"Gli effetti della pratica musicale sullo sviluppo delle capacità non musicali"

Prof. Alice Mado Proverbio, PhD
Università di Milano-Bicocca

Il gioco musicale nel bambino facilita l'acquisizione della

- lingua madre e
- delle lingue straniere

Consapevolezza fonologica

Memory & Cognition
January 2014, Volume 42, Issue 1, pp 41–52 | Cite as

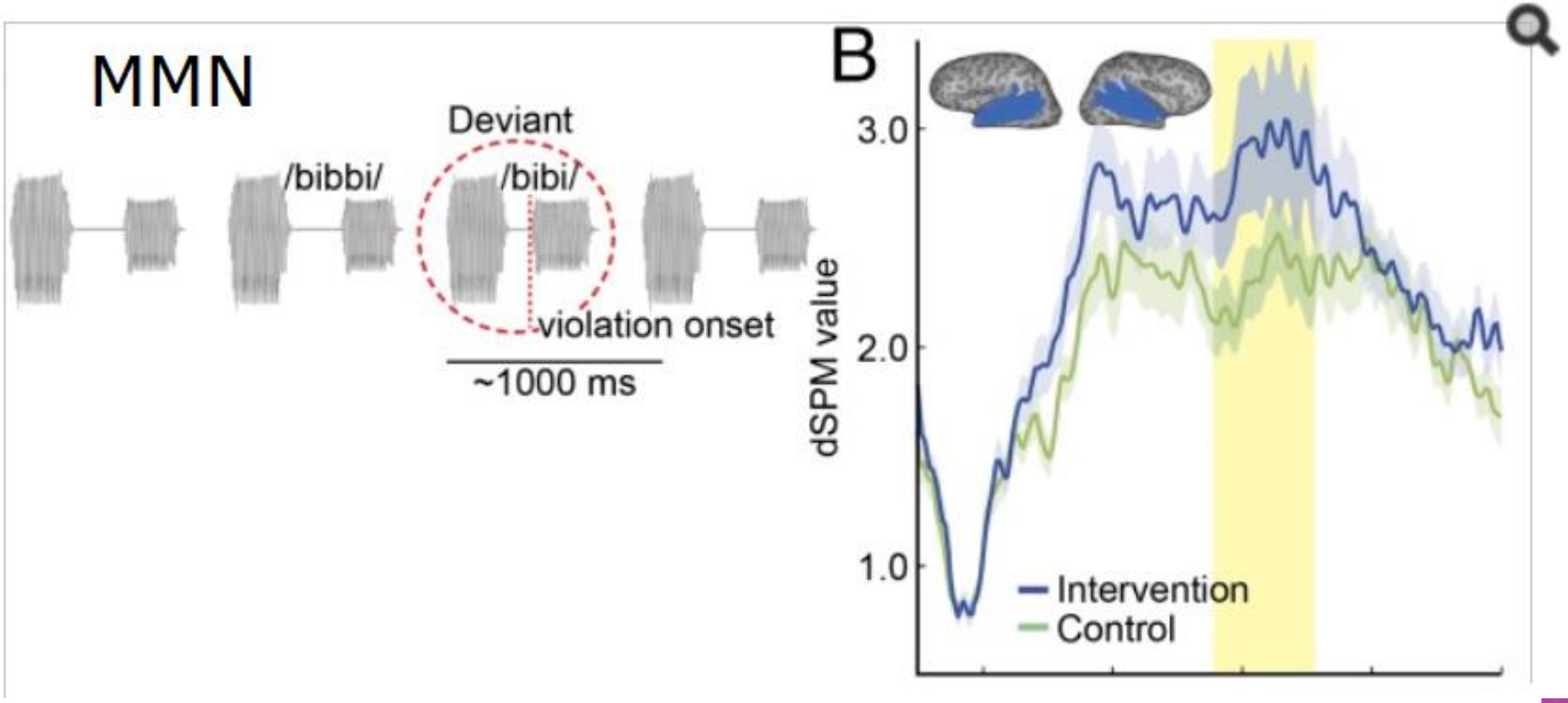
Singing can facilitate foreign language learning

Musical intervention enhances infants' neural processing of temporal structure in music and speech

T. Christina Zhao, and Patricia K. Kuhl

PNAS 2016 May, 113 (19) 5212-5217.

Nine-month-old infants were randomly assigned to music (intervention) or play (control) activities for 12 sessions.

