IMPLICAZIONI NEUROSCIENTIFICHE NELLA PRODUZIONE E NELL'ASCOLTO MUSICALE

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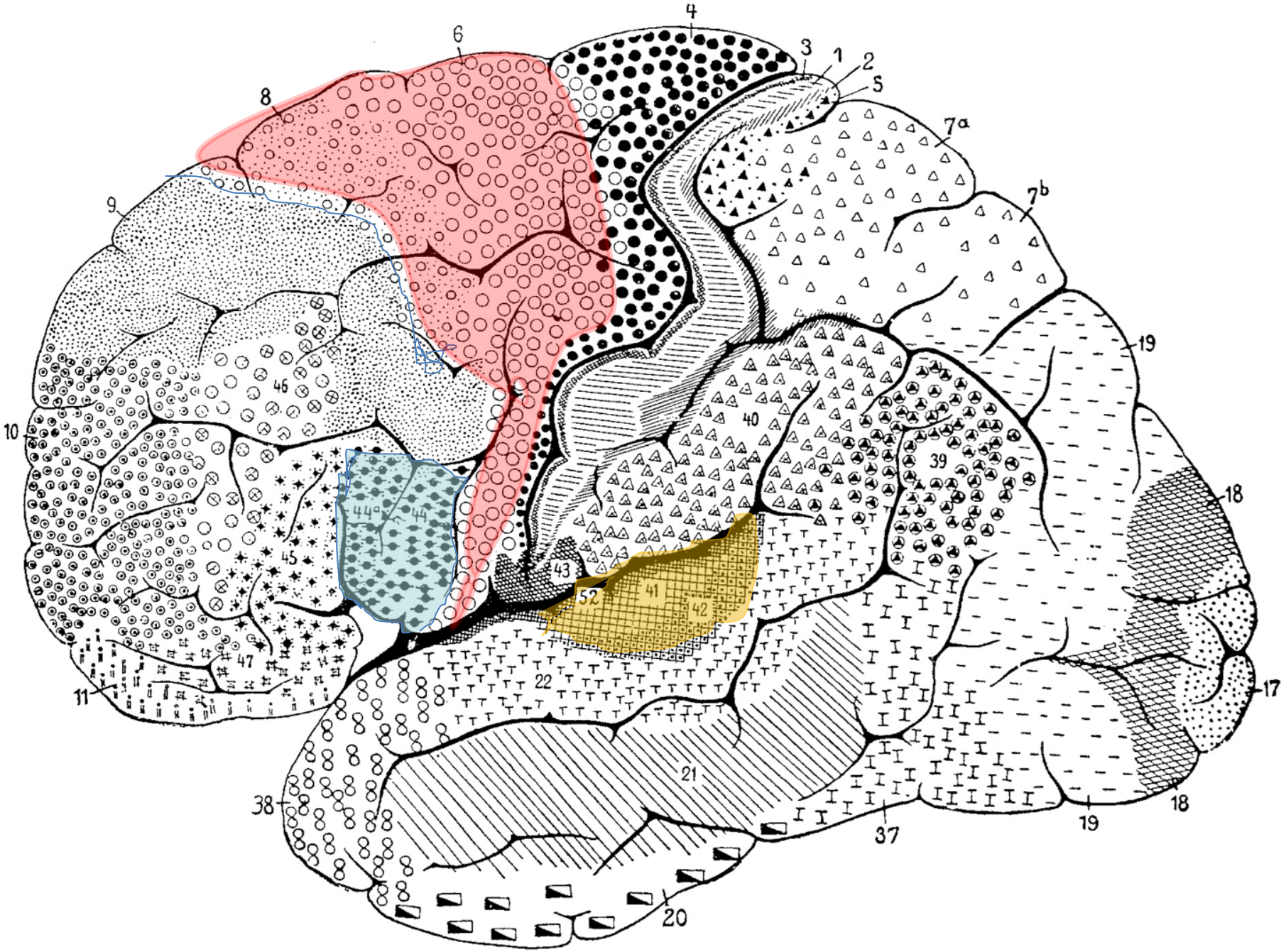
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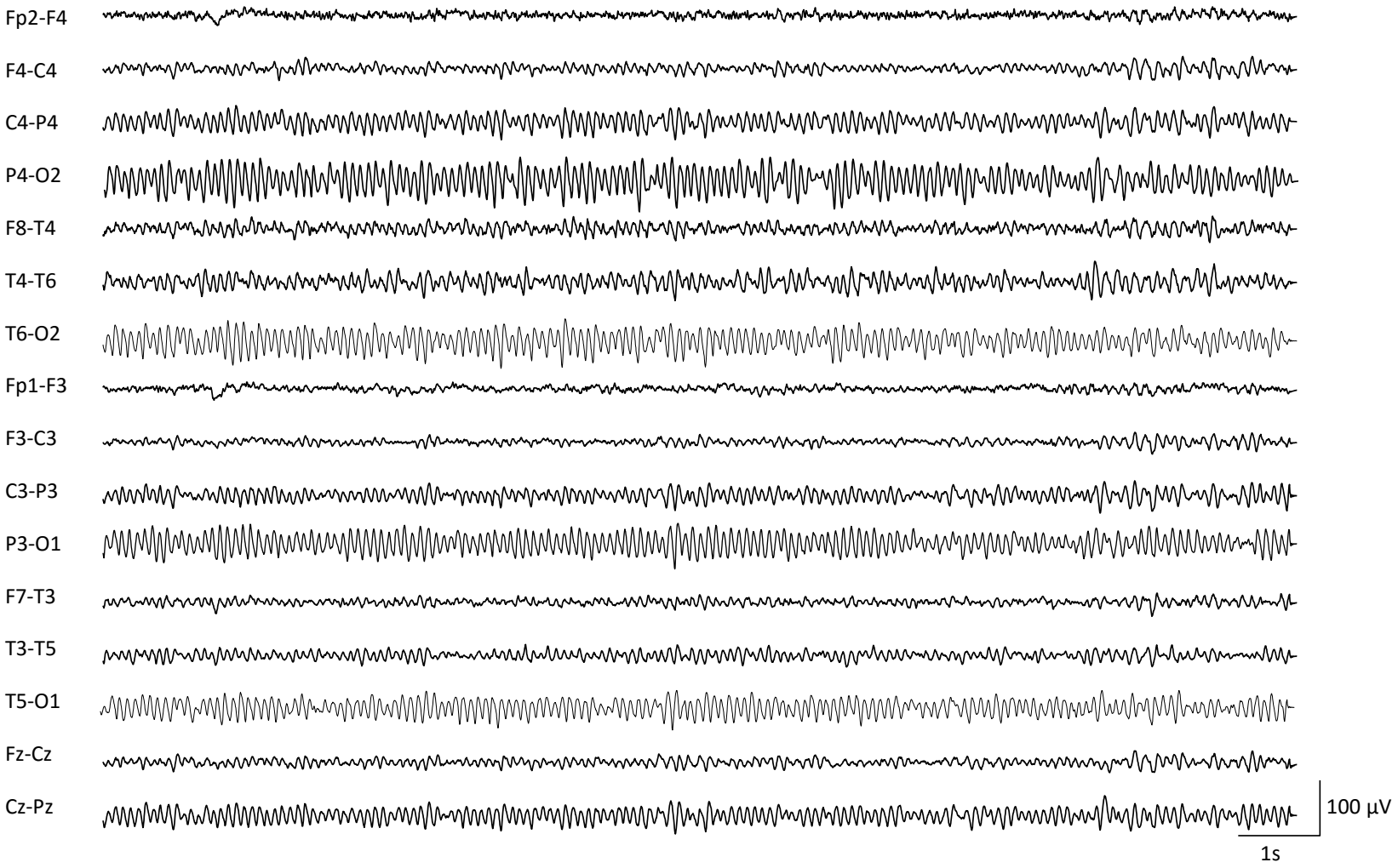

Fp2-F4
F4-C4
C4-P4
P4-O2
F8-T4
T4-T6
T6-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
F7-T3
T3-T5
T5-O1
Fz-Cz
Cz-Pz
100 µV
1s

Ritmi EEG

Ritmo: segnale la cui forma d'onda si ripete regolarmente dopo un intervallo di tempo fisso

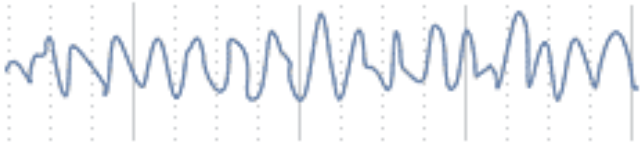
- Sommazione di attività neuronali unitarie
- Attività ritmiche possono risultare da attività unitarie ritmiche altamente sincronizzate o dalle costanti di tempo dei sistemi cerebrali generatori che impongono un ritmo ad attività unitarie di frequenza variabile

Four Categories of Brain Wave Patterns

Beta (14-30 Hz)

Concentration, arousal, alertness, cognition

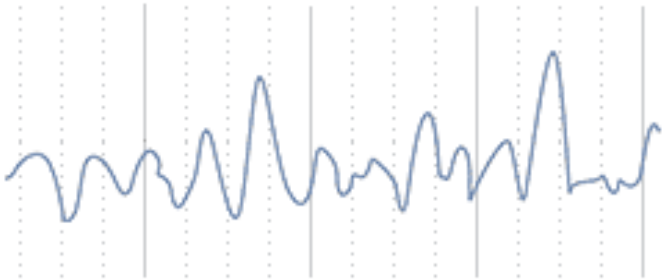
Higher levels associated with anxiety, disease, feelings of sparation, fight or flight



Alpha (8-13.9 Hz)

Relaxation, superlearning, relaxed focus, light trance, increased serontonin production

Pre-sleep, pre-waking drowsiness, mediation, beginning of access to unconscious mind

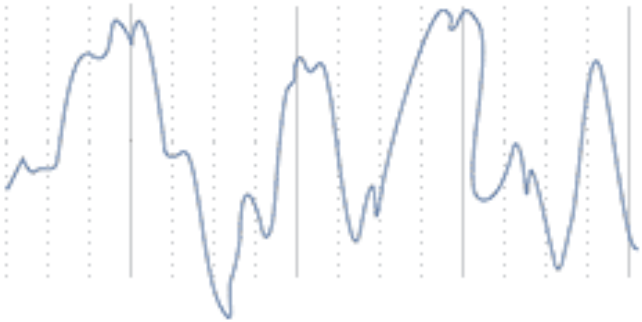


Theta (4-7.9 Hz)

Dreaming sleep (REM sleep)
Increased production of catecholamines (vital for learning and memory), increased creativity

Integrative, emotional experiences, potential change in behavior, increased retention of learned material

Hypnagogic imagery, trance, deep mediation, access to unconscious mind



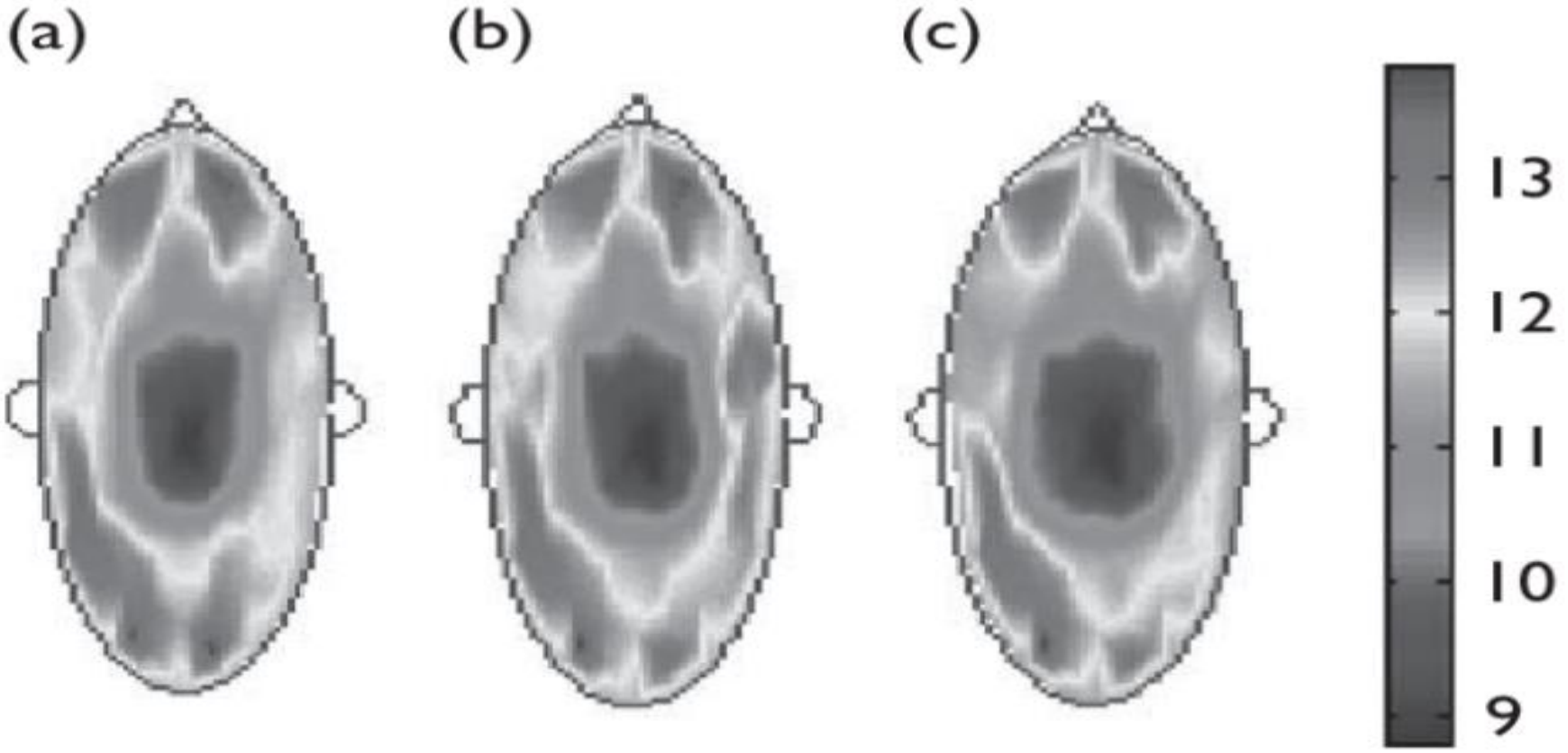
Delta (.1-3.9 Hz)

Dreamless sleep
Human growth hormone released

Deep, trance-like, non-physical state, loss of body awareness

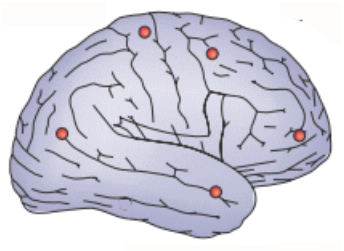
Access to unconscious and "collective unconscious" mind, greatest "push" to brain when induced with Holosync®

Weiyi Ma et al 2013. EEG gamma band spectral map in 15 subjects during melody modulation. Clock or counterclockvise refers to the circle of the fifth

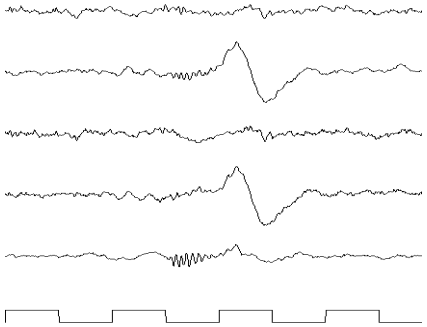


Topographic maps of γ-band spectral power (μV^2). (a) Counterclockwisely modulated melody (7SL – C key); (b) ORI (G key); and (c) Clockwisely modulated melody (7SH – D key).

