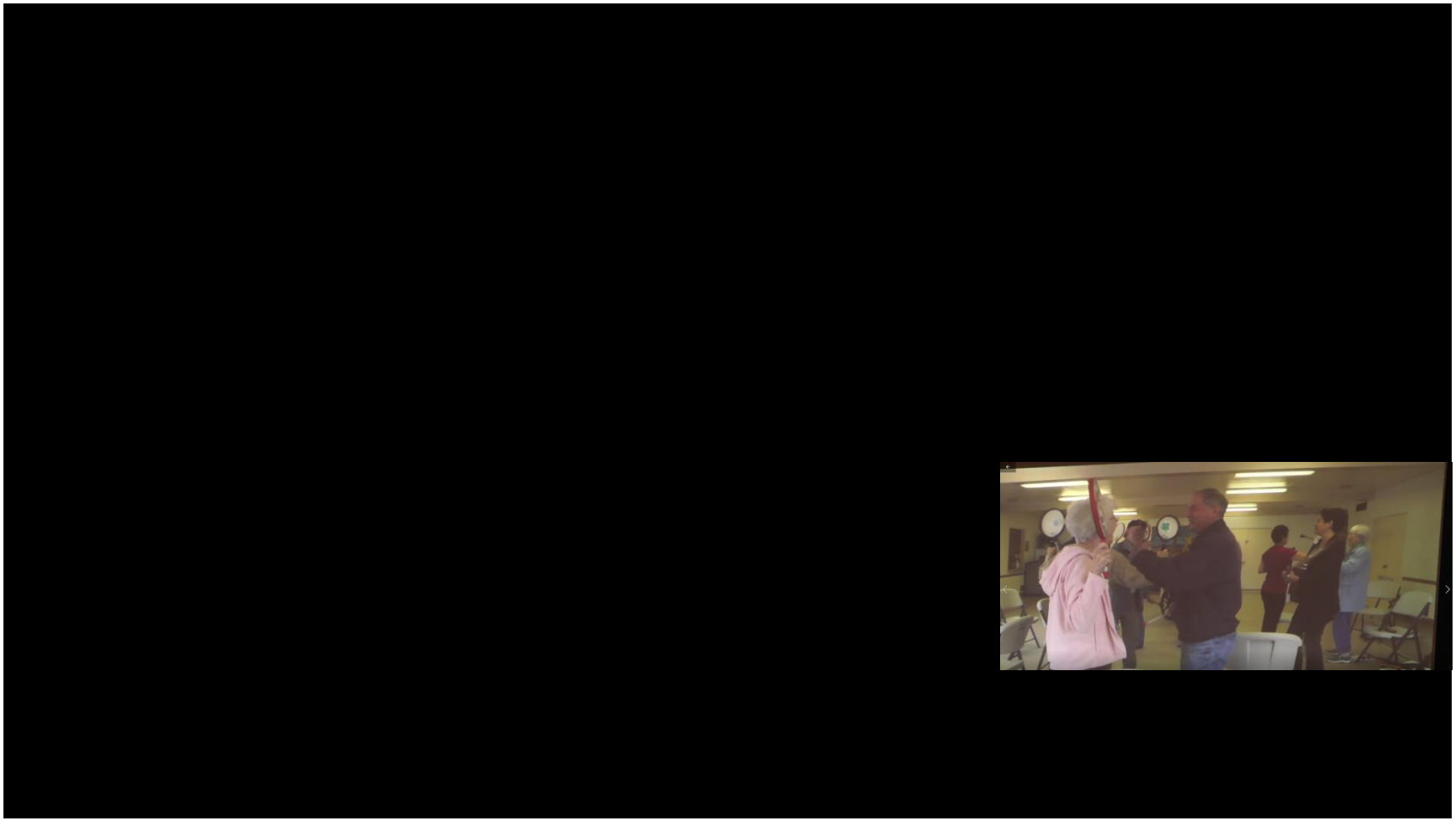
Musicotherapy. Neurological disorders



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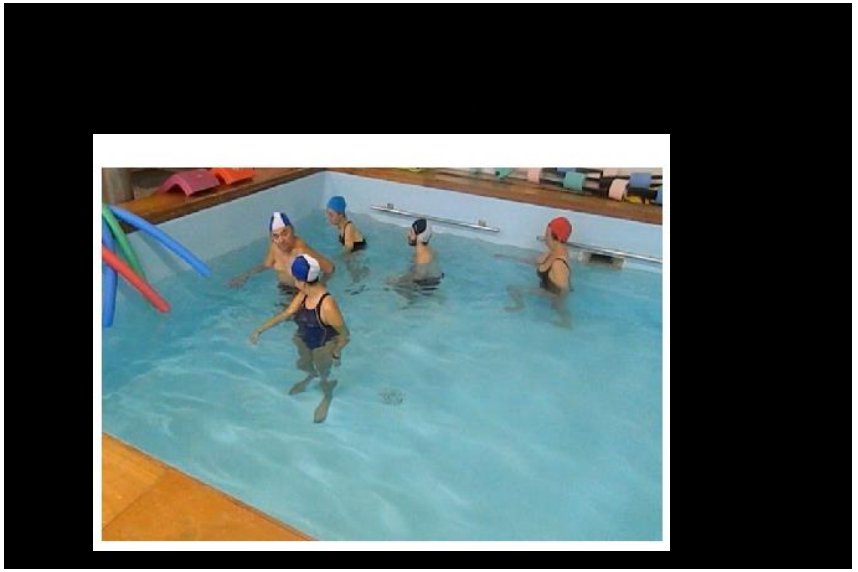
Musicotherapy. Alzheimer and Parkinson



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Musicotherapy Parkinson

2 minutes of movie

Coreografia

Pulizia passo

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Music and fetal brain development

Brain development depends for an important part on the stimuli of the environment.

Stimulation resulting from an enriched environment during the early stages of development in intrauterine life is important, particularly important for premature infants, infants who are underweight, infants who have a disorders of brain development, and infants who have been neglected.

Stimulus obtained through music in these cases is one of the potential effective remedies: MUSICOTHERAPY.

Musicotherapy in Neonatology and Neonatal Intensive Care

MUSICOTHERAPY:
discipline that uses music as an alternative form of care and communication in the non-verbal sphere, **where music must also be considered in its simplest forms of sound "language".**

Interpersonal process in which the therapist uses music and all its physical, emotional, mental, social, aesthetic aspects, to help premature babies to improve, recover or maintain health. Music can be created by the therapist / parent or can draw inspiration from the various styles, periods of the existing musical literature.

GENERAL PURPOSES OF MUSIC THERAPY IN NICU:

- to promote the neurological and socio-affective development of the child and the knowledge of its signals by parents and caregivers;

- to create through music and music practice a space in which parents and children can feel safe, and where they can know and recognize each other;

- to educate the family to maintain the beneficial effects of musical practice in the long run even after discharge to the hospital, ensuring that music can always be a positive space in which the relationship between parents and the child can remain intact and not governed by problems medical, creating moments of emotional sharing useful to the family and the development of the child in all stages of its growth.