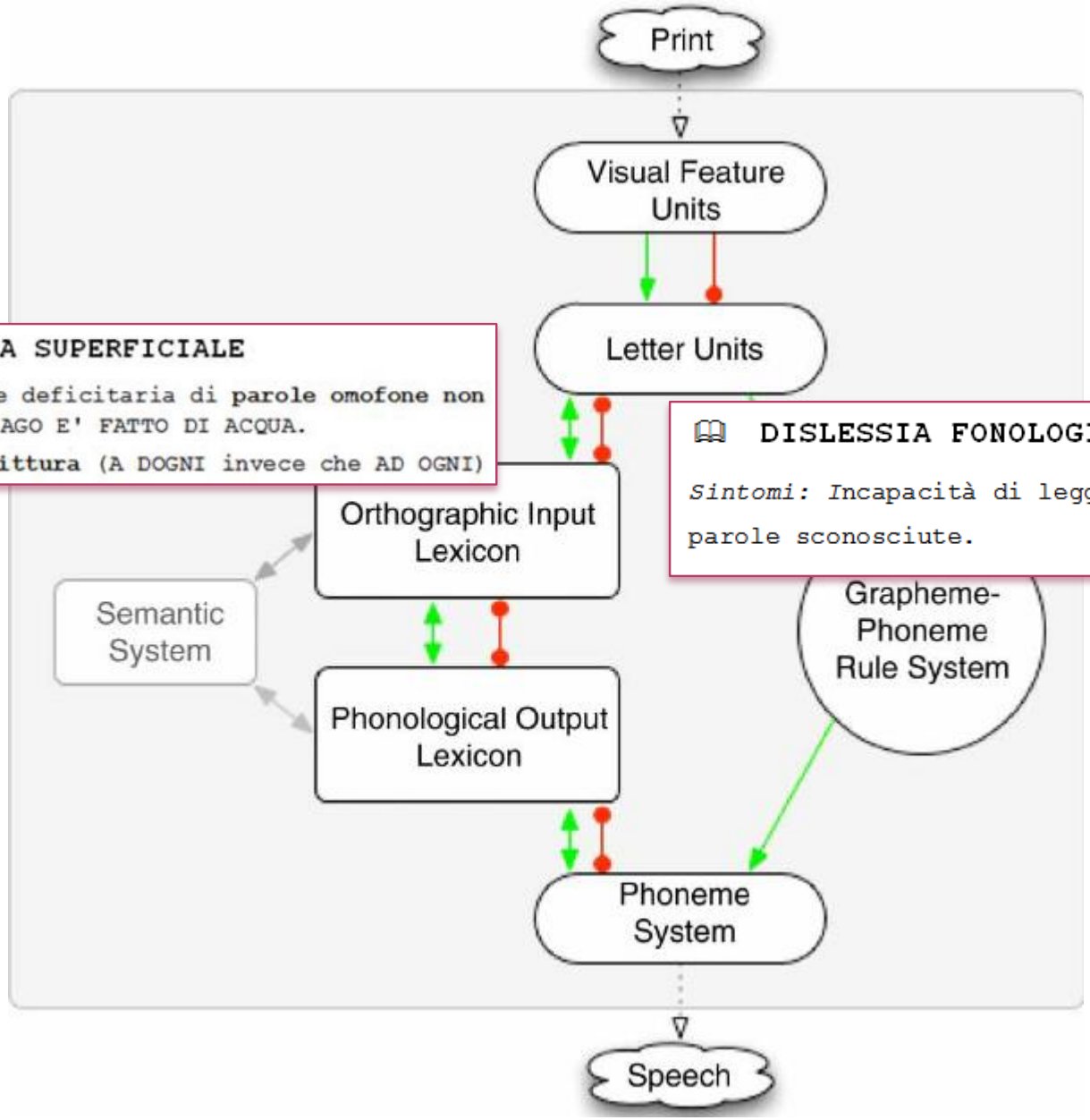


Dyslexia, Temporal Processing and Music: The Potential of Music as an Early Learning Aid for Dyslexic Children