Methodological procedure



EEG acquisition



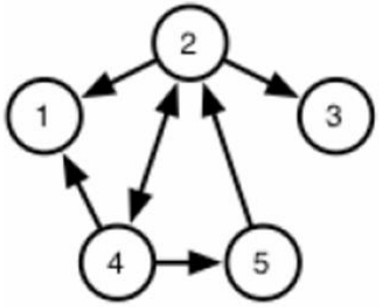
single channel PSD

PDC and Connectivity Indices

Threshold

Connections <> 0

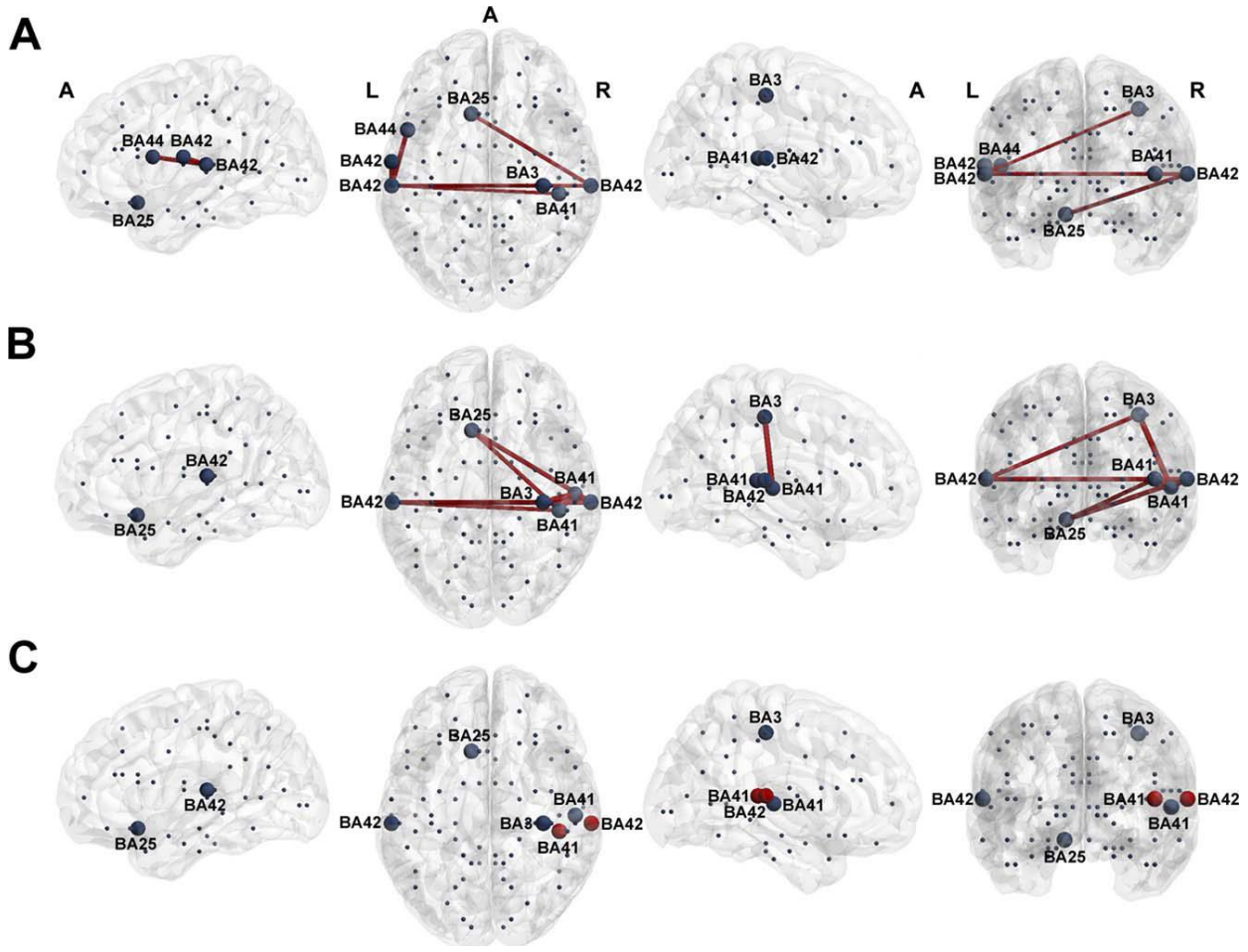
Adjacency matrix and graph.



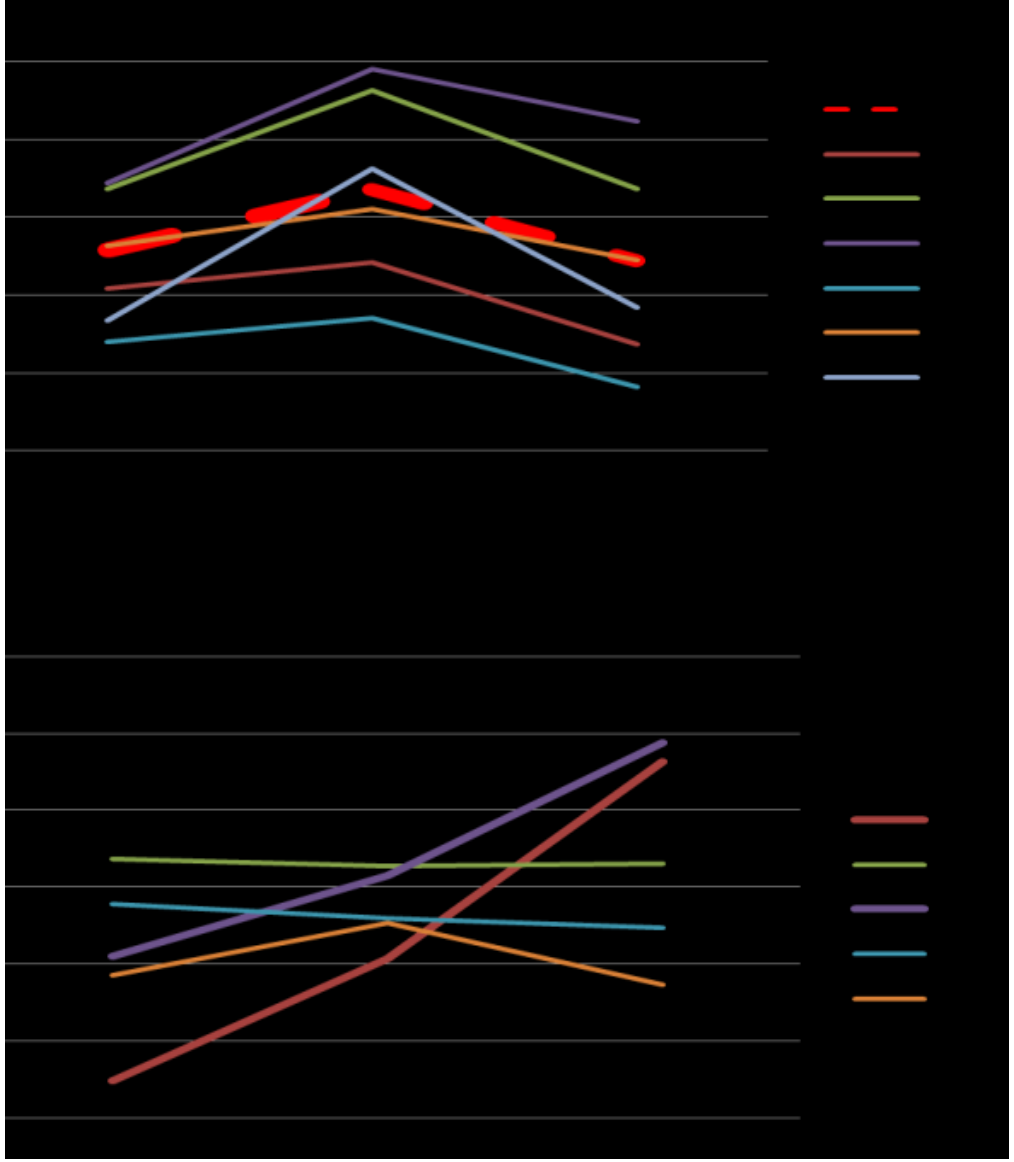
$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 \end{pmatrix}$$

- Estimation of :
  - Power spectra density (PSD and main frequency components.
  - Directionality indexes (PDC) and associated parameters.
- Identification and graphical representation of links connecting different leads.

The “Silent” Imprint of Musical Training Klein C., F Liem, Hanggi J, Elmer S, Jancke L Human Brain Mapping 37:536–546 (2016)

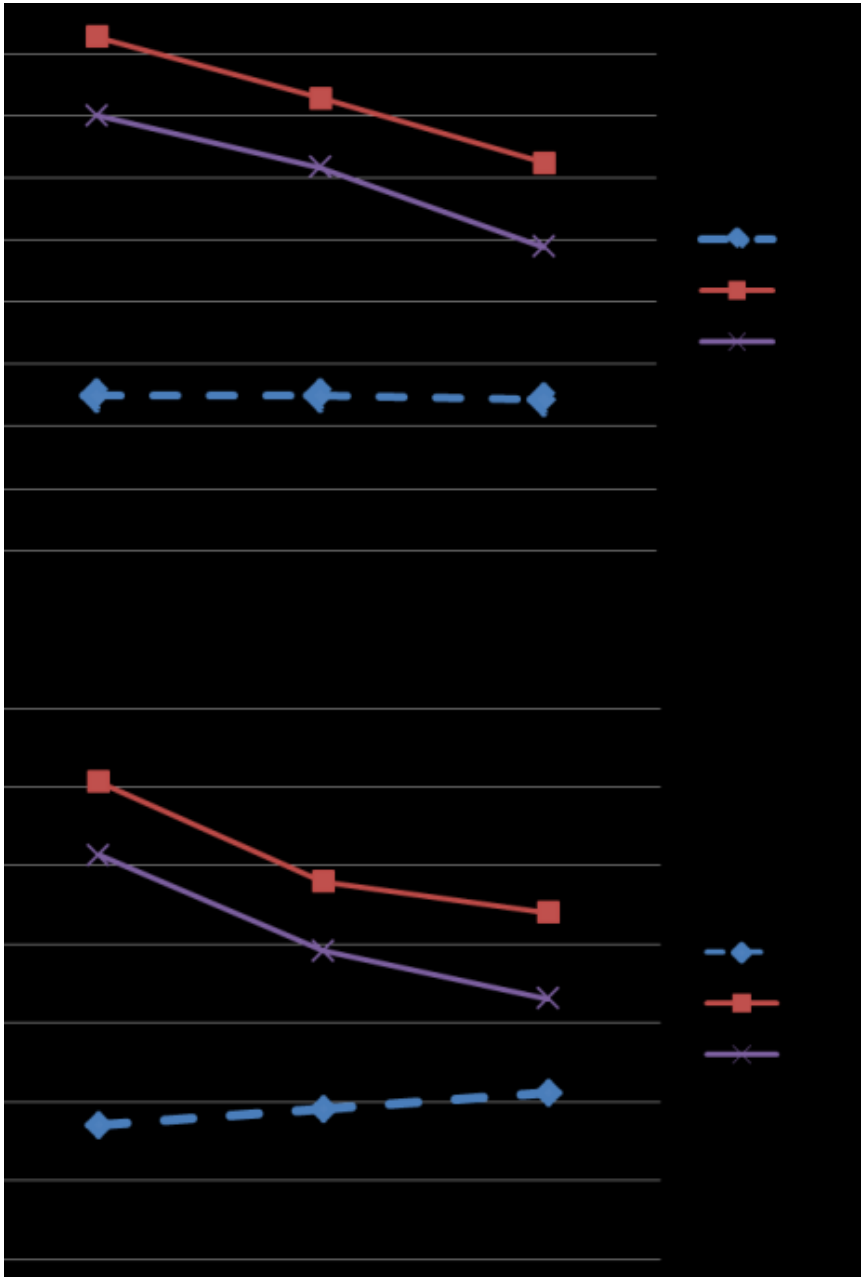


Incresed connectivity (red) in musicians vs musical laymen for theta (A) and alpha (B) frequency bands. C: nodes for alpha frequency band between which musicians showed an increased connectivity. In the right auditory cortex auditory areas 41, 42 (red) musicians show an increased degree value compared to non musicians



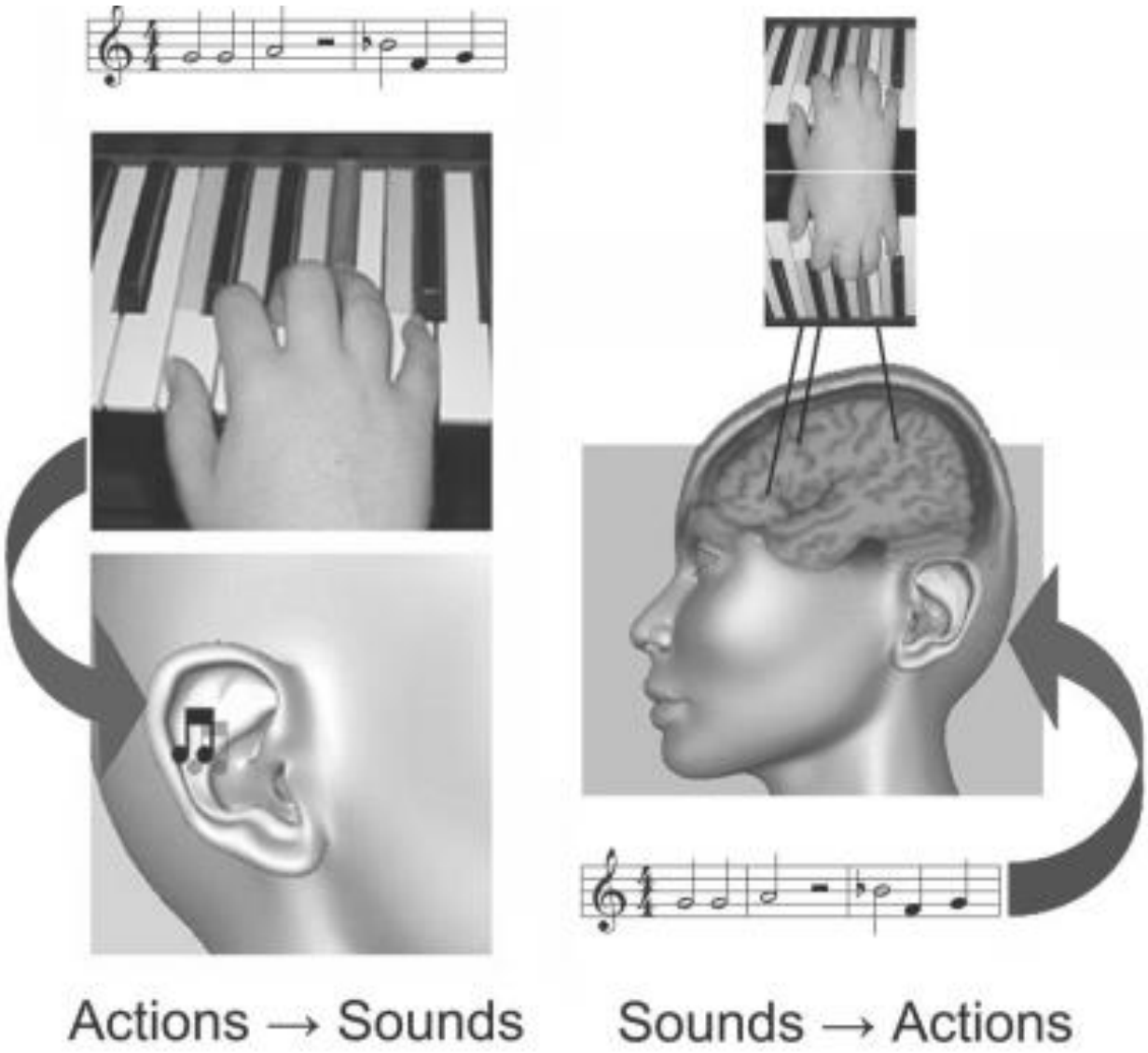
From left to right: rest, pleasant , unplesant stimulus
Above:six control subjects
Below five patients two of whom Showed increased connectivity during the unplesant musical stimulus

Varotto, Fazio, Rossi, Avanzini, Franceschetti, Panzica Music and emotion: an EEG connectivity study in patients with disorders of consciousness IEEE EMBS conference 2012



Varotto 2012

Audiomotor Recognition Network While Listening to Newly Acquired Actions



From Lahav, Saltzman and Schlaugh 2007

RITMO E METRO

- **Ritmo**: l'organizzazione delle relazioni temporali tra i singoli elementi di una sequenza di eventi. *Frequenza:* numero volte in cui un evento si ripete regolarmente nell'unità di tempo). *Periodo:* intervallo tra punti omologhi dell'evento che si ripete.
- **Metro**: identificato dalla percezione della pulsazione (astrazione concettuale corrispondente a un picco di energia attentiva). Crea un'aspettativa delle pulsazioni successive.
- **Tactus:** pulsazione su cui battiamo il tempo (pulsazioni in diverse scale temporali percepite simultaneamente vengono organizzate secondo una gerarchia che determina il tactus).