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Music therapy in NICU*i*

MUSIC in NICU

Among other specific goals on the hospitalized newborn

To favour

- **support for the neurological and psychological development of the premature child,**
- **monitoring through the use of hearing music,**
- **promotion of mother-child bonding and emotional attachment and support in the parental relationship,**
- **monitoring of the ecological importance of sound within the department (*for example through the use of the Mozart Effect*).**

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Journal of Perinatology

Altmetric: 22 Citations: 6 More detail »

Original Article

Bach music in preterm infants: no 'Mozart effect' on resting energy expenditure

H Rosenfeld Keidar, D Mandel, F B Mimouni & R Lubetzky

Journal of Perinatology **34**, 153–155 (2014)

MUSIC FOR PRETERM INFANTS

- **OBJECTIVE:** To study whether Johan Sebastian Bach music has a lowering effect on **resting energy expenditure (REE)** similar to that of Wolfgang Amadeus Mozart music.
- **STUDY DESIGN:** Prospective, randomized clinical trial with cross-over in 12 healthy, appropriate weights for gestational age (GA), gavage fed, metabolically stable, preterm infants. Infants were randomized to a 30-min period of either Mozart or Bach music or no music over 3 consecutive days. REE was measured every minute by indirect calorimetry.
- **RESULT:** Three REE measurements were performed in each of 12 infants at age 20±15.8 days. Mean GA was 30.17±2.44 weeks and mean birthweight was 1246±239 g. REE was similar during the first 10-min of all three randomization periods. During the next 10-min period, infants exposed to music by Mozart had a trend toward lower REE than when not exposed to music. This trend became significant during the third 10-min period. In contrast, music by Bach or no music did not affect significantly REE during the whole study. On average, the effect size of Mozart music upon REE was a reduction of 7.7% from baseline.
- **CONCLUSION:** **Mozart music significantly lowers REE in preterm infants, whereas Bach music has no similar effect.** We speculate that 'Mozart effect' must be taken into account when incorporating music in the therapy of preterm infants, as not all types of music may have similar effects upon REE and growth.

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Regular Article

Live music reduces stress levels in very low-birthweight infants

Diana Schwilling, Michael Vogeser, Fabian Kirchhoff, Frauke Schwaiblmair, Anne-Laure Boulesteix, Andreas Schulze, Andreas W. Flemmer

First published: 7 February 2015 Full publication history

MUSIC FOR PRETERM INFANTS

- **AIM:** **Music might benefit preterm infants in stressful, intensive care environments**. However, data on stress level indicators, determined by salivary cortisol levels, are scarce. We evaluated **the effect of live harp music** on the stress level indicators of preterm infants in a neonatal intensive care unit (NICU).
- **METHODS:** We exposed 20 stable preterm infants **to music for 15 min on three consecutive days**. Saliva was collected before the music was played and 25 min and 4 h after it ended. Salivary cortisol levels were measured by liquid chromatography-tandem mass spectrometry and vital signs, oxygen saturation, bradycardia, apnoeas and oxygen desaturations were recorded. Pain levels were assessed by the Bernese Pain Scale for Neonates.
- **RESULTS:**
  - **Salivary cortisol** was significantly lower 25 min (18.9 nmol/L [3.9-35.6] p = 0.001) and 4 h after music (17.4 nmol/L [3.9-35.3] p = 0.003) than at baseline 4 h before exposure (19.5 nmol/L [7.2-51.1]).
  - After music, the number of **apnoeas and oxygen desaturations** was significantly reduced on all three, days and the number of bradycardia episodes on day one.
  - **Pain scores** significantly improved after music on all 3 days.

- **CONCLUSION:** **Exposure to live music reduced salivary cortisol and had beneficial effects on the physiologic parameters of stable preterm infants in a NICU**

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Musicotherapy research in the NICU: an updated meta-analysis.

Standley J, Neonatal Netw, 2012

MUSIC in NICU

- **PURPOSE: To provide an overview of developmental and medical benefits of music therapy for preterm infants**.
- **DESIGN: META-ANALYSIS.**
- **SAMPLE:** Empirical music studies with preterm infants in the neonatal intensive care unit (NICU).
- **MAIN OUTCOME:** Evidence-based NICU music therapy (NICU -MT) was highly beneficial with an overall large significant effect size (Cohen's d = 0.82). Effects because of music were consistently in a positive direction.
- **RESULTS:** Results of the current analysis replicated findings of a prior meta-analysis and included extended use of music.
- **(1) Benefits were greatest for live music therapy (MT) and for use early in the infant's NICU stay** (birth weight <1,000 g, birth postmenstrual age <28 weeks).
- Results justify **strong consideration for the inclusion of the following evidence-based NICU - MT protocols in best practice standards for NICU treatment of preterm infants:**

- **music listening for pacification, music reinforcement of sucking, and music pacification as the basis for multilayered, multimodal stimulation.**

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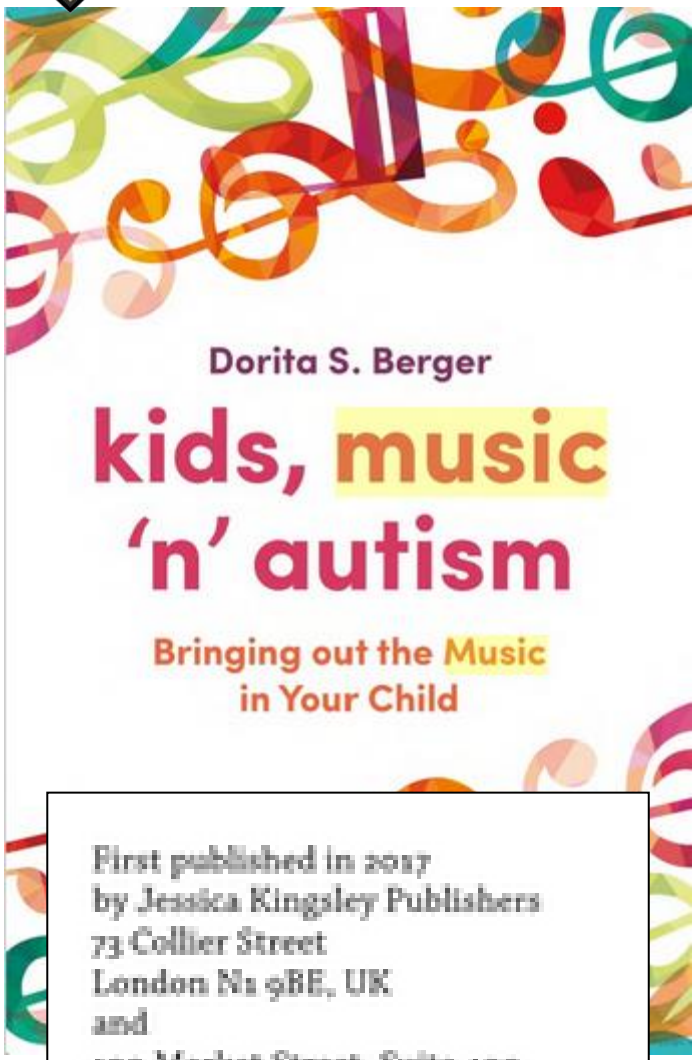