Psychology of Music,
2000, **28,** 218–229

KATIE OVERY

Lo studio della musica migliora o previene il DISTURBO SPECIFICO DI LETTURA



📖 **DISLESSIA SUPERFICIALE**

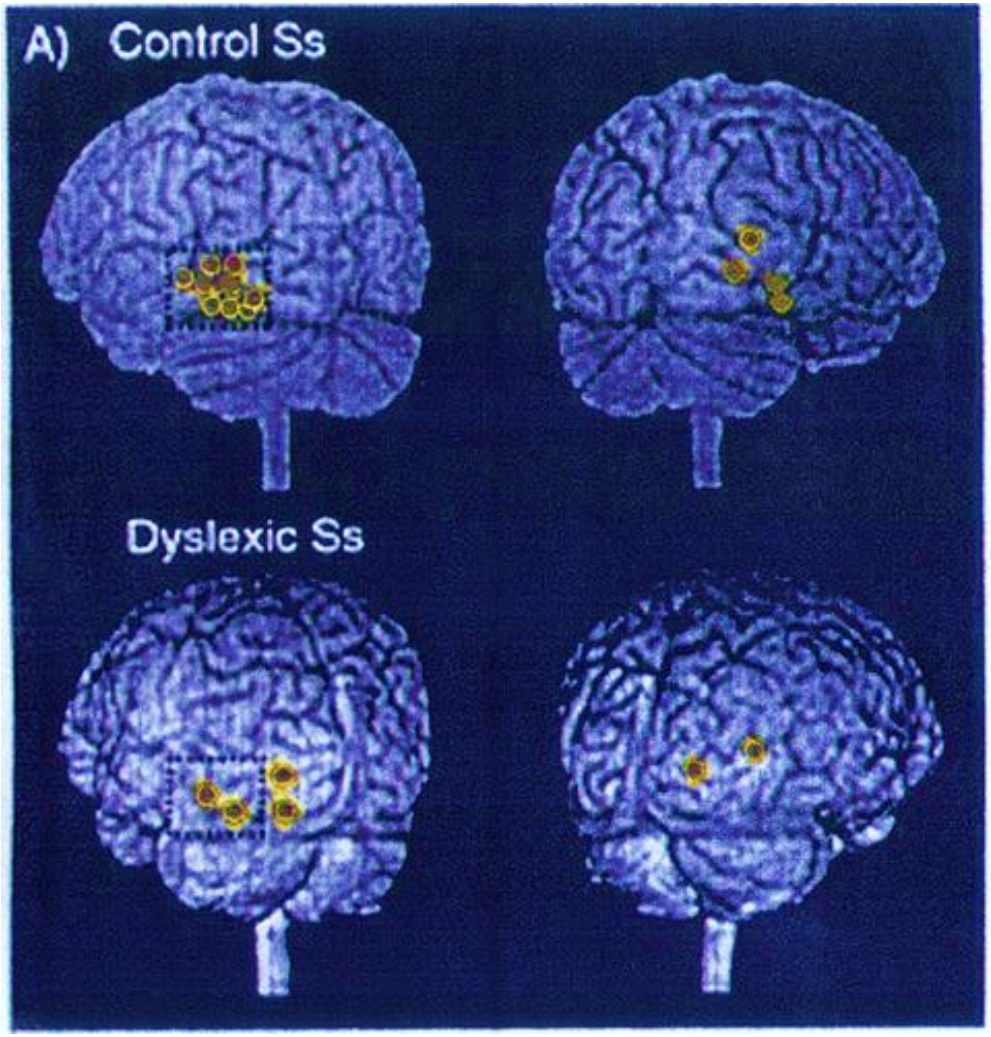
lettura silente deficitaria di **parole omofone non omografe** L'AGO E' FATTO DI ACQUA.

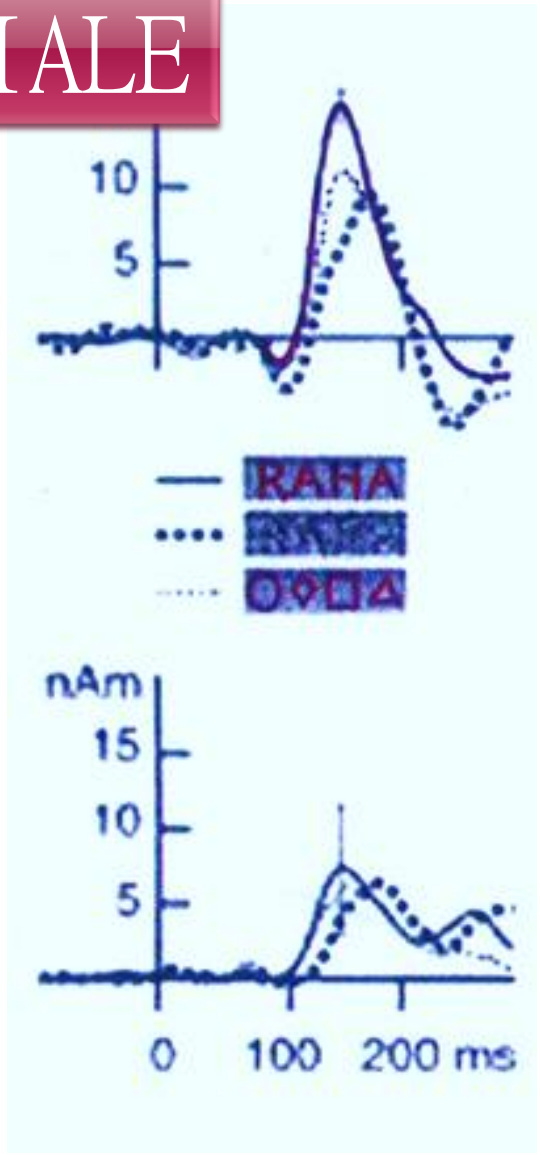
deficit di scrittura (A DOGNI invece che AD OGNI)