METRO

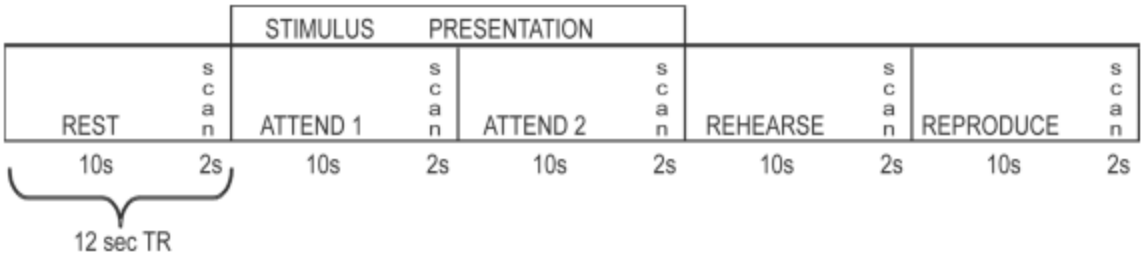
- Risente di variabili percettive che determinano la preferenza di rapporti temporali semplici (2:1, 3:1, 3:2) e di determinati intervalli (300-800 ms: Fraisse 1982, London 2004).
- Risente di variabili non temporali (altezza, intensità, struttura melodica e armonica)
- «Entrainment» (dal francese entrener): coordinazione spazio-temporale risultante dalla capacità di rispondere ritmicamente a un segnale ritmico percepito (Phillips-Silver et al 2000)

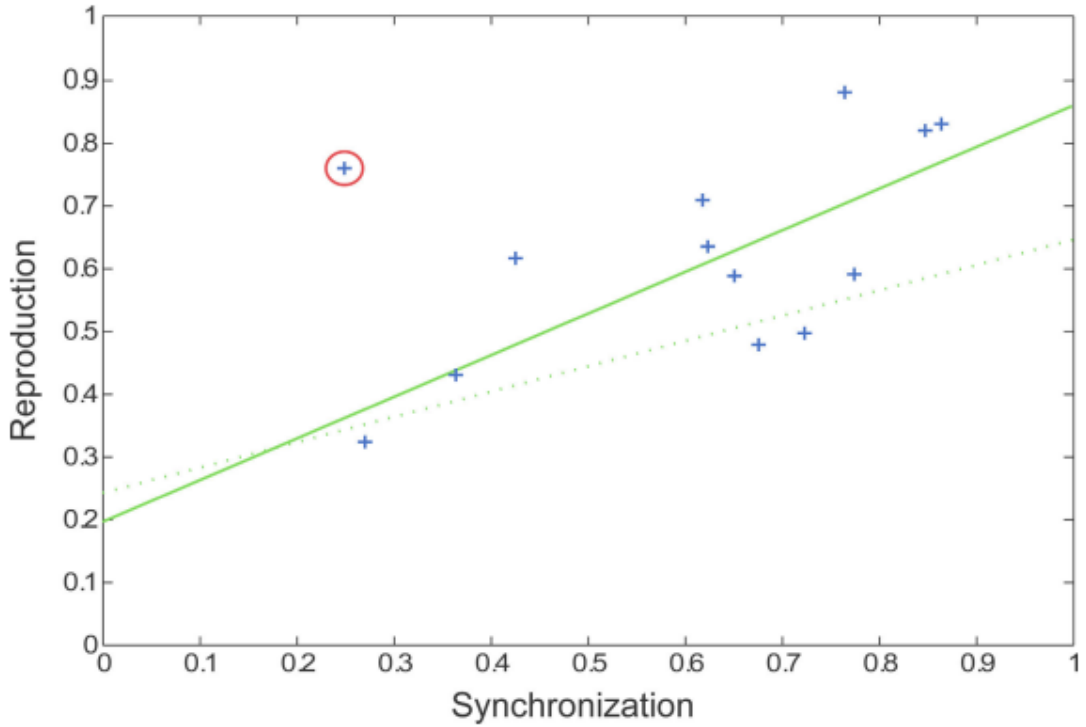
frontiers in
PSYCHOLOGY

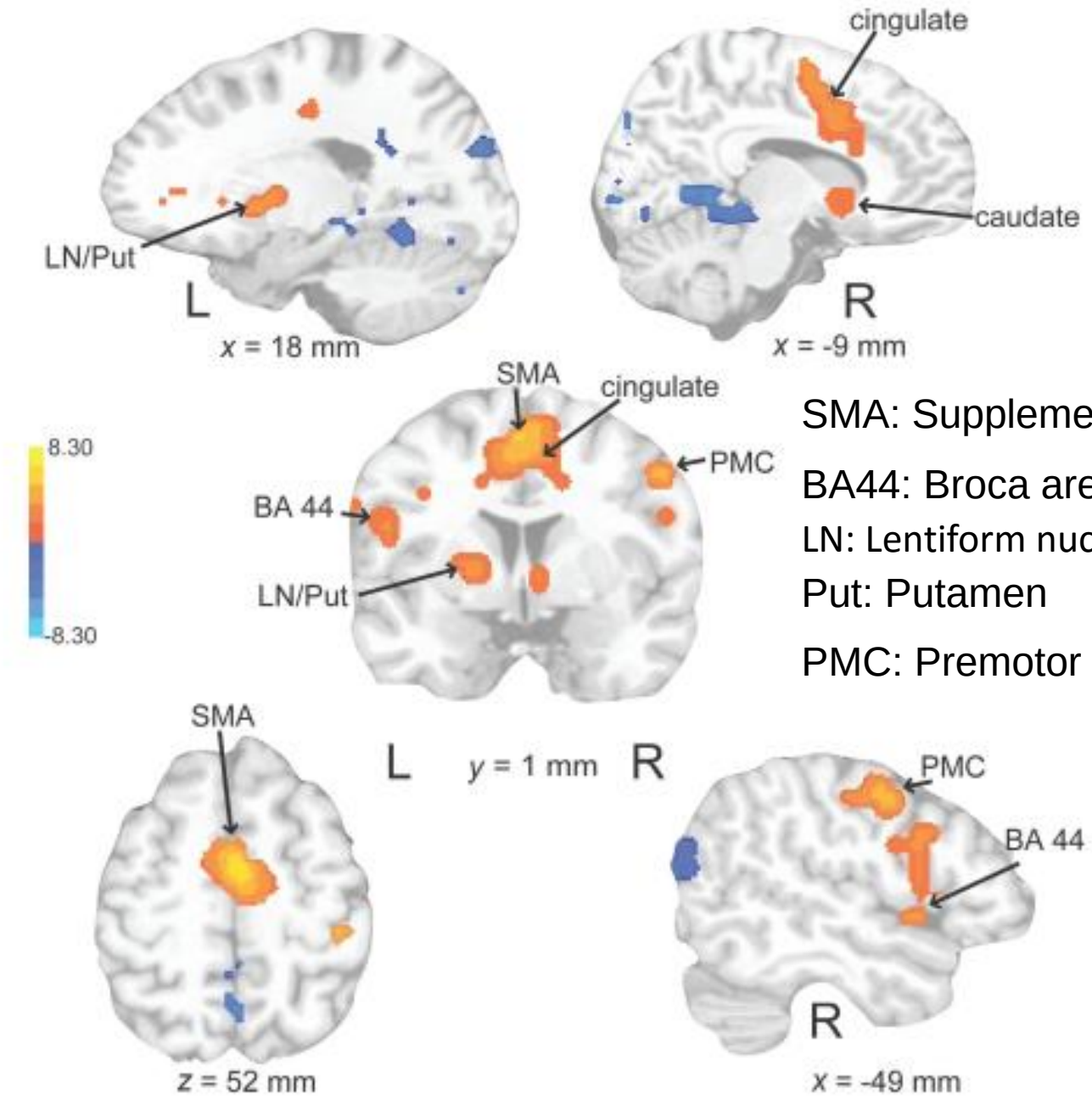
ORIGINAL RESEARCH ARTICLE
published: 24 December 2010
doi: 10.3389/fpsyg.2010.00224

Neural responses to complex auditory rhythms: the role of attending

*Heather L. Chapin[1], Theodore Zanto[2], Kelly J. Jantzen[3], Scott J. A. Kelso[4,5], Fred Steinberg[6] and Edward W. Large[1]**







SMA: Supplementary Motor Area

BA44: Broca area

LN: Lentiform nucleus

Put: Putamen

PMC: Premotor Cortex

Auditory reharse condition – rest

Chapin et al 2010

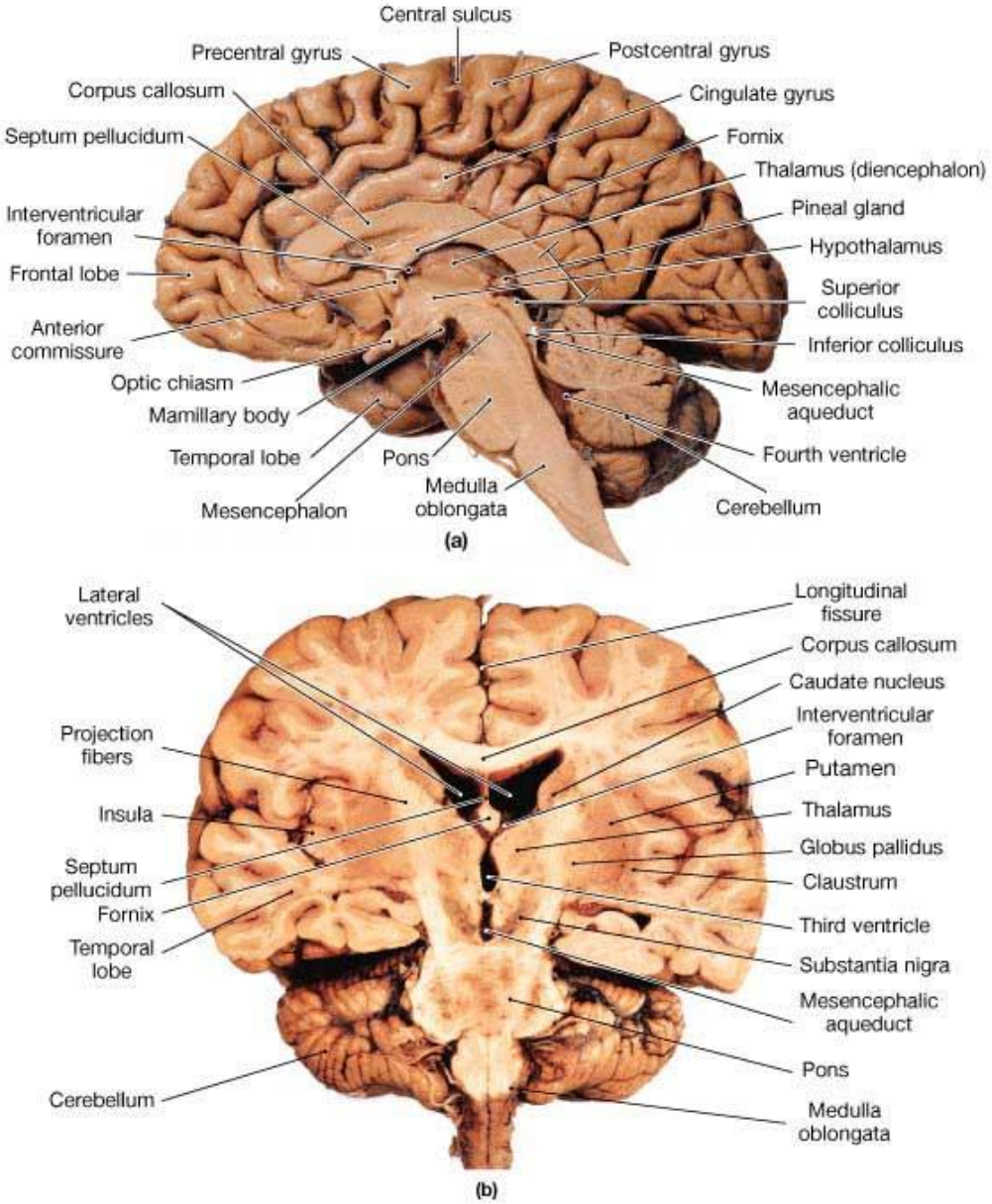
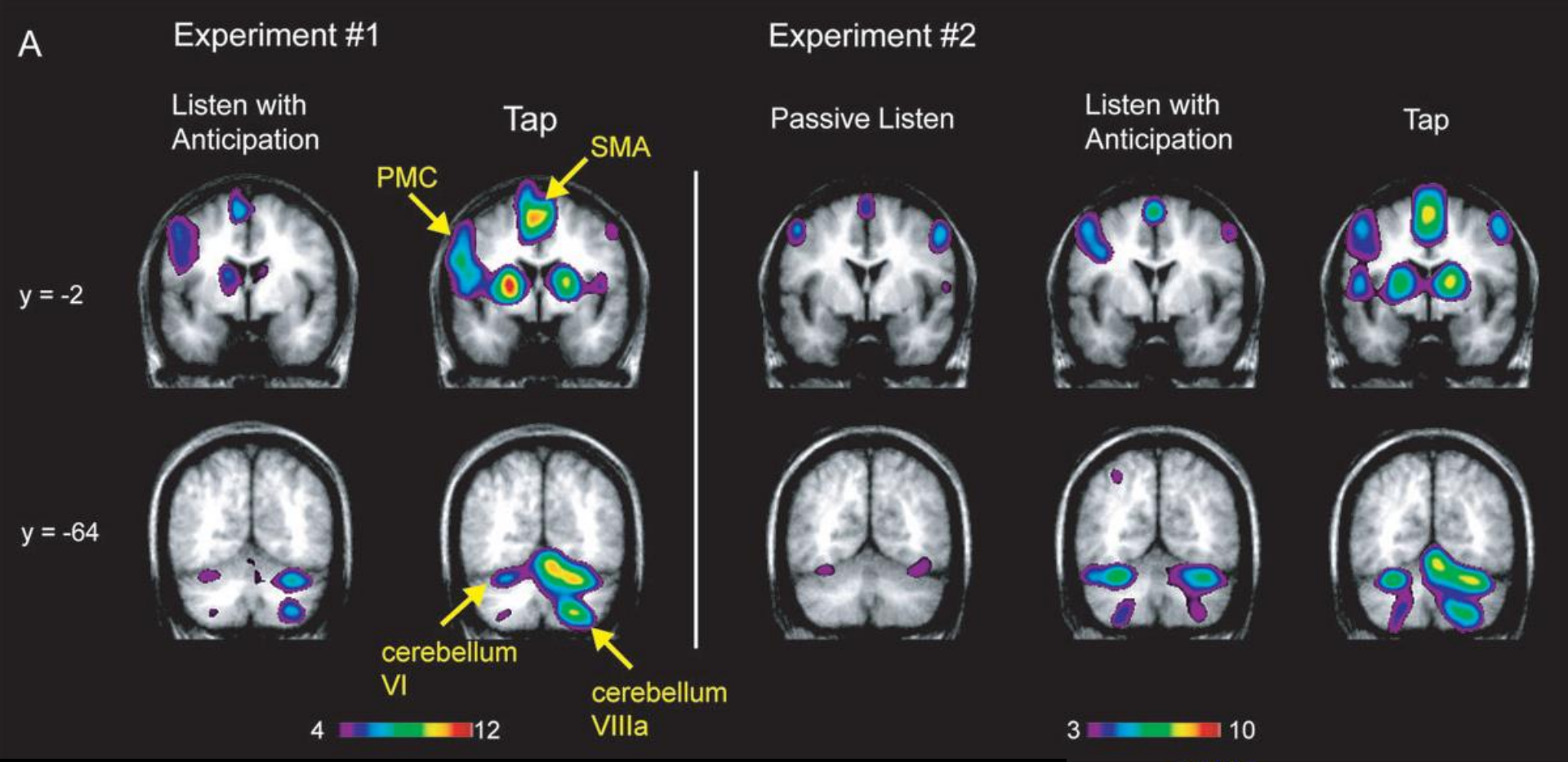


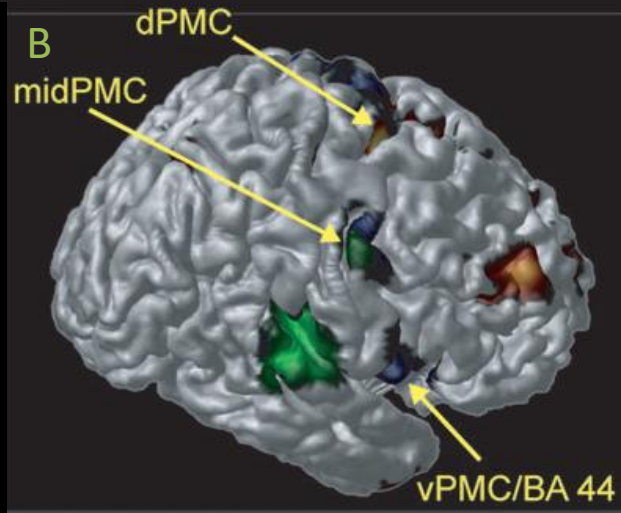
FIGURE 14-12 The Brain in Section. (a) Midsagittal section. **(b)** Frontal section.