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400 Market Street, Suite 400
Philadelphia, PA 19106, USA

development, in support of including music stimulation for developing good brain function, diagnosis notwithstanding! The brain begins to develop from the moment of conception, and continues in various stages throughout development, although not entirely in a consistent, predictable time frame and manner. Brain development *in utero* depends on many factors, including the mother's nutrition, the amount of in-utero fetal stimulation (including earphones to the belly during pregnancy), general health and care of the mother (e.g., relaxed or anxious, hurried or slowed, etc.). In other words, *everything* that happens outside of the womb influences what occurs within. One timeline suggests that some three or four weeks after conception, a thin layer of cells that forms on the embryo begins to fold and fuse, structuring something akin to a liquid tube. This becomes the basis of the brain and spinal cord. Within this first month, cells in this tube begin to multiply profusely, ultimately creating some 250,000 or more neurons per minute! In fact, most of the brain's lifetime of cells—I repeat, *lifetime of cells*—are produced by the end of six months in the womb! At about the third month (14 weeks or so), some cells begin to perform some elementary physiological functions, and the

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PMCID: PMC4499461
NIHMSID: NIHMS584316

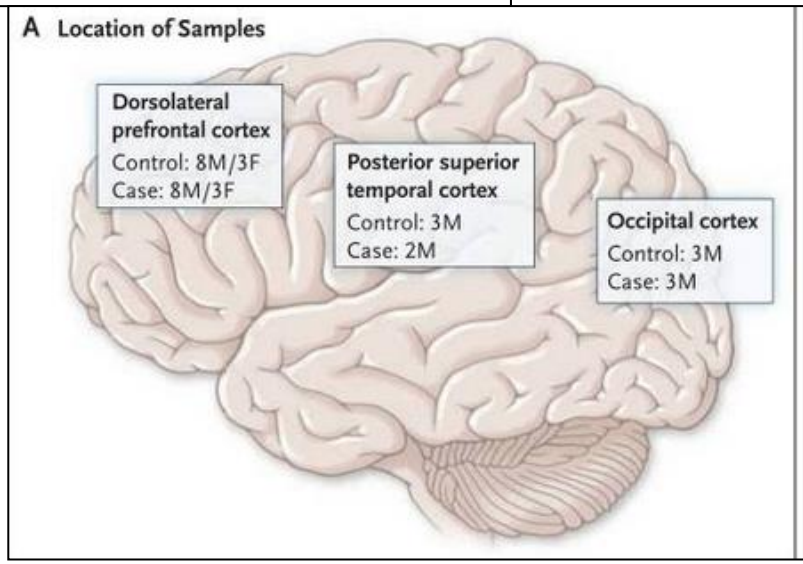
MUSIC FOR PREVENTING AUTISM?

Patches of Disorganization in the Neocortex of Children with Autism

Rich Stoner, Ph.D.,# Maggie L. Chow, Ph.D.,# Maureen P. Boyle, Ph.D.,# Susan M. Sunkin, Ph.D., Peter R. Mouton, Ph.D., Subhojit Roy, M.D., Ph.D., Anthony Wynshaw-Boris, M.D., Ph.D., Sophia A. Colamarino, Ph.D., Ed S. Lein, Ph.D.,# and Eric Courchesne, Ph.D.#

In children with autism**, absence of important genetic markers in the cellular layers of prefrontal and temporal cortices**: *«the first crucial development for the formation of the six different layers with the different types of brain cells is a process that begins before birth and in autism it is interrupted »*. The visual cortex is not affected by this problem. The frontal cortex is associated with higher cognitive functions, such as complex communication and the understanding of some social stimuli; The temporal cortex is associated with language.

Just the anomaly present in these brain areas could help to understand why **some children with autism show a clinical improvement through an early and prolonged treatment over time, *perhaps even stimulating in uterine life (with music?).*** *"The results of the study support the hypothesis that in children with autism the brain would sometimes be able to reconstitute the connections to get around the first focal defects*": study this mechanism could perhaps be useful, as they report, to explore how this occurs improvement.



Postmortem Tissue Acquisition. *We obtained 42 fresh-frozen postmortem cortical tissue blocks (1 to 2 cm^3) from the superior or middle frontal gyrus of dorsolateral prefrontal cortex, posterior superior temporal cortex, or occipital cortex (Brodmann's area 17) from children, 2 to 15 years of age, with autism (case samples) or without autism (control samples).*

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frontiers in Psychiatry

Front Psychiatry. 2017; 8: 305.
Published online 2018 Jan 11. doi: 10.3389/fpsyt.2017.00305

MUSIC FOR PREVENTING AUTISM?

Antenatal Training with Music and Maternal Talk Concurrently May Reduce Autistic-Like Behaviors at around 3 Years of Age

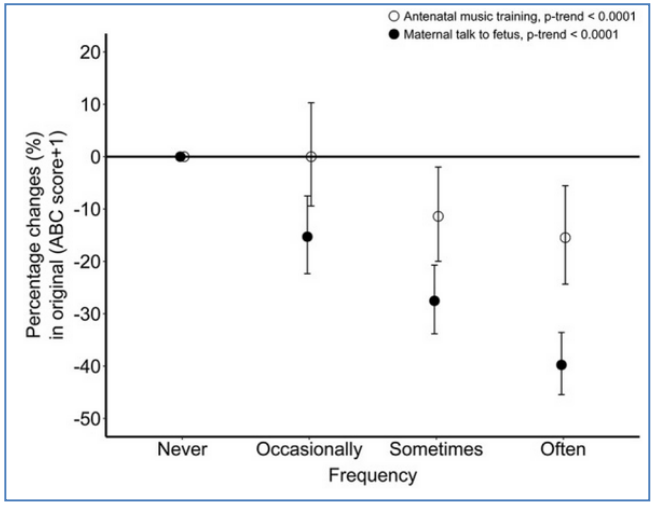
Zeng-Liang Ruan,[1] Li Liu,[1] Esben Strodl,[2] Li-Jun Fan,[1] Xiao-Na Yin,[3] Guo-Min Wen,[3] Deng-Li Sun,[3] Dan-Xia Xian,[3] Hui Jiang,[1] Jin Jing,[4] Yu Jin,[4] Chuan-An Wu,[3,*] and Wei-Qing Chen[1,5,*]

Prenatal training with music and motherly conversation with the fetus in China. Evaluation of their effects on the development of autistic behaviors during early childhood.

- **2014-2016,** **34,749 parents of children under 3 years** enrolled in kindergarten. Self-administered questionnaires on demographic data, **prenatal music training and maternal interview with the fetus during pregnancy, autistic behaviors.**

..Tobit regression analysis: **prenatal music training and maternal interview (analysis of maternal speech) with the fetus were associated with a reduction in autistic behaviors in children, with a dose-dependent relationship. ..**

- A significant interaction effect between prenatal music training and maternal speech to the fetus on autistic behaviors, found that **children who often had prenatal music training experience and maternal speeches had the least risk of autistic behaviors**, *while* **children who have never been exposed to maternal speeches and only sometimes have had prenatal musical training experience have had the highest risk.**



Conclusion:

Prenatal training through music and the mother's conversation with the fetus could reduce the risk of child-like autistic behavior around 3 years of age.

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Pediatrics
May 2013, VOLUME 131 / ISSUE 5

The Effects of Music Therapy on Vital Signs, Feeding, and Sleep in Premature Infants

Joanne Loewy, Kristen Stewart, Ann-Marie Dassler, Aimee Telsey, Peter Homel

Article | Figures & Data | Info & Metrics | Comments

Download PDF

MUSIC in NICU

Ocean disk

instrument, filled with small metal balls. When the disc is rotated, the metal balls move slowly to create a sound effect intended to simulate the fluid sounds of the uterus.