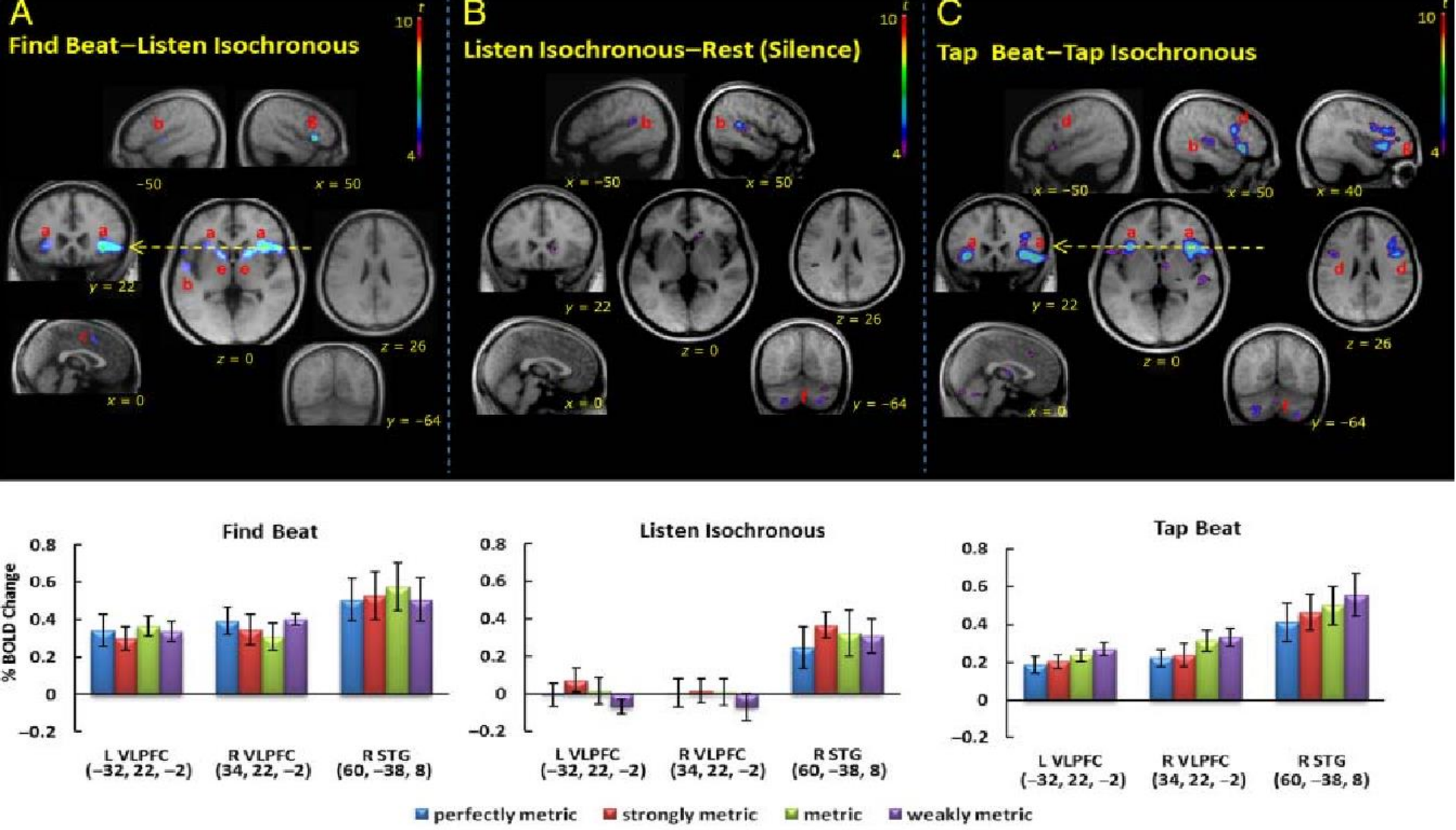


fMRI activations associated to musical rhythm perception

A: Left listening in anticipation of tapping and while tapping on the musical rhythm (Exp 1). **Right:** naively listening to rhythm, listening with anticipation and while tapping

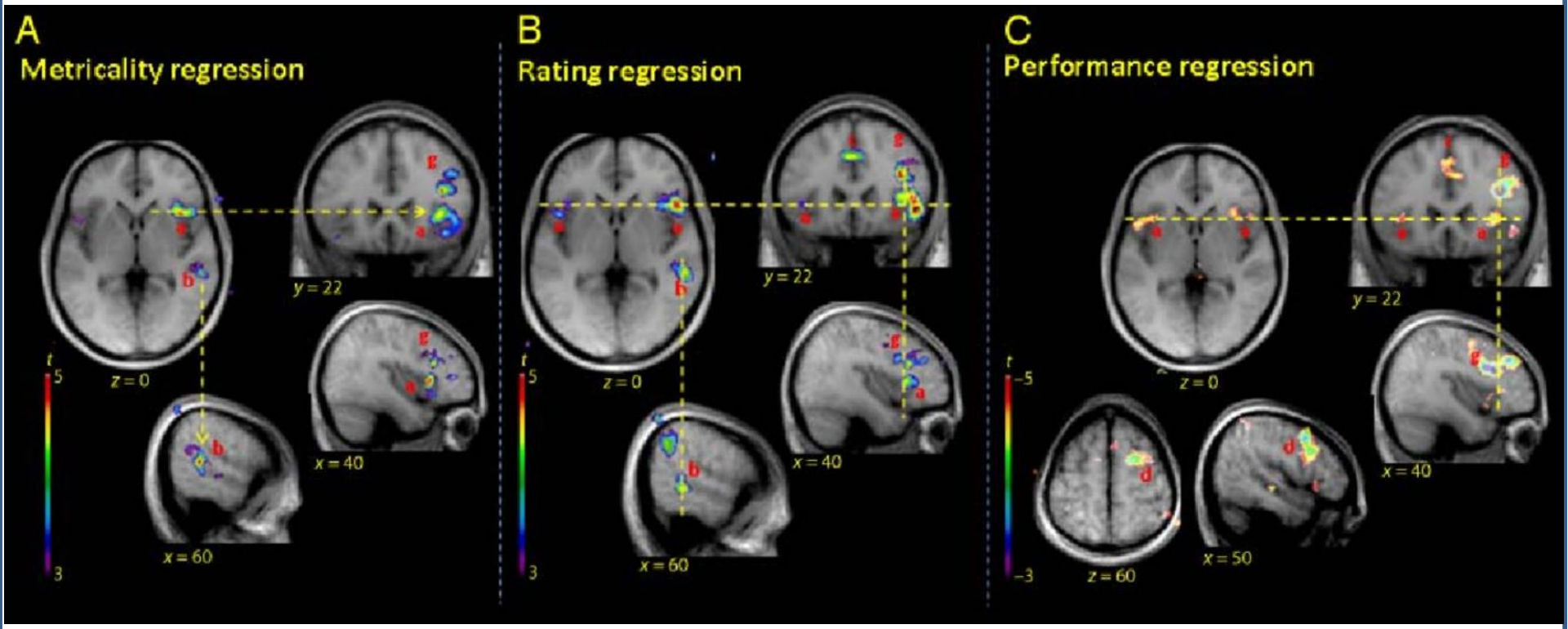
B: activation of dorsal mid and ventral premotor cortex projected on tridimensional rendering: Green: activated during passive listening. Blue: activated wile tapping. (Chen et al 2008)

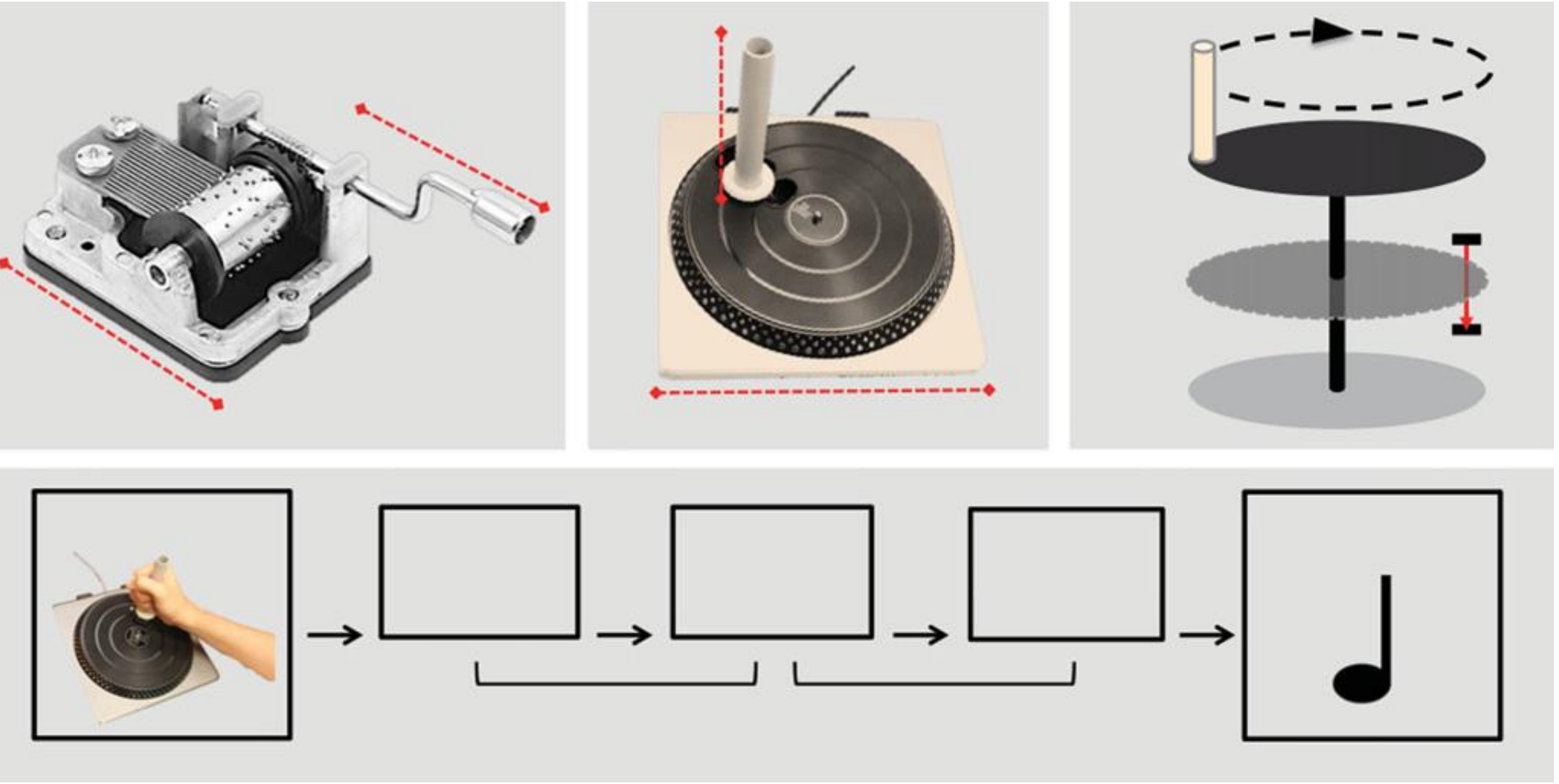




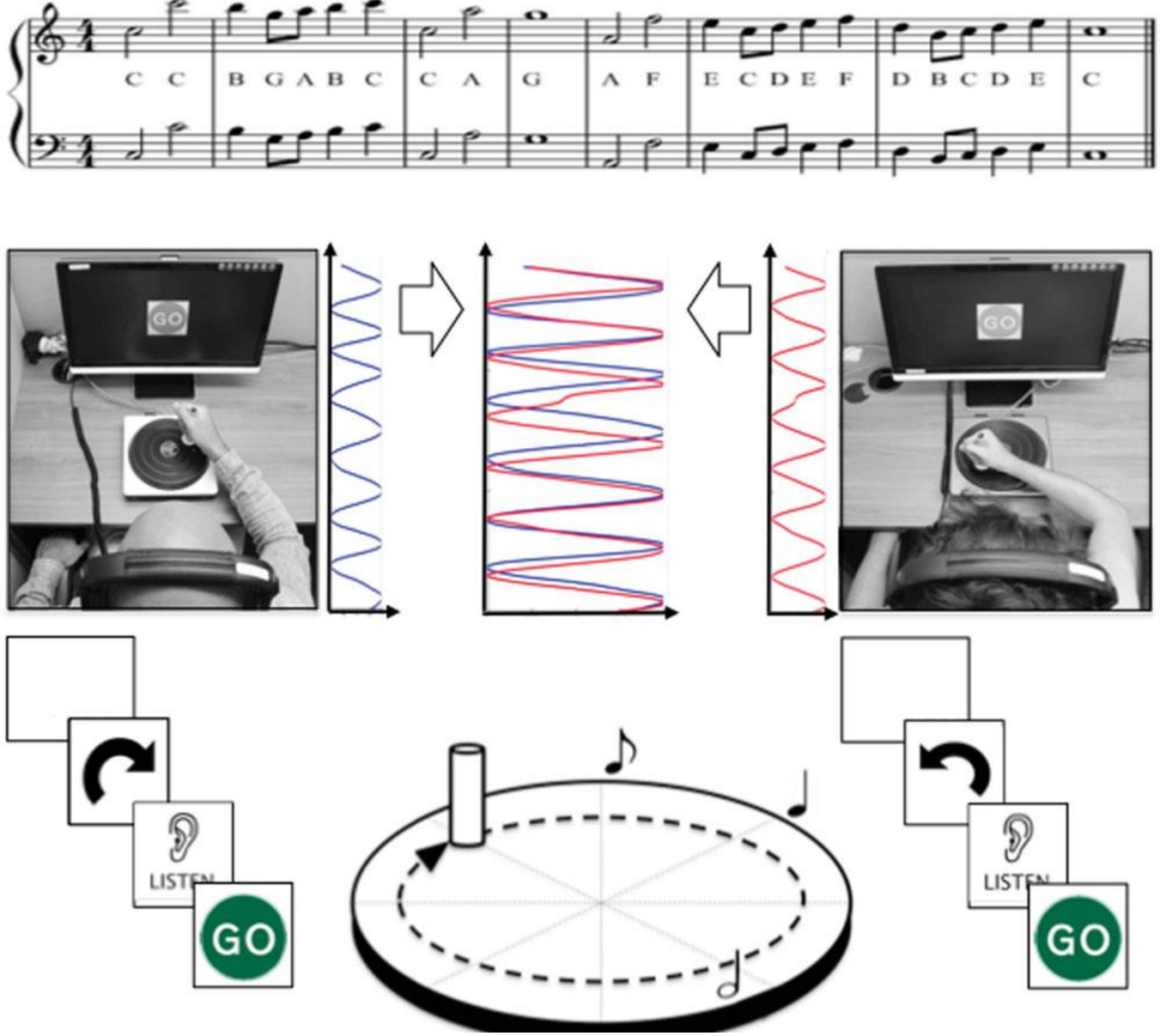
L/R: left/Right frontolateral prefrontal cortex; R STG: superior temporal gyrus

From Kung etal 2013

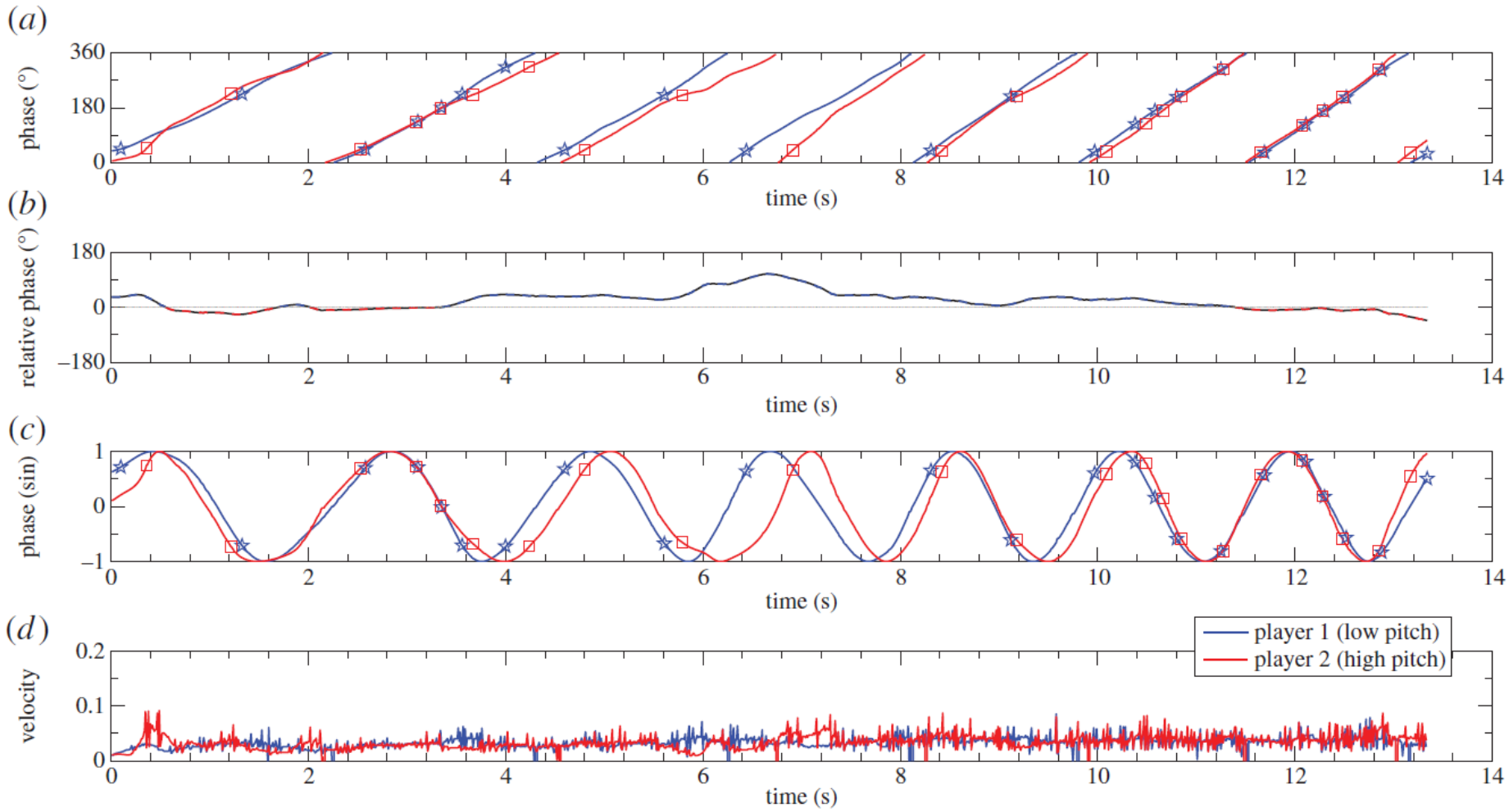

A
Metricality regression
B
Rating regression
C
Performance regression
y = 22
z = 0
x = 40
x = 60
x = 50
z = 60
t
5
3
−5
−3