The live elements of music such as rhythm, breath, and parent-preferred lullabies may affect physiologic function (eg, heart and respiratory rates, O_2 saturation levels, and activity levels) and developmental function (eg, sleep, feeding behavior, and weight gain) in premature infants.

- **METHODS:** A randomized clinical multisite trial of 272 premature infants aged ≥32 weeks with respiratory distress syndrome, clinical sepsis, and/or SGA (small for gestational age) served as their own controls in 11 NICUs. Infants received 3 interventions per week within a 2-week period, when data of physiologic and developmental domains were collected before, during, and after the interventions or no interventions and daily during a 2-week period.
- **RESULTS:** Three live music interventions showed changes in heart rate interactive with time. Lower heart rates occurred during the lullaby ($P < .001$) and rhythm intervention ($P = .04$). Sucking behavior showed differences with rhythm sound interventions ($P = .03$). Entrained breath sounds rendered lower heart rates after the intervention ($P = .04$) and differences in sleep patterns ($P < .001$). Caloric intake ($P = .01$) and sucking behavior ($P = .02$) were higher with parent-preferred lullabies. Music decreased parental stress perception ($P < .001$).
- **CONCLUSIONS:** The informed, intentional therapeutic use of live sound and parent-preferred lullabies applied by a certified music therapist can influence cardiac and respiratory function. Entrained with a premature infant's observed vital signs, sound and lullaby may improve feeding behaviors and sucking patterns and may increase prolonged periods of quiet–alert states. Parent-preferred lullabies, sung live, can enhance bonding, thus decreasing the stress parents associate with premature infant care.

small slit-shaped rectangular musical instrument: provides a compelling rhythm with a relaxing tone, played with percussion of soft wands or fingers, simulating a sonority of the heartbeat that the newborn would have already felt in the womb.

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First Sounds: Rhythm, Breath and Lullaby

MUSIC in NICU

First Sounds: Rhythm, Breath, Lullaby International Neonatal Intensive Care Unit Training

Joanne Loewy and coll.

Thursday, November 12, 2015, 8am-6pm (10 cr.)

Louis Armstrong Center for Music and Medicine, New York

Joanne Loewy, DA, LCAT, MT-BC ; Aimee M. Telsey, MD; Ann-Marie Dassler, RN, FNP, MSN;

Christine Vaskas, MS, MT-BC, LCAT; Andrew Rossetti, MMT, LCAT, MT-BC

A uterus-like environment through sound and music, music therapy has proven to deepen the state of infantile sleep, support child self-regulation, assist in stabilizing respiration and heart rate, improve parent / infant bonding, reinforce feeding / sucking rhythms and weight gain and promoting a sense of security during **painful procedures.**

For the newborn hospitalized, music therapy interventions establish social connections and promote healing through self-regulation, as well as satisfying children's developmental, physical and emotional needs. **Many families of intensive care infants experience stress, trauma and anxiety** in relation to their child's hospitalization.

Musical psychotherapy interventions for families of newborns in intensive care seek to encourage and support the process of linking caregivers to children, provide trauma improvements, provide a means to address, provide a tangible way for caregivers to connect to their child through songwriting / creation and provide a respite for families.

Pregnancy in music. It's never too early for music learning

. The fetus, with the development of hearing, begins to perceive and appreciate the music. **The mother, listening to music during pregnancy, gets a moment of wellbeing and serenity** that, of course, also feels the child who is developing neural connections to language, movement, learning, memories and emotions.

Listening to quality music during pregnancy also means **to make up the mother-child relationship:** it helps them to communicate today but above all in the future; the child lives with the mother those feelings of well-being that gives him the music.

Large number of researches on **intrauterine memory**: the child remembers and then recognizes the mother's voice.
A melody that has accompanied him in prenatal life, come to light can calm him, reassure, make you feel good: it is something familiar, a sort of leitmotiv with the previous life that can make the change in life less drastic.

- It is advisable to pregnant women:
  sing to their child to use those songs even after birth: an instrument to calm the baby and remind him of the well-being experienced in intrauterine life.
- The music for its acoustic and symbolic peculiarities, becomes a real research of the sensations that have been felt in the womb.
- **It is scientifically proven** that the fetus has reactions to sounds and music:
  the variation of the heart rate and movements of the body.
- Listening to music, even in intrauterine life, **modulates the production of hormones and stimulates the production of endorphins**, physiological substances that mitigate pain and slow down the rhythm of the heartbeat .
- **The sounds perceived by the fetus (language and music) can influence brain development, including future language skills.**
- The fetal brain is able to learn and, if stimulated, undergoes mutations from the structural point of view and proper neuronal connections that can influence the development of language during childhood (multicentre study of Finns, Dutch and Danish ***(Partanen et al, 2013, PNAS).***

Conclusions

- **Music induces motivation to movement, reactions of the vegetative system, changes in heart rhythm and breath, but also reinforces emotions.**
- **The intrauterine auditory environment plays a key role** in the development of auditory function and language.
- The stimulation resulting **from an enriched environment (**eg acoustic stimuli, music, language, ..) during the early stages of development in intrauterine life, promotes neuro-plasticity and connectivity, neurogenesis and myelination.
- **In the fetus, music stimulates brain development and already plays a first role as a language for communicating.**

- ***In the third trimester of pregnancy neurological functions begin to be structured and among these the auditory functions that will lead to the formation of language after birth.***
- During the pregnancy period **mother and fetus are in continuous communication**; both speak, listen and respond.
- In the meantime, music can be a faithful companion throughout pregnancy.
- The mother, listening to music during pregnancy, gets wellbeing and serenity reducing the levels of anxiety and stress that could act in a negative way on the fetus.
- Fetal responses are probably influenced by the effects that music has on the mother. Listening to quality music during pregnancy also means feeding/strengthe-ning the mother-child relationship.

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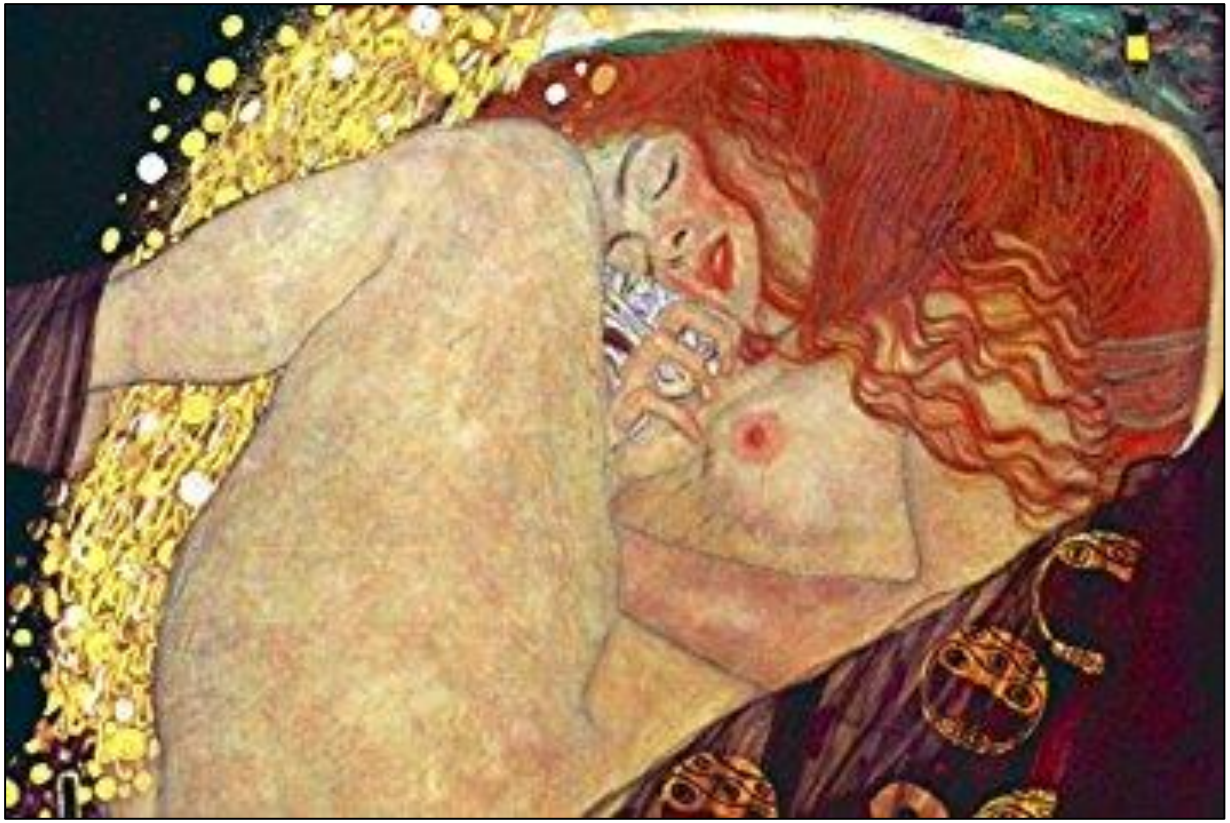
Gustav Klimt (1908) DANAE



On the left the golden spermatozoa of Zeus.
On the right, cells and embryos that symbolize conception.

Thanks to:

- Eckart Altenmüller
- Giuliano Avanzini
- Marta Bellu
- Francesca Bolognesi
- Chiara Da Ronch Giorgio Fabbri
- Ernesto Gastaldo
- Patrik Fazio
- Alfredo Raglio
- Stefano Tugnoli

Other material

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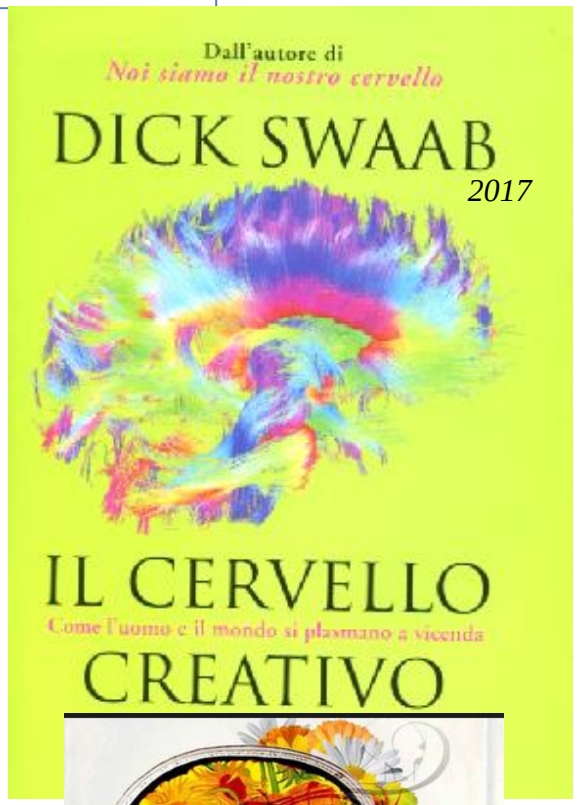
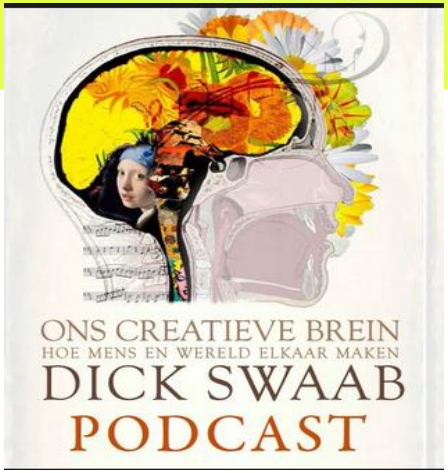
Music stimulates brain development

From the 24th week the fetus begins to feel, to hear
- Music can directly influence brain development.
- There are **effects on the behavior of children who were made to listen to music without listening to the mother.**
- Music **modulates the rate of some of the mother's hormones** that can cross the placenta and affect brain development.
- The methods of musical proposals seem to be able to exert their effects even before the 24th week of pregnancy.
- **The sounds that penetrate the uterus are important for the development of the auditory system.**
- **The fetus also hears the heartbeat, the first metronome of the unborn child, the sounds and the voice coming from the maternal viscera.**
- If a baby cries after birth, the mother can hold it against her breast on her left side to calm him down and make him feel his own heartbeat.
- **<u>After birth,</u> listening to a recording of the maternal heartbeat stimulates the baby to suckle.**





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Music stimulates brain development

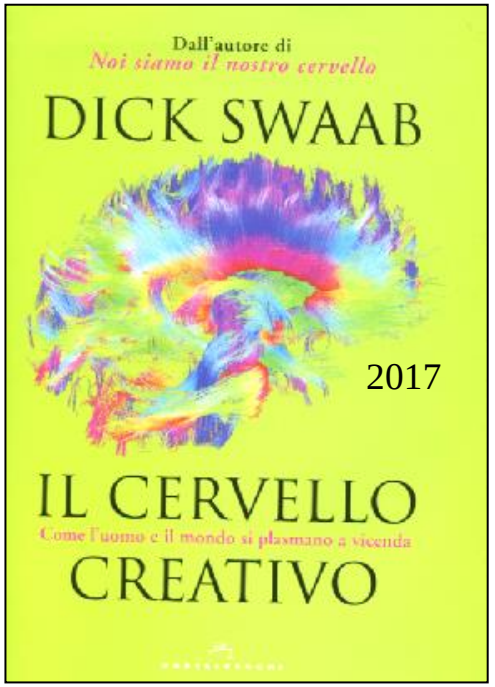
Recordings of fetal heartbeat have shown that **during the third trimester of pregnancy the fetus is able to distinguish the mother's voice from that of other people; it also distinguishes mother tongue from another language.**

Newborns have a strong preference for the mother's voice and tongue: passages of text that the mother read them aloud before birth, music and songs, including lullabies, which they listened to during the last weeks of pregnancy.

As long as it is in the uterus, the fetus learns aspects of the culture in which it will find itself immersed once it is born.

The fetus is sensitive to the melody, at the height of the notes and the rhythm.