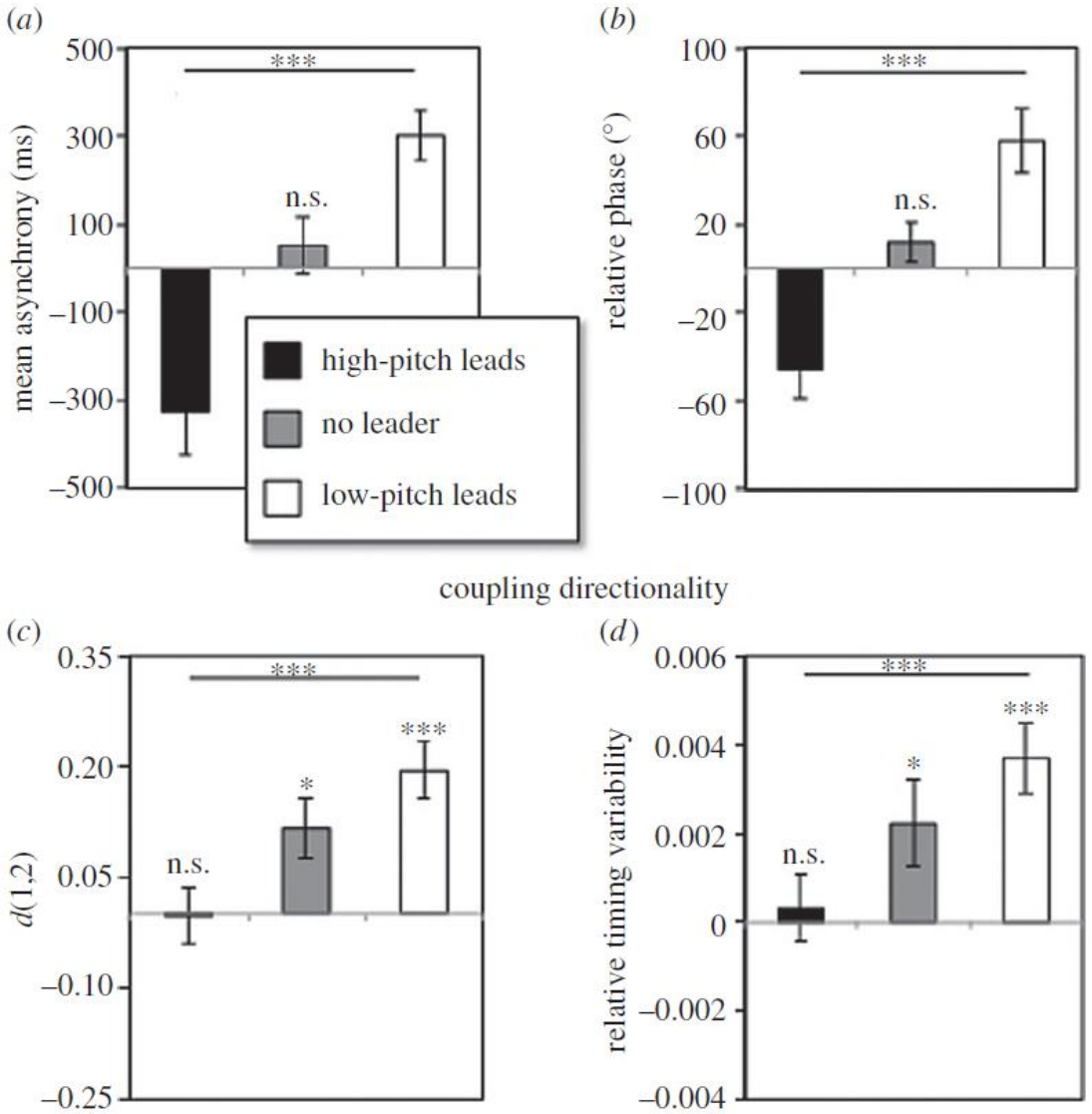
The electromechanical (E) music box depicted on the center can produce a melody when rotated either clockwise or antoclockwise Novembre et al 2015



Two non musicians make music together following the monitors instructions about the leadership role and rotation direction. Novembre et al 2015



(a) Phase xpressed in degrees. (b) relative phase (color indicates who produces the movement earlier . (c) phase expressed in sine (d) rotation velocity. Novembre et al 2015

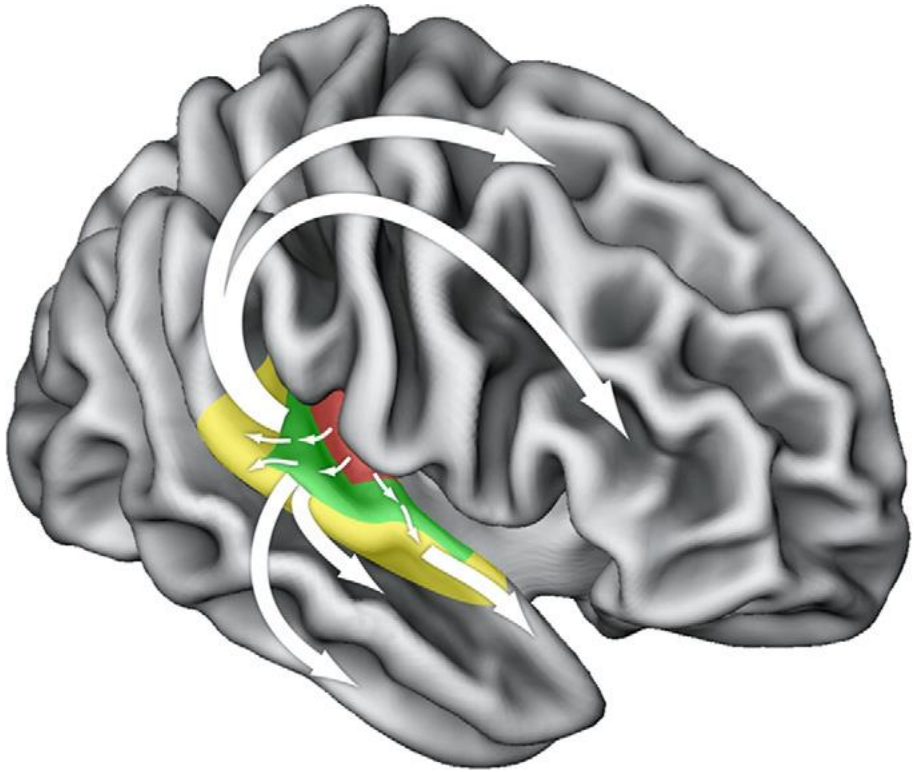


Mean signed asynchronies (a) and mean relative phase (b) indicate the instantaneous leadership, (c) and (d) coupling directionality. Positive values indicate that the low pitch player is leading , negative value viceversa. Novenbre et al 2015

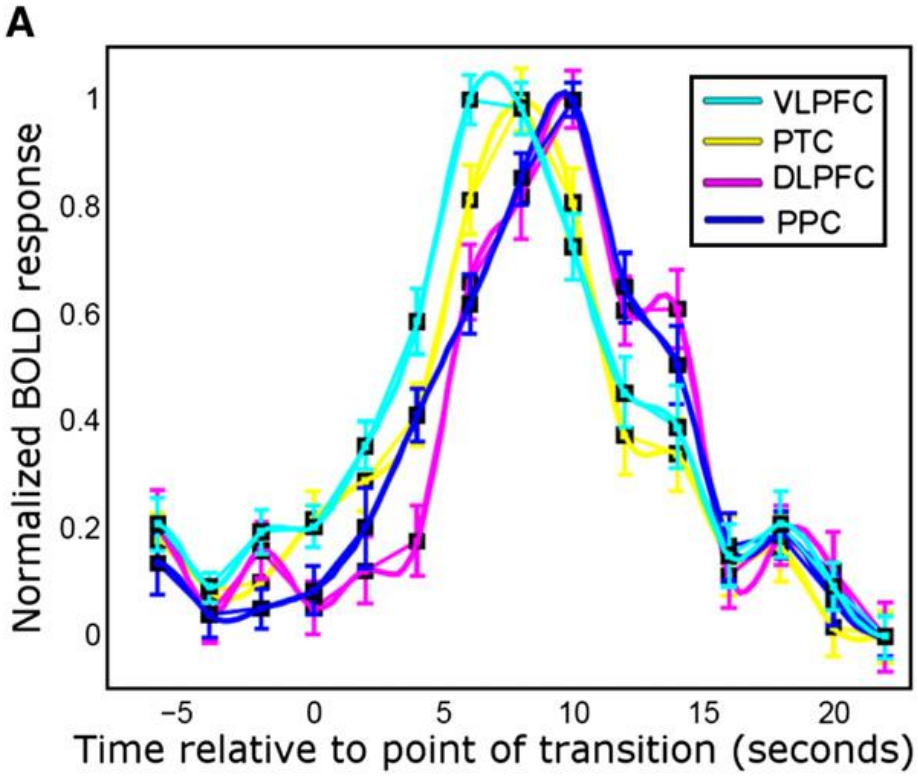
Table 1. Measures of coordination precision. Mean and standard deviation of the signed asynchronies and relative phase.

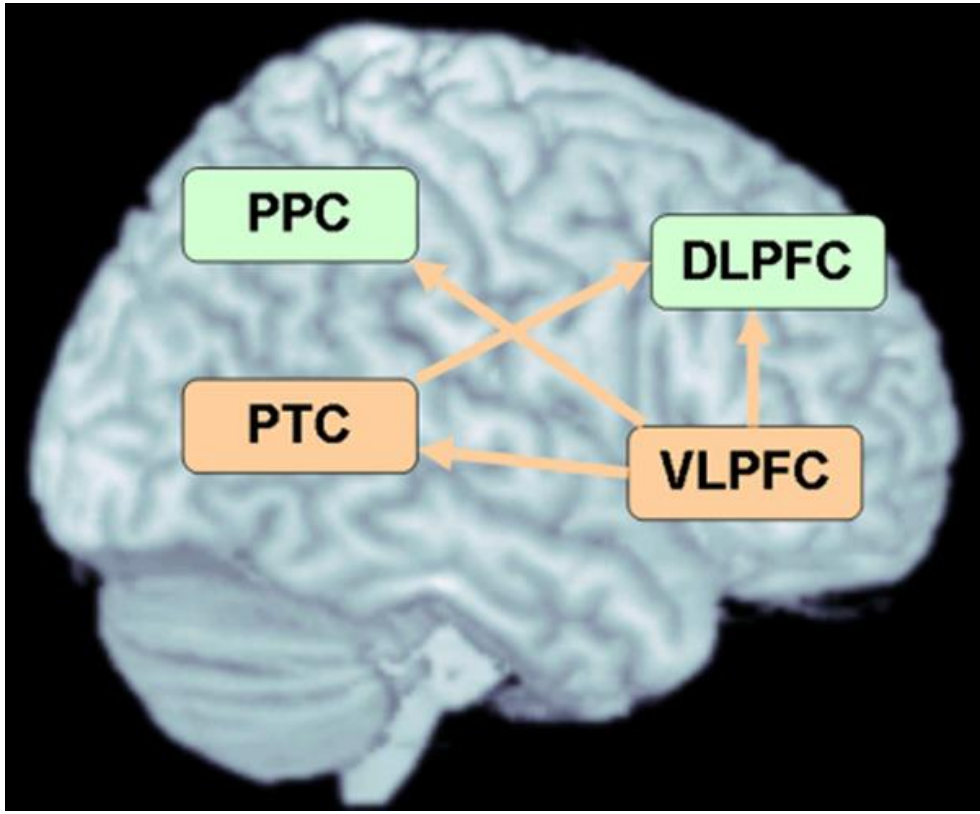
	high-pitch leads	no leader	low-pitch leads
asynchronies (s.d.)	502.32 ± 154.70	466.18 ± 179.14	456.99 ± 131.38
rel. phase (s.d.)	77.30 ± 26.62	68.16 ± 26.90	72.07 ± 21.64

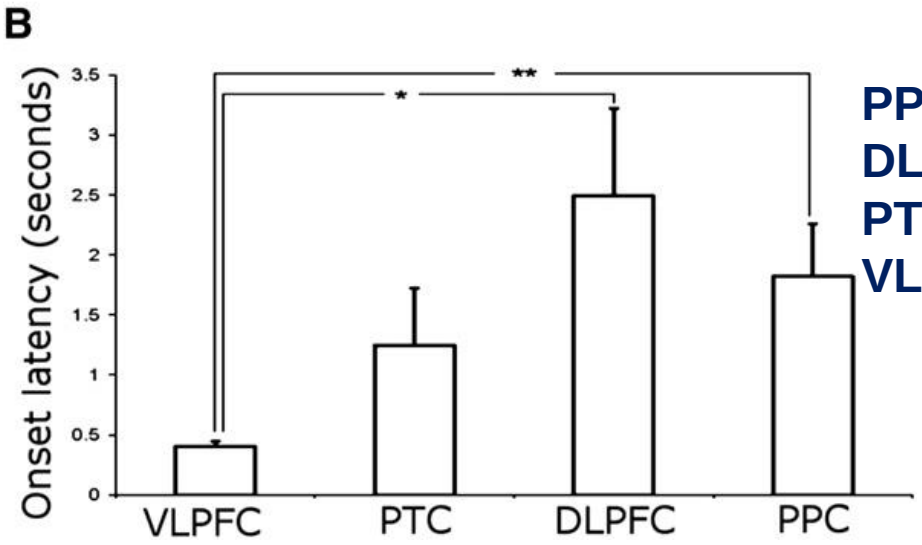
Novembre et al 2015



Robert J. Zatorrea,1 and Valorie N. Salimpoora, 2013







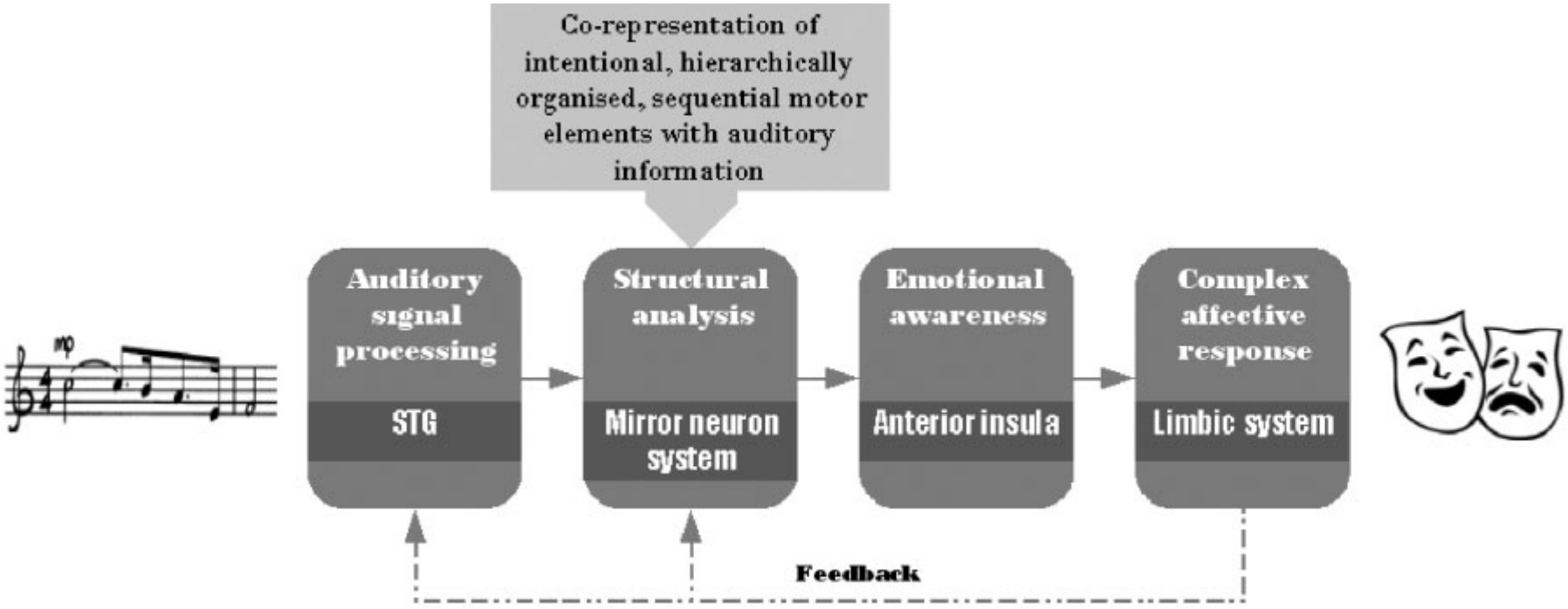
PPC: posterior parietal cortex **40**
DLPFC: dorsolateral prefrontal cortex **9**
PTC: posterior temporal cortex **21/22**
VLPFC: ventrolateral prefrontal cortex **47, 44/45**