***Music experts* even before being born.**



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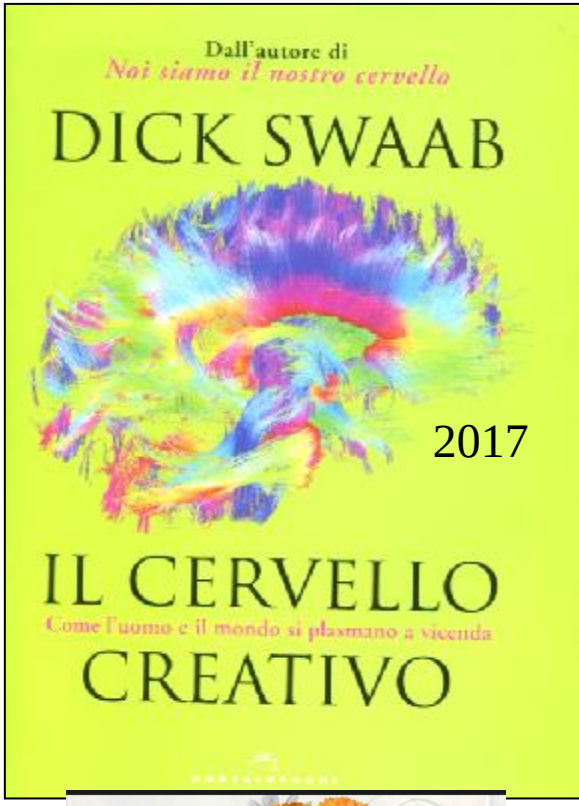
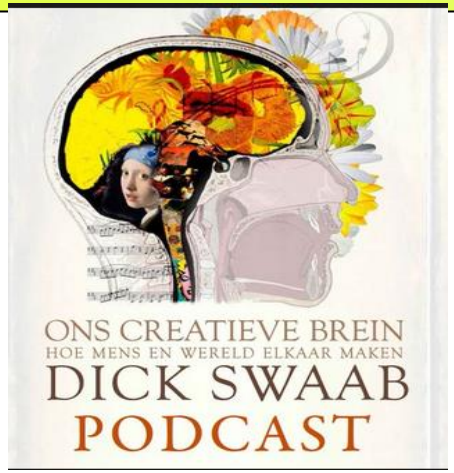
Music stimulates brain development

- Newborns remember the music they listened to in the womb. They can recognize a melody that the mother often listened to during pregnancy, es. the daily theme song of a television series.
- The sensitivity of the children in the uterus for the melodies would also justify **the tonal differences of the crying of the western and oriental babies: the French babies cry with a growing tone**, **while the German babies with a low tone, exactly according to the average course of the pitch of speech in the respective languages.**

At the moment it is not possible to say whether this constitutes the first expression of the development of the mother tongue, ... The preference of the newborns for the music heard in the uterus ceases after about three weeks.

The signature tune of the TV series followed by the mother during pregnancy does not (fortunately) endure lasting effects on the child's musical tastes.





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PRENATAL MUSICAL EXPERIENCE

Music and prenatal life

Marta Bellu,
Gianpaolo Donzelli
Università di Firenze
2017

AIM: TARGETS:
Evaluate the **effects of prenatal musical experience (PME) in the 3rd trimester of pregnancy** on the pregnant woman and on the fetus.
Check for any difference between music listening (PME) and absence of music (non-PME) listening among fetuses. Within the PME condition, the musical stimulus was administered according to different methodologies:
"Live" performance of a piece of music by the live musician / musician
Administration of the same piece music recorded recorded music

Cross-examination on seven pregnant women (28-30 weeks pregnancy) and in a longitudinal survey on three pregnant women at 30, 35, 37 weeks. Study population: seven pregnant women with low-risk single pregnancy of which 5 out of 7 pluripar women and seven fetuses including 4 males and 3 females

Materials: Tools for stimulus administration: - **Acoustic violin and loudspeaker**; dbSPL meter
Instruments for the detection of fetal parameters:

- Scan and cardiotocograph

PME self-assessment tools on the pregnant woman: - STAI (*Spielberg, 1989*); tailor-made questionnaires; interview with the medical staff who took part in the trial: -

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Procedures

- Administration of **the same piece of music performed live by the musician and issued by a speaker for each participant**
  The intensity of the sound was adjusted so that the two music presentation modes did not differ significantly (65-85 dbSPL)

Tabella 5.3 Prototipo del modello sperimentale

CONDIZIONE DI CONTROLLO	CONDIZIONE ESPLORATIVA1	CONDIZIONE DI CONTROLLO	CONDIZIONE ESPLORATIVA 2	CONDIZIONE DI CONTROLLO
Non musica 1	*Musica 1*	*Non musica 2*	*Musica 2*	*Non musica 3*
2'	3'	2'	3'	2'

EVALUATION OF FETAL PARAMETERS

1. **N. accelerations of fetal heart rate**
2. **N. generalized movements per minute**
3. **Average duration of generalized movements**
4. **N. of isolated movements per minute**
5. **Average duration of isolated movements**
6. **N. of beginnings of a motor pattern**

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Movements of the fetus during music

Marta Bellu, 2017

Risultati

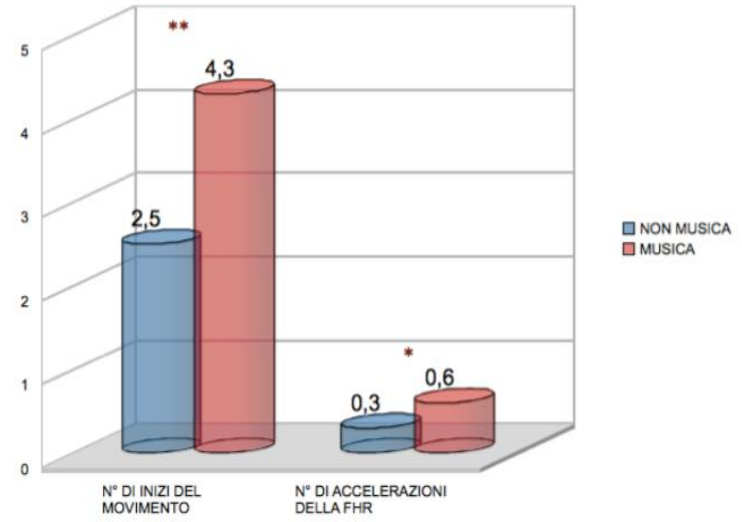

Illustrazione 1: *confronto delle medie del n° di volte in cui inizia un movimento e del n° di accelerazioni della frequenza cardiaca fetale (FHR) tra Musica e Non Musica a 28-30 sett EG*