Neural dynamics of event segmentation in music: Converging evidence for dissociable ventral and dorsal networks

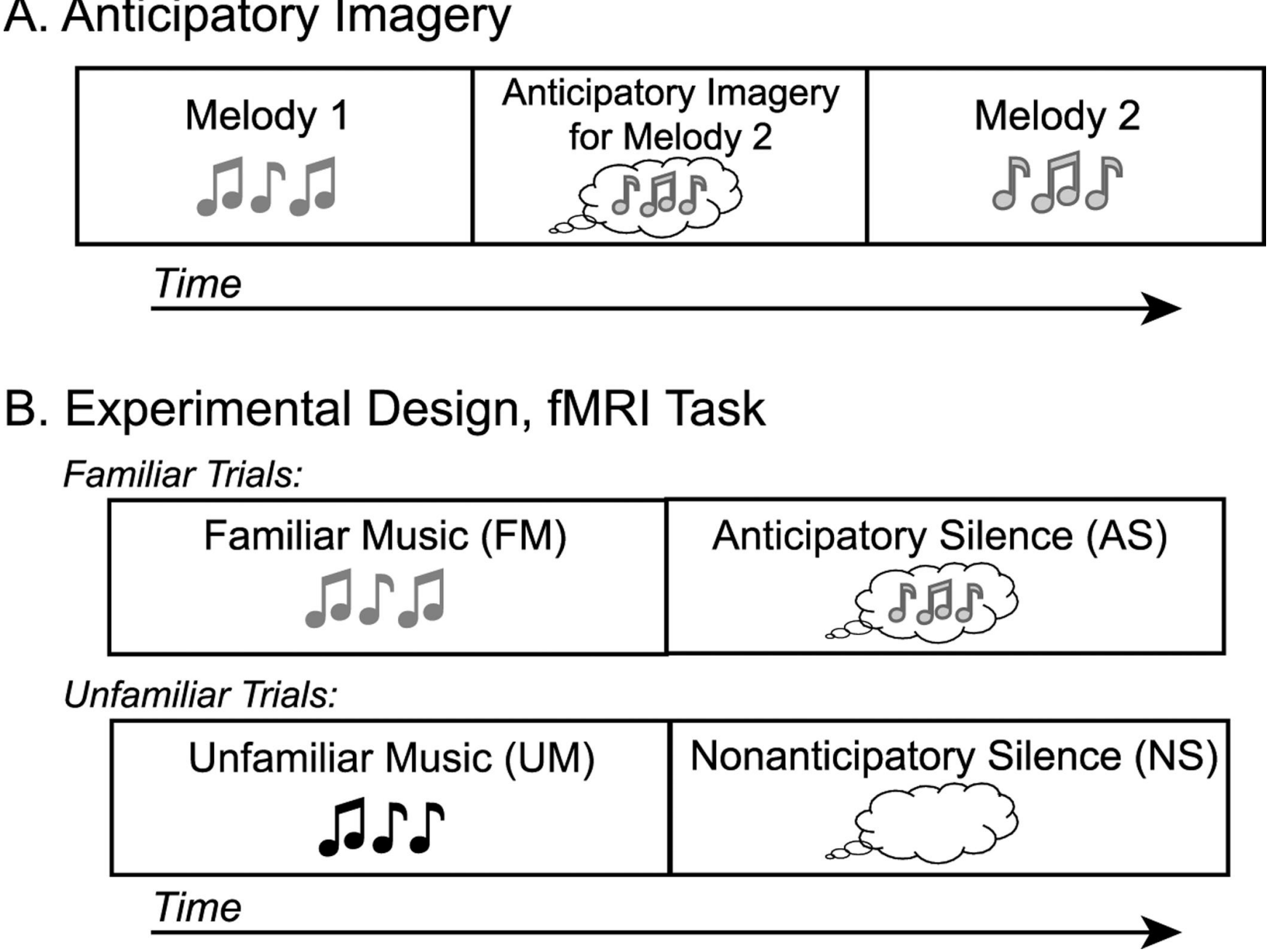
Sridharan, Levitin, Chafe, Berger, Menon (Stanford) Neuron 2007

- Two dissociable, but causally linked networks that are strictly right lateralized
- Early activated **fronto-temporal network** is associated with detecting salient event
- Subsequently activated **dorsal fronto-parietal network** associated with maintaining attention and updating working memory

Music and mirror neurons: from motion to ’e’motion. Molnar-Szakacs I, Katie Overy K SCAN (2006) 1, 235–241

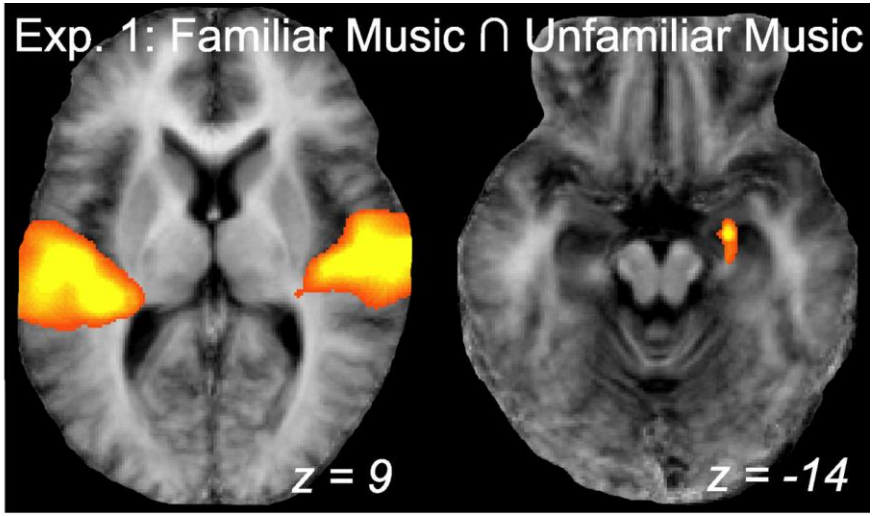


Music notes from the lady sings the blues. By Billie Holiday and Herbie Nichols



Leaver et al 2009

A.



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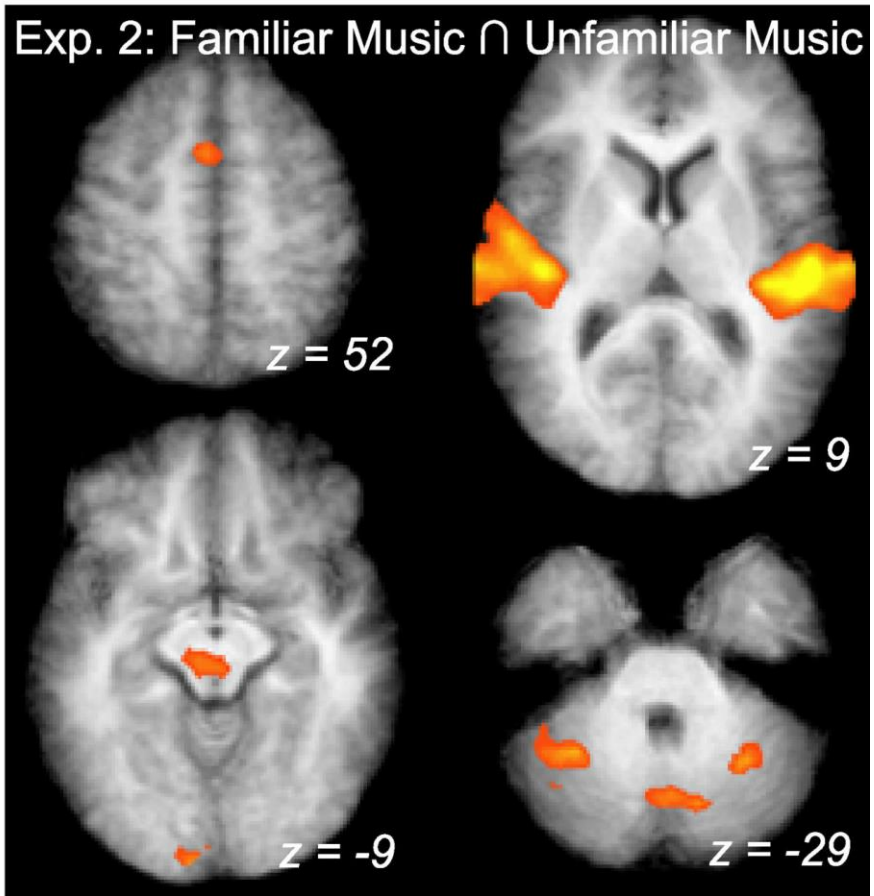
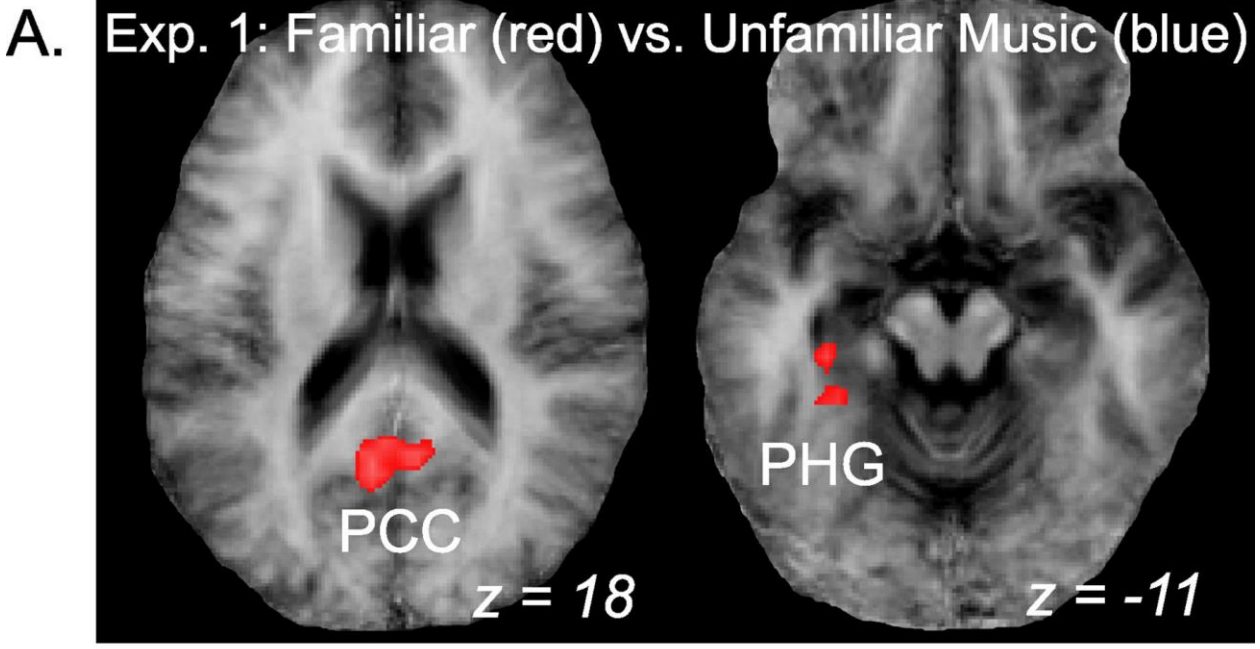
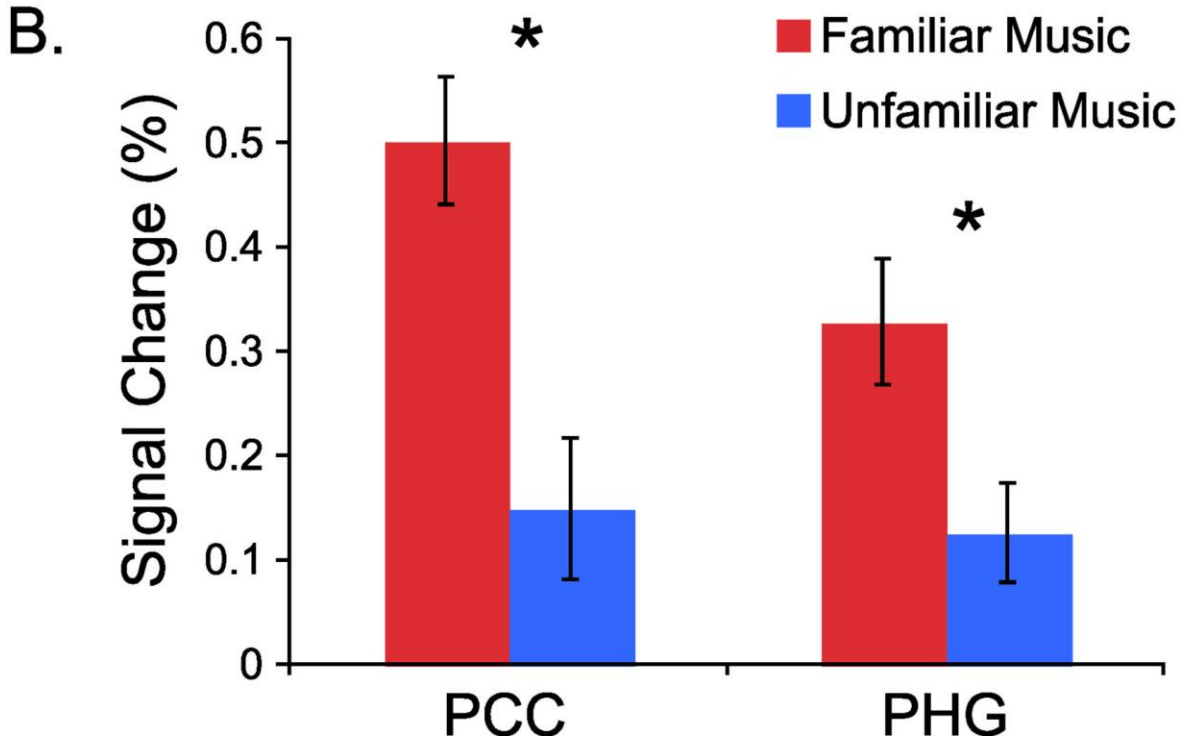


Leaver et al 2009

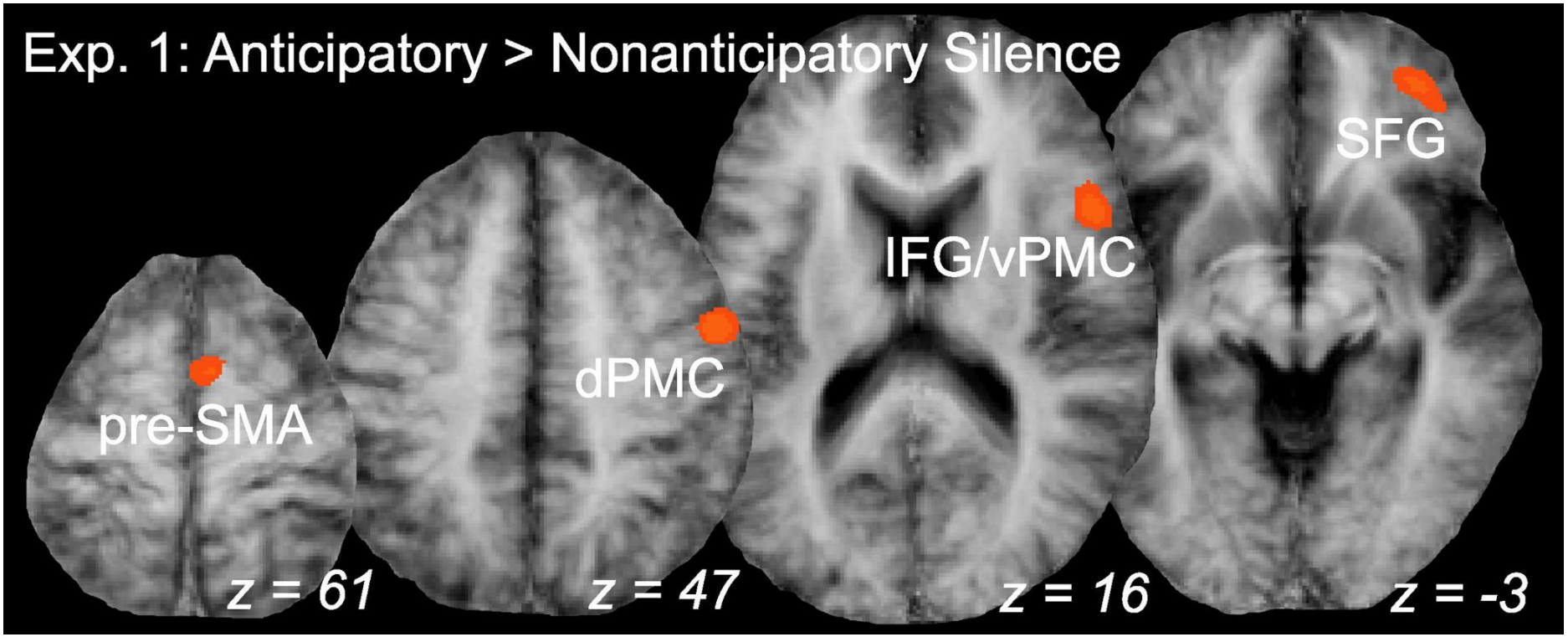




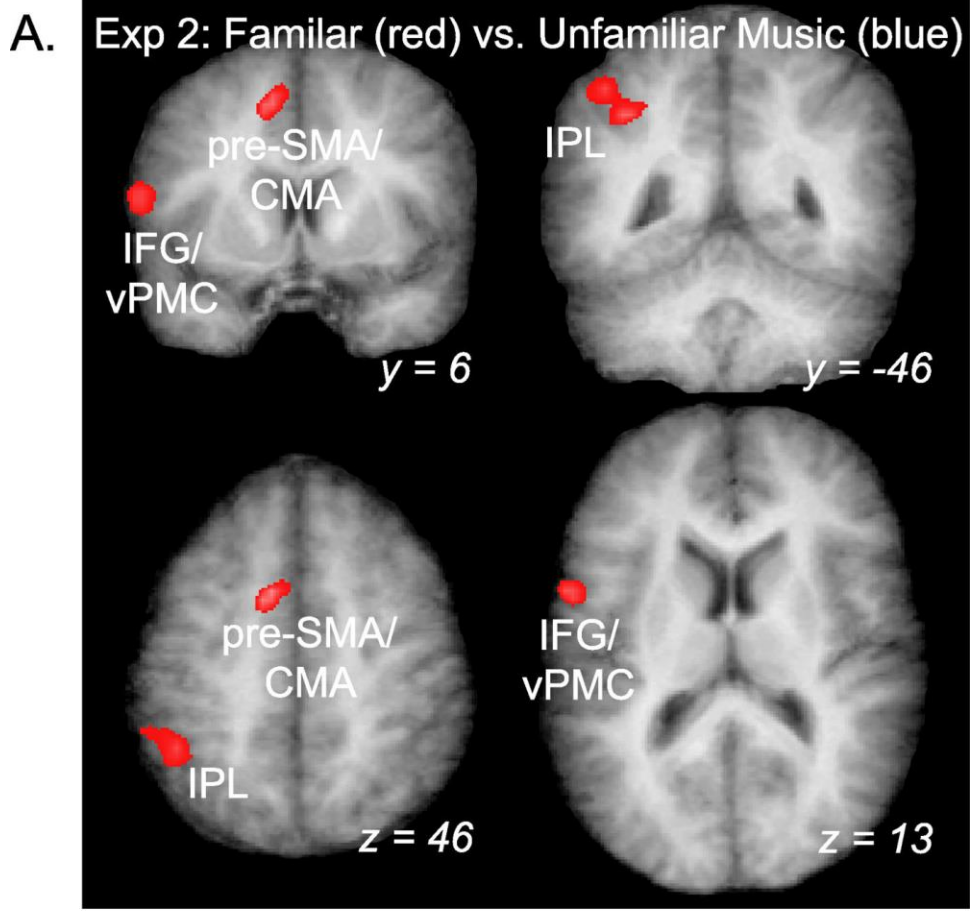
Leaver et al 2009

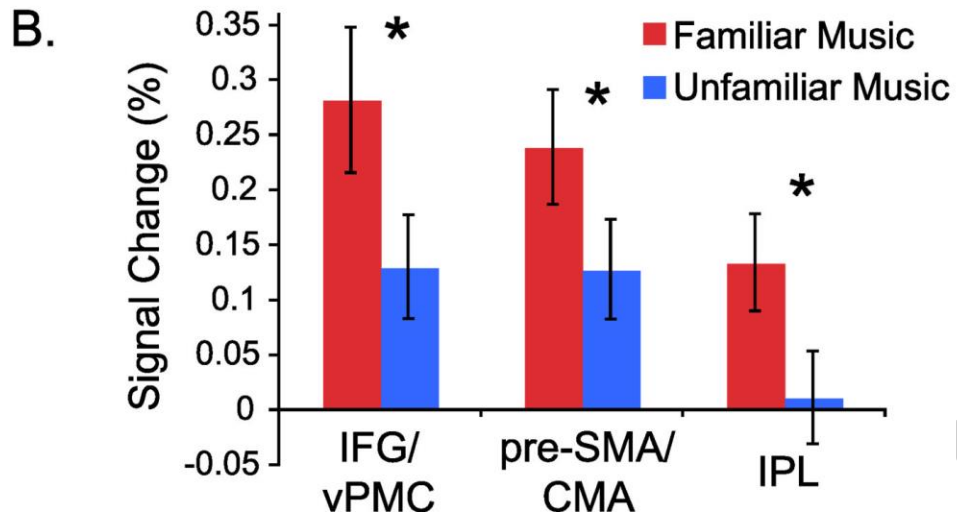
Anticipatory imagery for familiar music

Leaver et al 2009

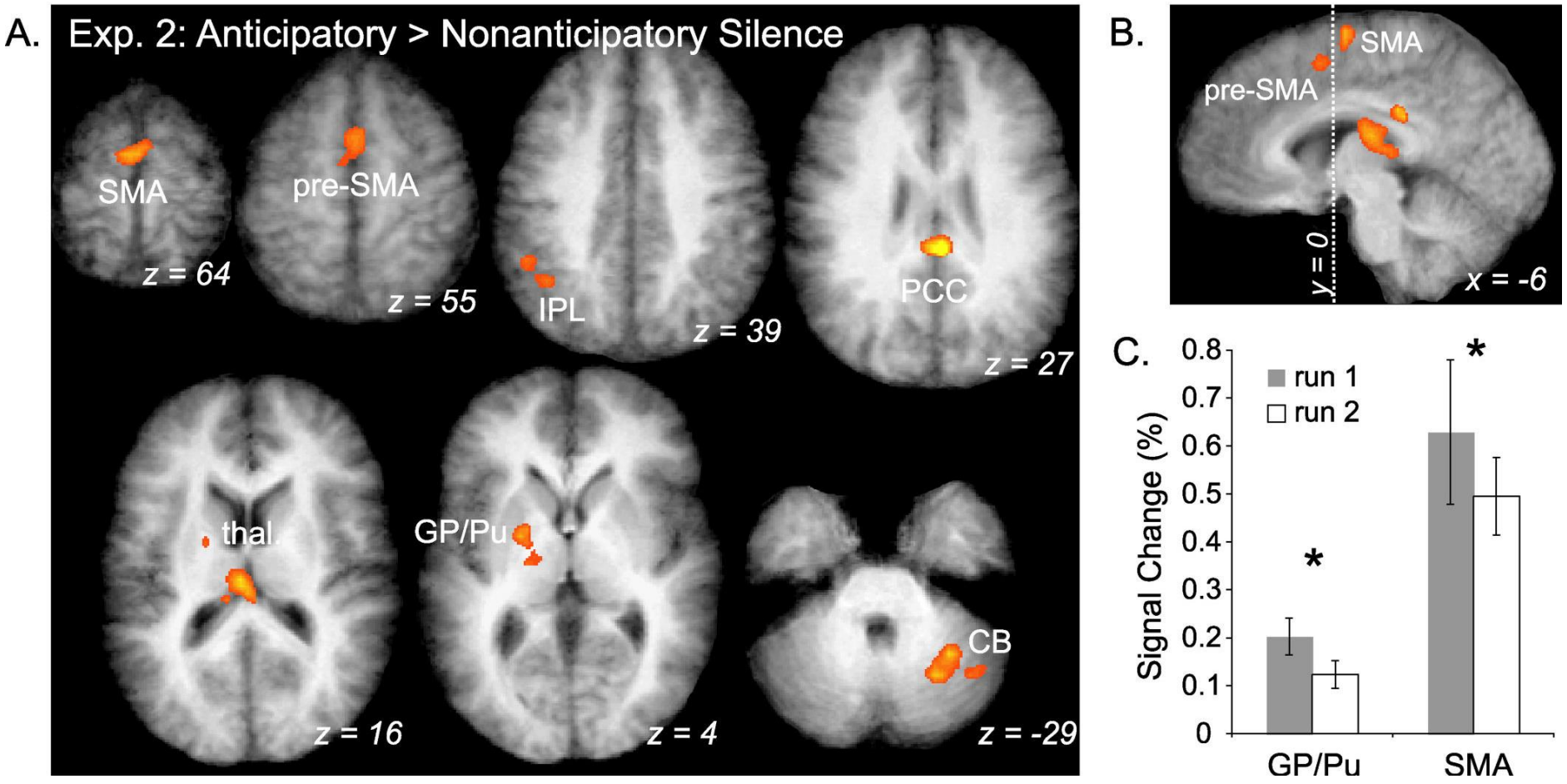


SFG superior frontal gyrus, IFG inferior frontal gyrus, vPMC ventral premotor cortex, dPMC dorsal premotor cortex, pre-SMA presupplementary motor area



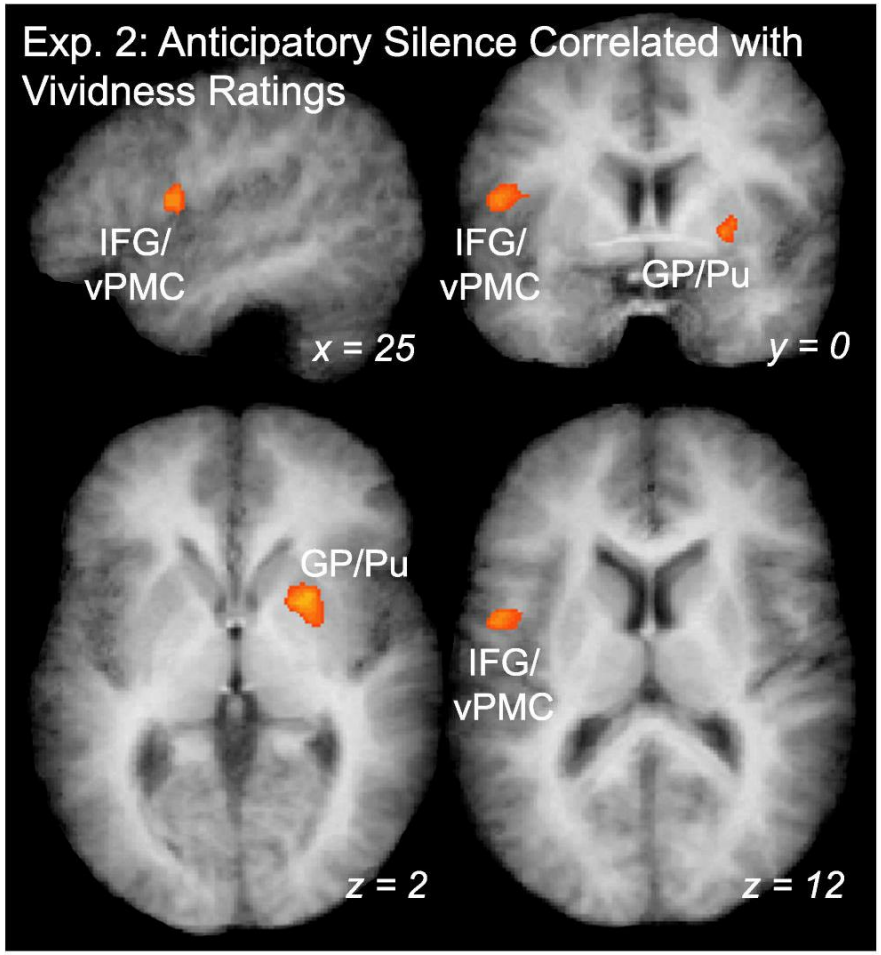


Leaver et al 2009

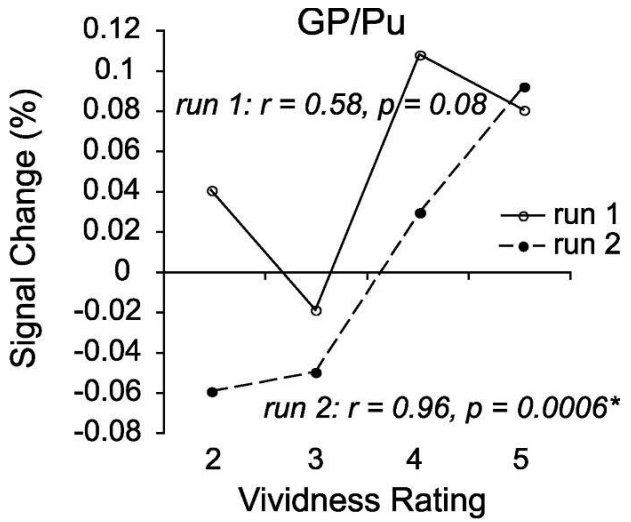


Leaver et al 2009

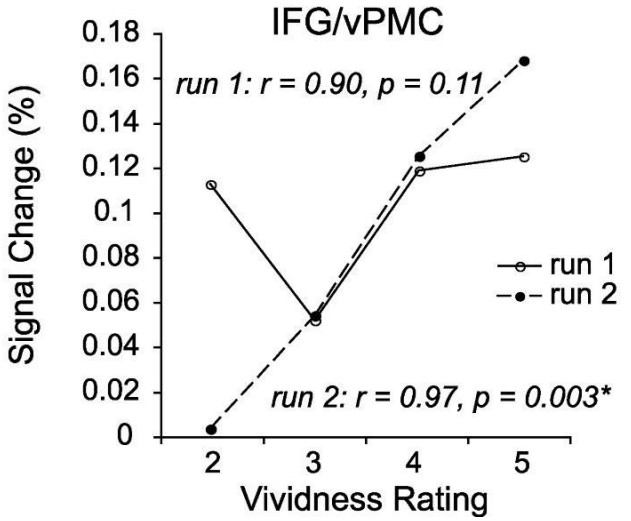
A.