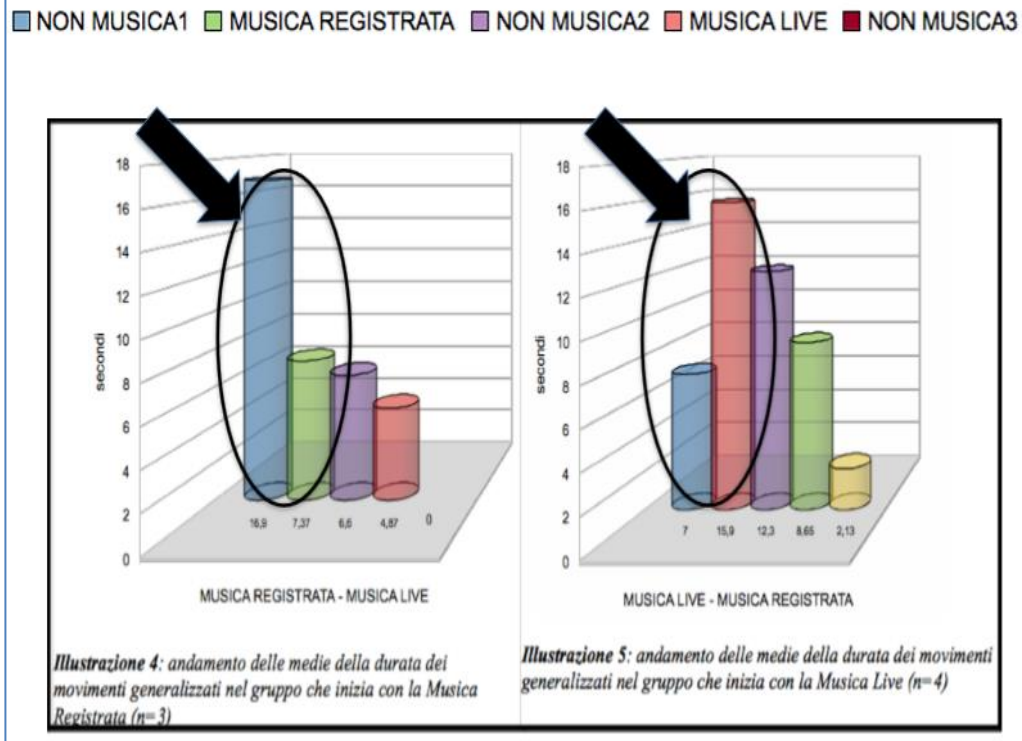

***Illustrazione 4**: andamento delle medie della durata dei movimenti generalizzati nel gruppo che inizia con la Musica Registrata (n=3)*

***Illustrazione 5**: andamento delle medie della durata dei movimenti generalizzati nel gruppo che inizia con la Musica Live (n=4)*

Fetuses respond to music, and even more so to live music, undertaking a movement pattern several times and increasing the number of FHR accelerations compared to the non-music condition.

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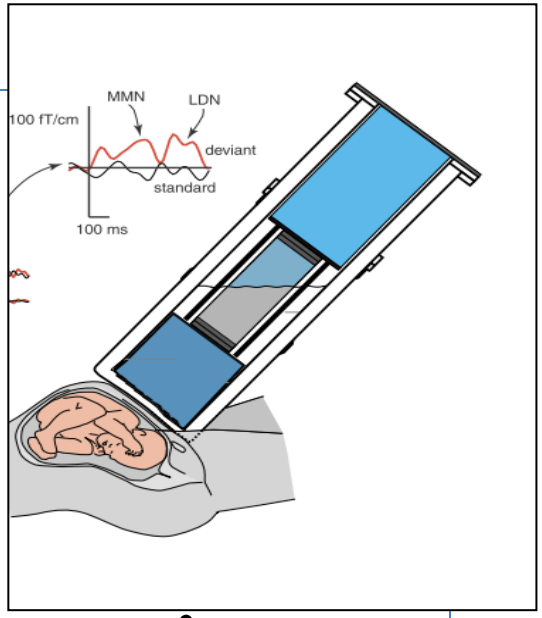
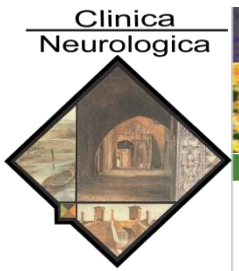
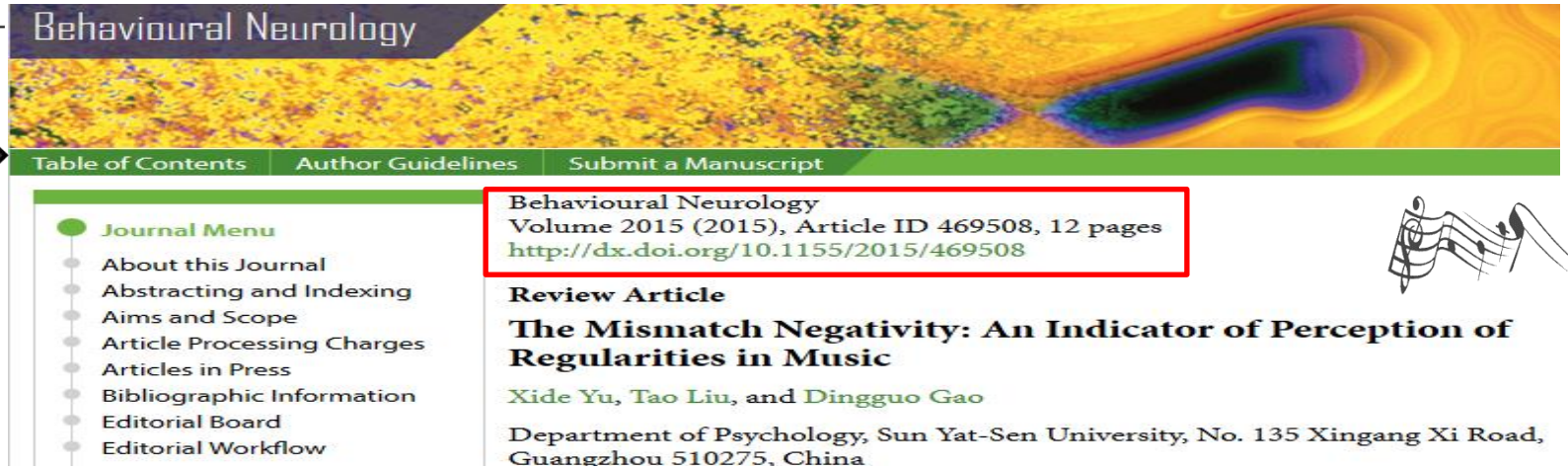
Studies on fetal brain functions

- Ecography
- Cardiotocography
- Electroencephalography
- Magnetoencephalography
- functional Magnetic Risonance Imaging
- Hormones, and other neurochemical parameters







.. Since MMN can act as a neural plasticity index, it can be widely used in clinical areas and other applied areas, such as **the detection of musical preference in newborns** or the assessment of the integrity of the central auditory system of hearing disorders...

..To fully understand the neural substrates at the basis of regularity processing in music, it is important and useful to combine MMN with other experimental paradigms such as ERAN.