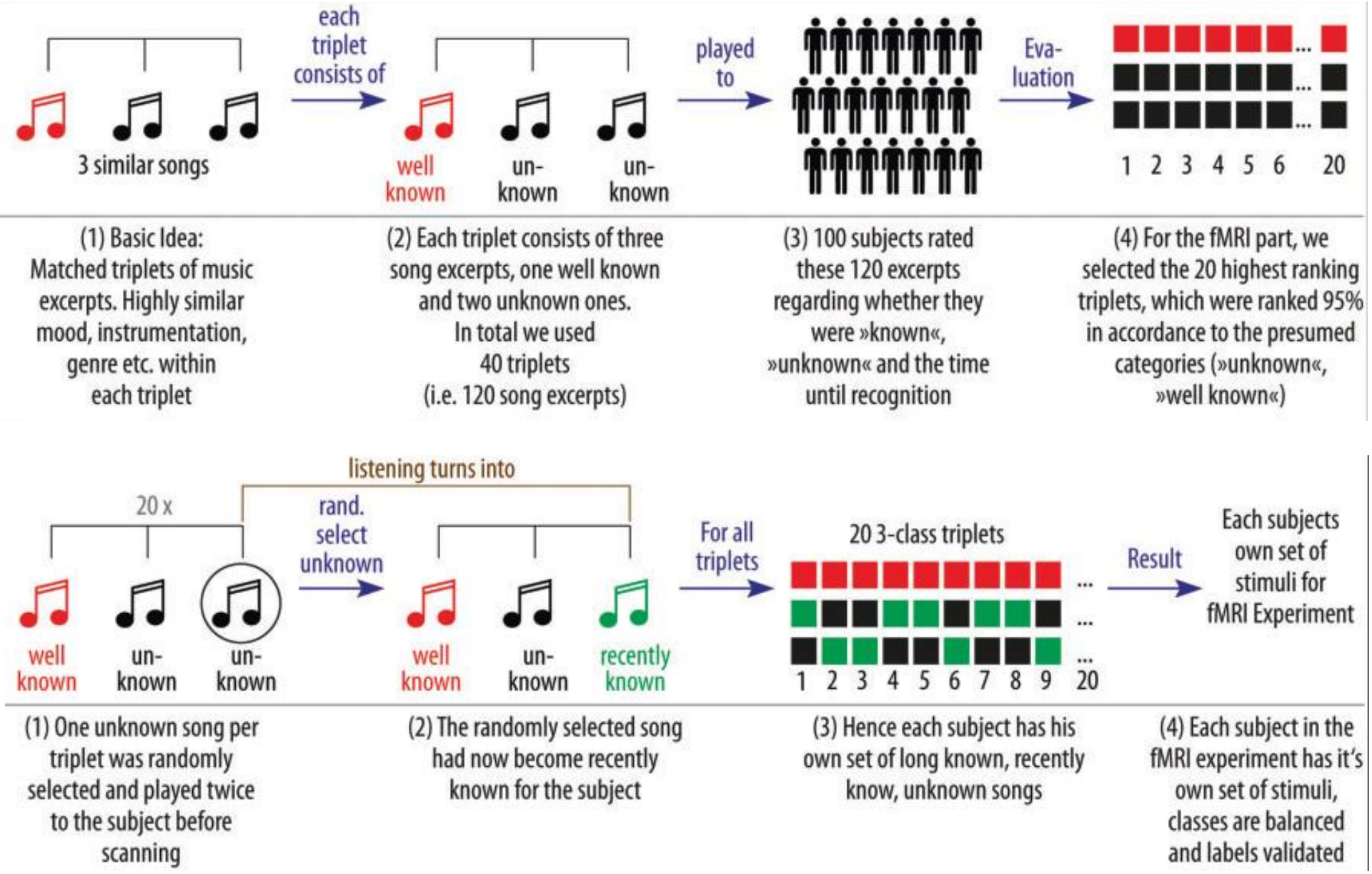
B.



C.

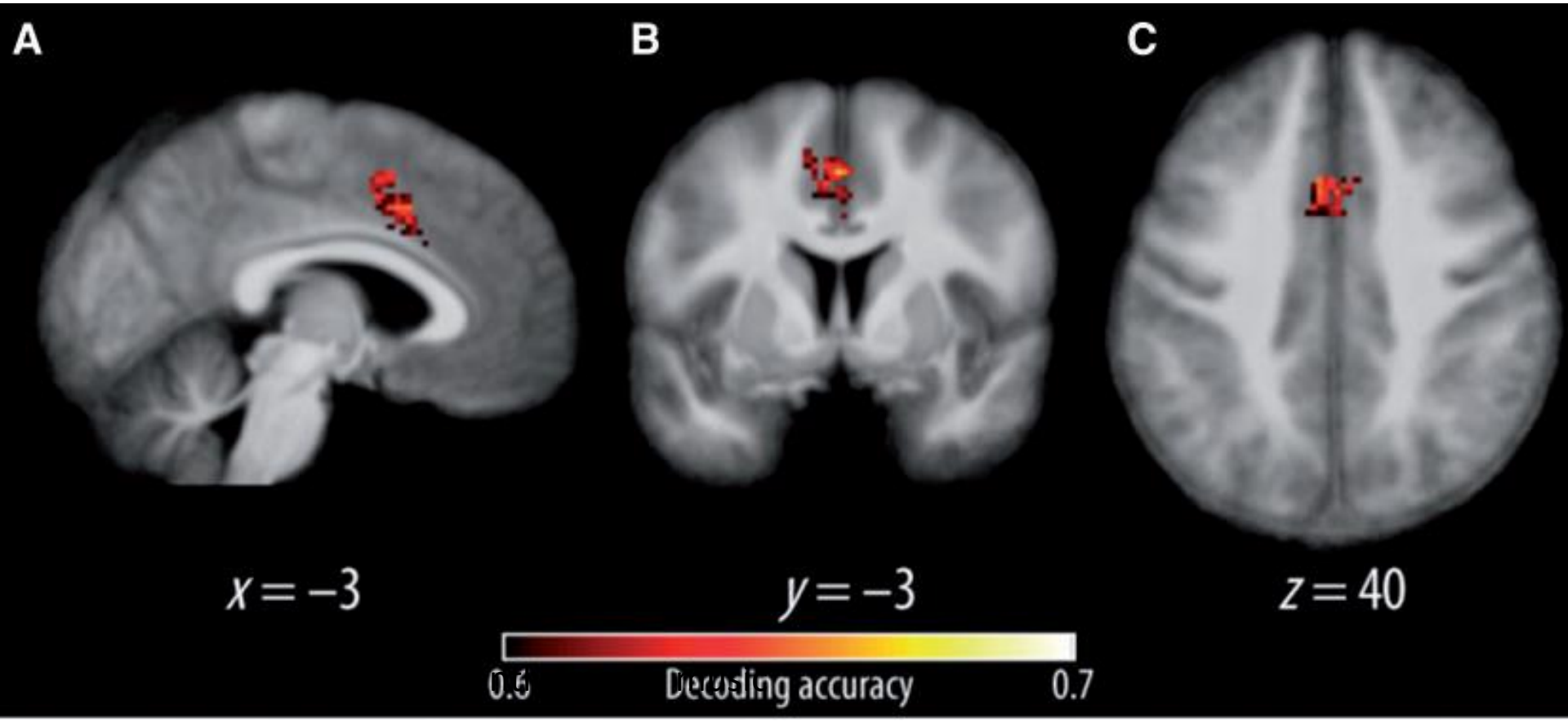


Leaver et al 2009



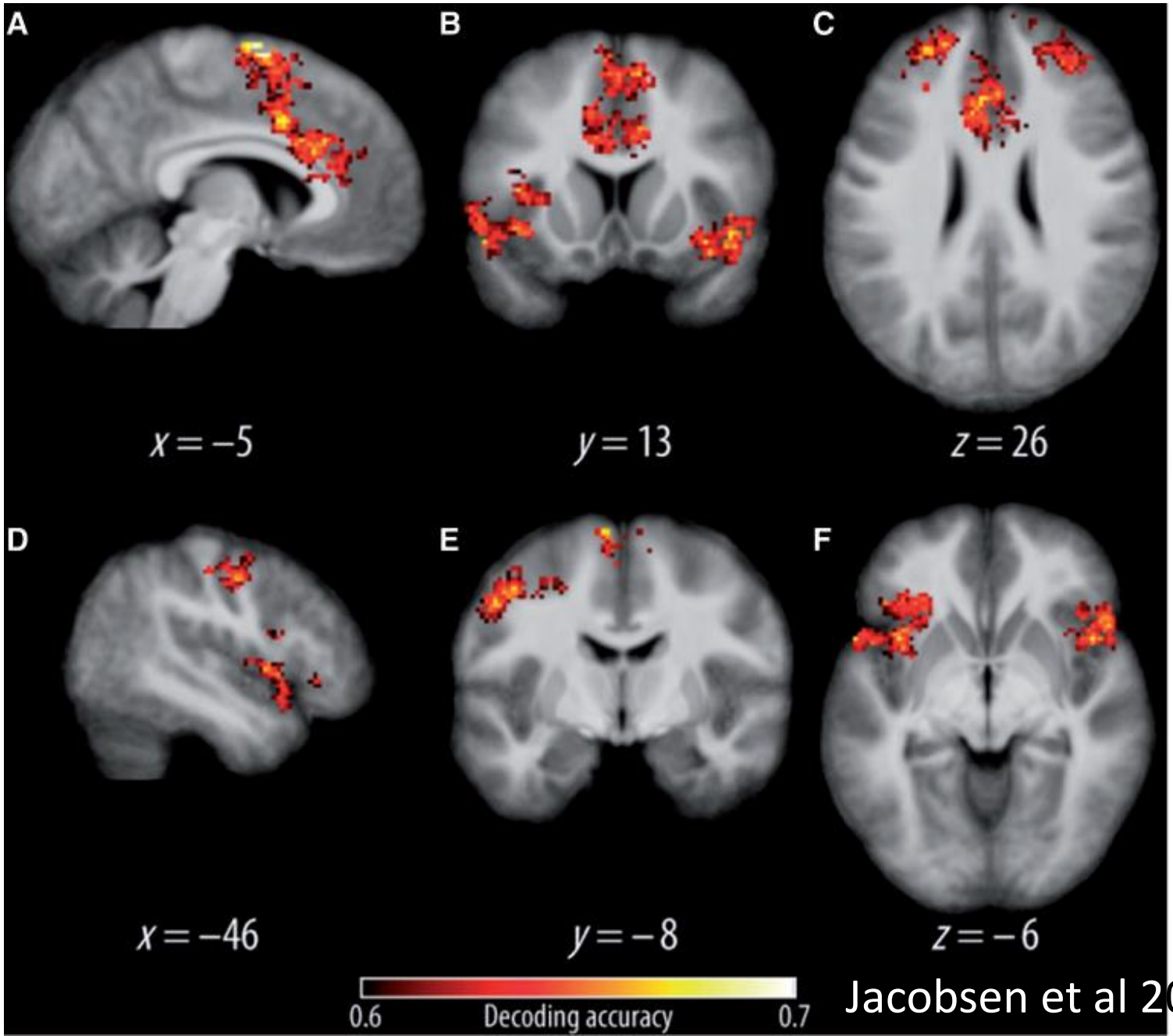
Jacobsen et al 2015

Why musical memory can be preserved in advanced alzhaimer disease Jacobsen et al 2015

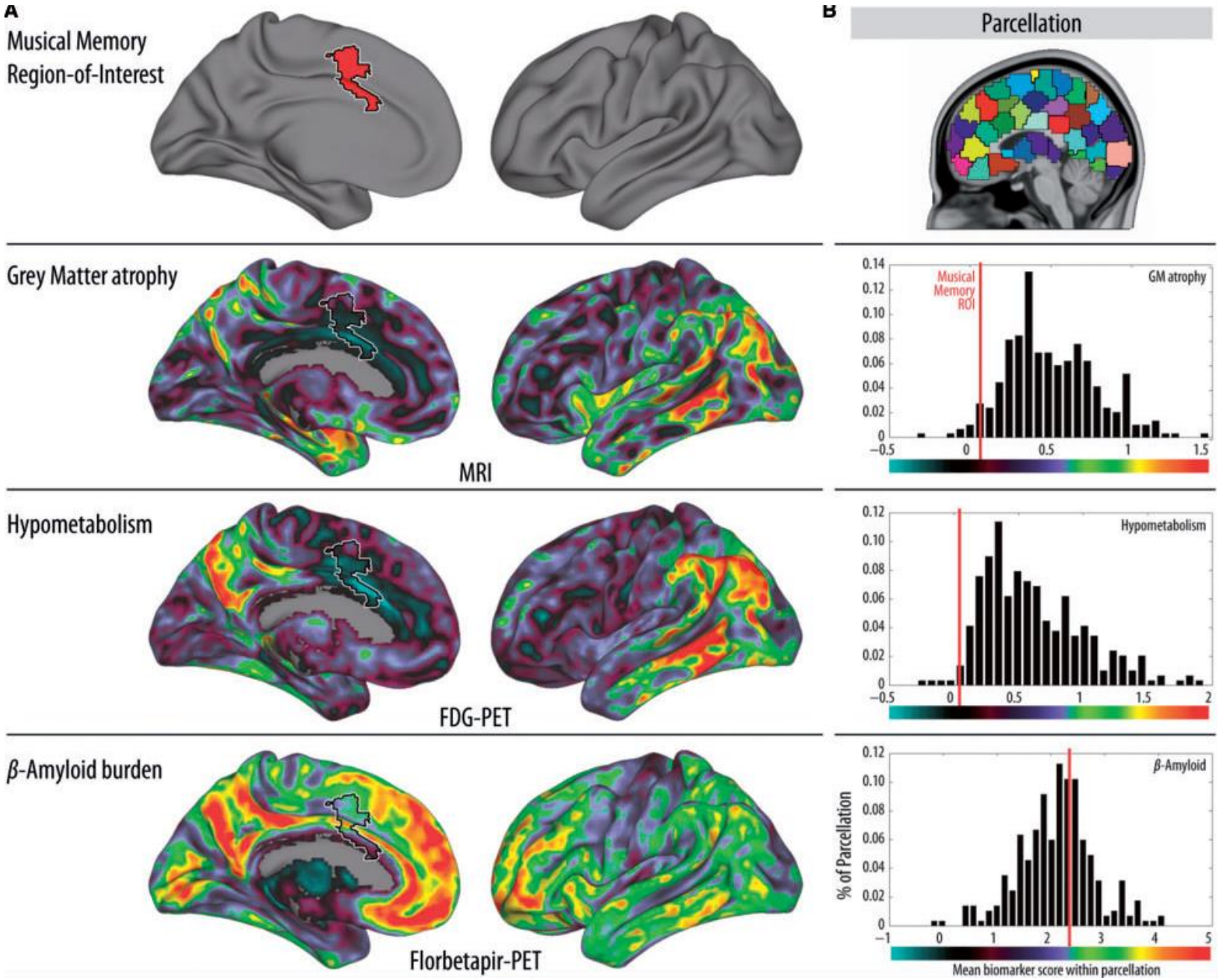


Long known vs recently known music

Long known vs unknown music



Jacobsen et al 2015



Jacobsen et al 2015

Robert J. Zatorrea,1 and Valorie N. Salimpoora, 2013

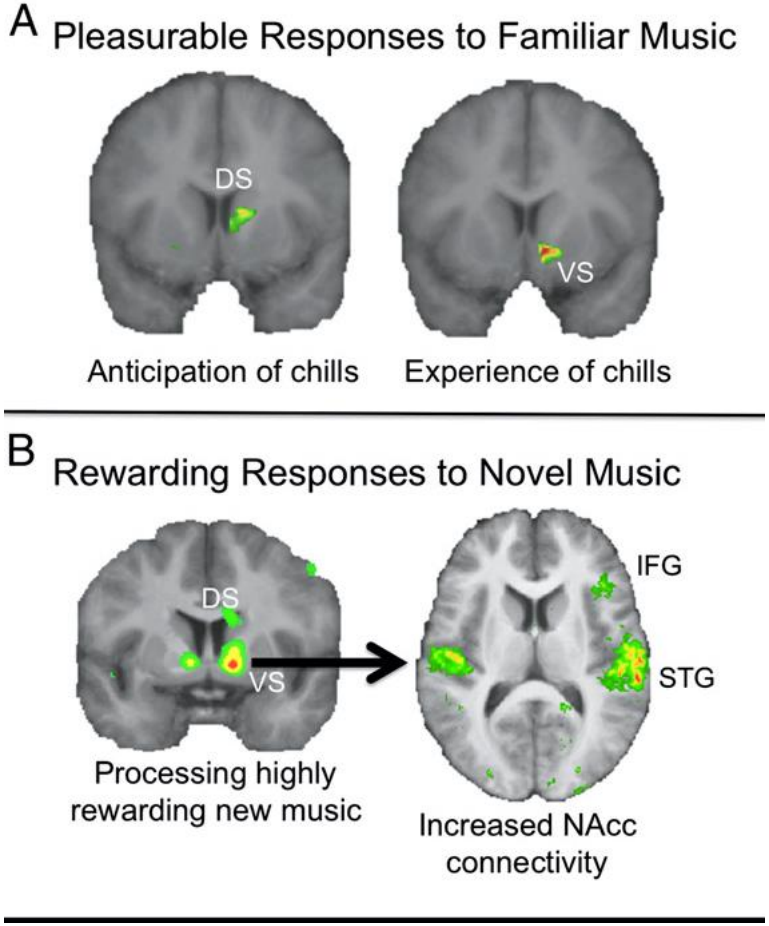


Fig. 3. Neural correlates of processing highly rewarding music. (A) Spatial conjunction analysis between [11C]raclopride positron emission tomography and fMRI while listeners heard their selected pleasurable music revealed