Assessing fetal response to maternal speech using a noninvasive functional brain imaging technique

Renaud Jardri [a,b,c,*], Véronique Houfflin-Debarge [a,c], Pierre Delion [a,c], Jean-Pierre Pruvo [a,c], Pierre Thomas [a,b,c], Delphine Pins [a,b,d]

Int J Dev Neurosci. 2012

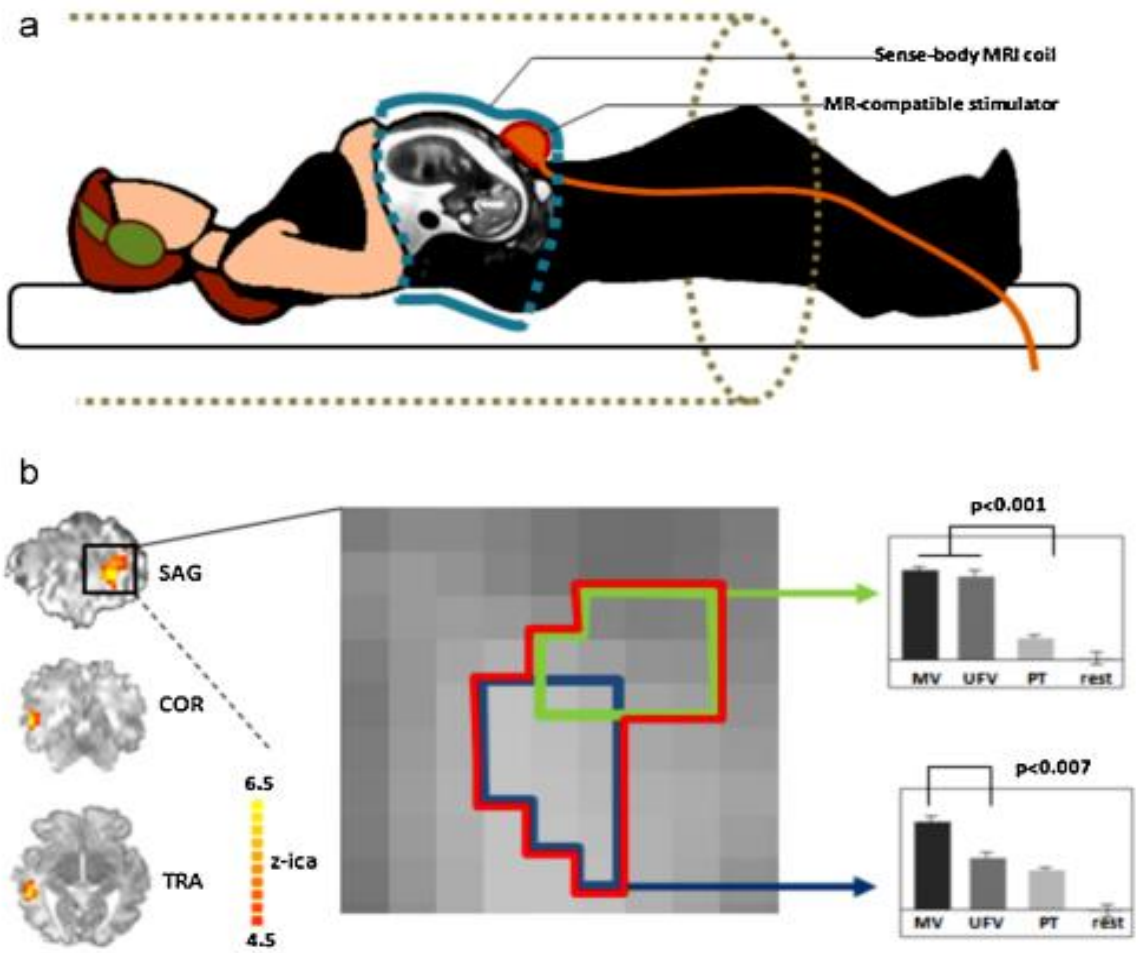


Fig. 1. Fetal brain responses to auditory stimuli. (a) Experimental setting. (b) Activation measured in the left superior temporal lobe in a 34 week GA fetus during auditory stimulation (left panel). The green cluster represents an increased response to speech compared with tones, while the blue cluster denotes a region displaying significant increases in activation during exposure to the maternal voice (middle and right panels).

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The fetus is able to receive musical stimuli

- Music can be heard by the fetus while the future mother is listening at the same time.
  - **What music do you listen to?**
- In France, Germany, Italy and the United States, special attention has been paid to the music to be listened to during pregnancy and to the effects it has on the expectant woman and the unborn child.
  Recent research shows that

  some composers would be more suitable than others.

  - **Mozart's music**, with its harmony and lack of repetitiveness, does not only need to become more intelligent (Mozart Effect): Mozart's notes are the most appreciated by future children.

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Music to listen to during pregnancy

- **Mozart e Vivaldi**, for example, are to be preferred over others. This is mainly **due to a constancy in the heart rate of the fetus, combined with a decrease in the uncoordinated motor activity perceived** while listening to songs by these artists.
- The music with their never repetitive variations of the notes would also contribute to develop the intelligence of the unborn child.
- ***Several studies seem to indicate that there would be music to be heard for every period of pregnancy.***

- **Music** to listen **to from the 1st to the 3rd month of pregnancy.**
- In this period it would be better to choose the baroque genre, which approaches the normal rhythm of the heartbeats. **Mozart, Schubert, Haendel, Vivaldi** are suggested.

The sounds to avoid:

- **The songs that evoke bad memories to the mother** (usually if the mother relaxes the child relaxes).
- **Rock music** (hard and acid).
- Classical music in which **instruments that excite like flute and violin predominate.**
- ***The music of Beethoven and Brahms seems to make the fetus shake.***

Generally, all the music that does not like and that makes you nervous.

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Music to listen to in pregnant

Music from the 4th to the 6th month of pregnancy

- It is suggested to **listen to sweet and relaxing melodies**, music that cradlasses the fetus and transmit tranquility.
- They are also suitable for the **lullabies**, relaxing thanks to the metric equilibrium, to the oscillating rhythm and to the sweet melody, also invented, as long ***as the words are simple, sung in half voice***, to reassure the fetus more.
- Composers include **Brahms, Chopin and Dvorak.**

Music from the 7th to the 9th month of pregnancy

- In this period it agrees that the rhythm becomes more animated**: alternating of soothing music with more vivid music**.
- The constant listening of a piece of music from the last months of pregnancy would give the fetus a **sense of security**, helping it to grow in a balanced and serene way.
- Also, if the song is re-proposed to the newborn, it will recognize it as a sound and it will encourage its relaxation.. *(Alfred Tomatis, otolaryngologist French, prenatal and post-natal music therapy expert).*

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Music to listen to in pregnancy

Comment

- Studies infer that the unborn child will be able to perfectly recognize the music frequently listened to during gestation.
- He/she often reacts by relaxing and calming himself/herself to the listening, as if that music brought him/her back to the welcoming and protective world of the maternal womb.

Interview
with Enrico Granieri,
July 2018

Dossier/2

LA MUSICA È UNA MEDICINA

ELIMINA L'ANSIA

CURA PERFINO LE MALATTIE

ANIMALI

ANCHE CANI E GATTI SOFFRONO DI STRESS E OBESITÀ

COMPORTAMENTO

I piedi: c'è chi li adora e chi ne ha paura

RELIGIONE

LE REGOLE MILLENARIE DELLA SACRA ROTA

SPECIALE AMBIENTE

1. Com'è l'aria che respiriamo
2. Che cosa succede ai nostri mari
3. Alluvioni, frane, terremoti, vulcani: come difenderci

MUSICA: perché ci fa piangere, ridere, emozionare

Oggi sappiamo che la musica agisce direttamente sul cervello. Non solo: note, passaggi melodici e armonie attivano diversi neuroni, generando cascate di sensazioni. Il bello è che ciò riguarda tutti, non importa quale sia la cultura di appartenenza, e spiegherebbe anche il successo di certe canzoni *di Andrea Porta*