📖 **DISLESSIA FONOLOGICA**

Sintomi: Incapacità di leggere le non-parole e le parole sconosciute.

DISLESSIA SUPERFICIALE





Insufficiente o atipica attività nella dislessia superficiale

Errori ortografici/visivi (‘A dogni’ invece di ‘Ad ogni’, Lago invece di l’ago)

THE WALL STREET JOURNAL.

RESEARCH REPORT

Music Ability Helps Reading

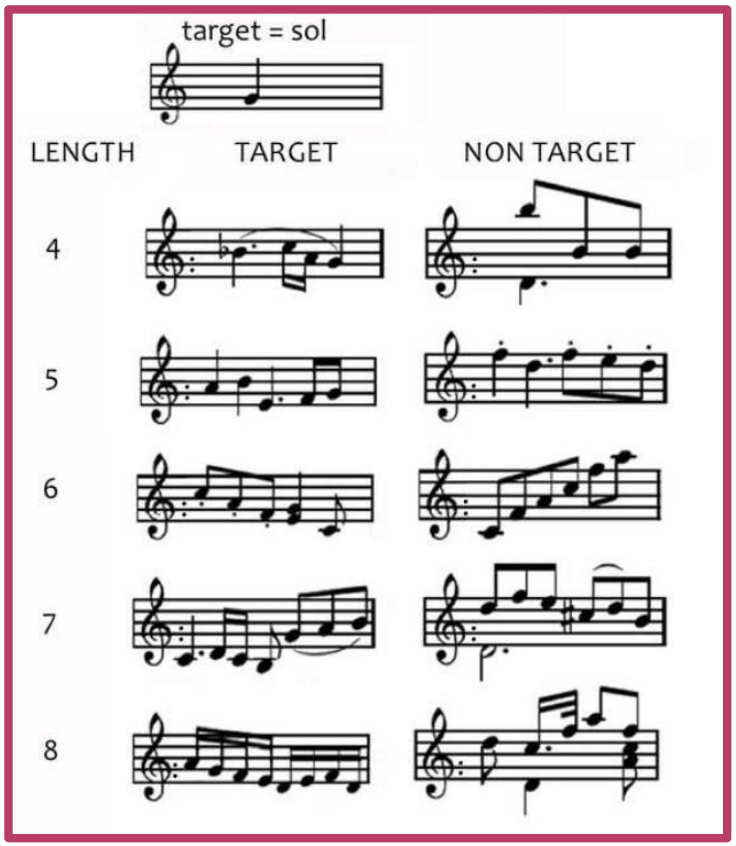
By ANN LUKITS
Feb. 18, 2013 4:25 p.m. ET

Playing a musical instrument from a young age appears to create new pathways in the brain that process written words and letters and may help children with reading disorders such as dyslexia, says a study in the journal Neuropsychologia. Musicians generally outperform nonmusicians on cognitive tests, but little is known about the effects of reading musical notes on the brain's circuitry as it relates to reading, researchers said.

Playing a musical instrument from a young age appears to create new pathways in the brain that process written words and letters and may help children with reading disorders such as dyslexia. ILLUSTRATION BY IZAR COHEN

Fifteen professional musicians who had played an instrument since childhood and 15 control subjects who couldn't read music participated in two experiments in Milan. Subjects were 26 to 31 years old. In one experiment, subjects pressed a button if they recognized the notes E, F, G, A and B (mi, fa, sol, la and ti on the musical scale) which randomly appeared in 300 short musical scores flashed on a computer screen. In the other experiment, they pressed the button when they spotted the letters B, G, L, M and S

music measures were selected from Mozart and Schumann pieces for piano and for violin.



target = B

LENGTH	TARGET	NON TARGET
4	ALBA	CANE
5	ABITO	PODIO
6	PIOMBO	CALICE
7	TRIBUNA	RIVISTA
8	BURRASCA	AVVOCATO
9	BAVAGLIO	ARANCIATA
10	DIRIGIBILE	TERMOMETRO

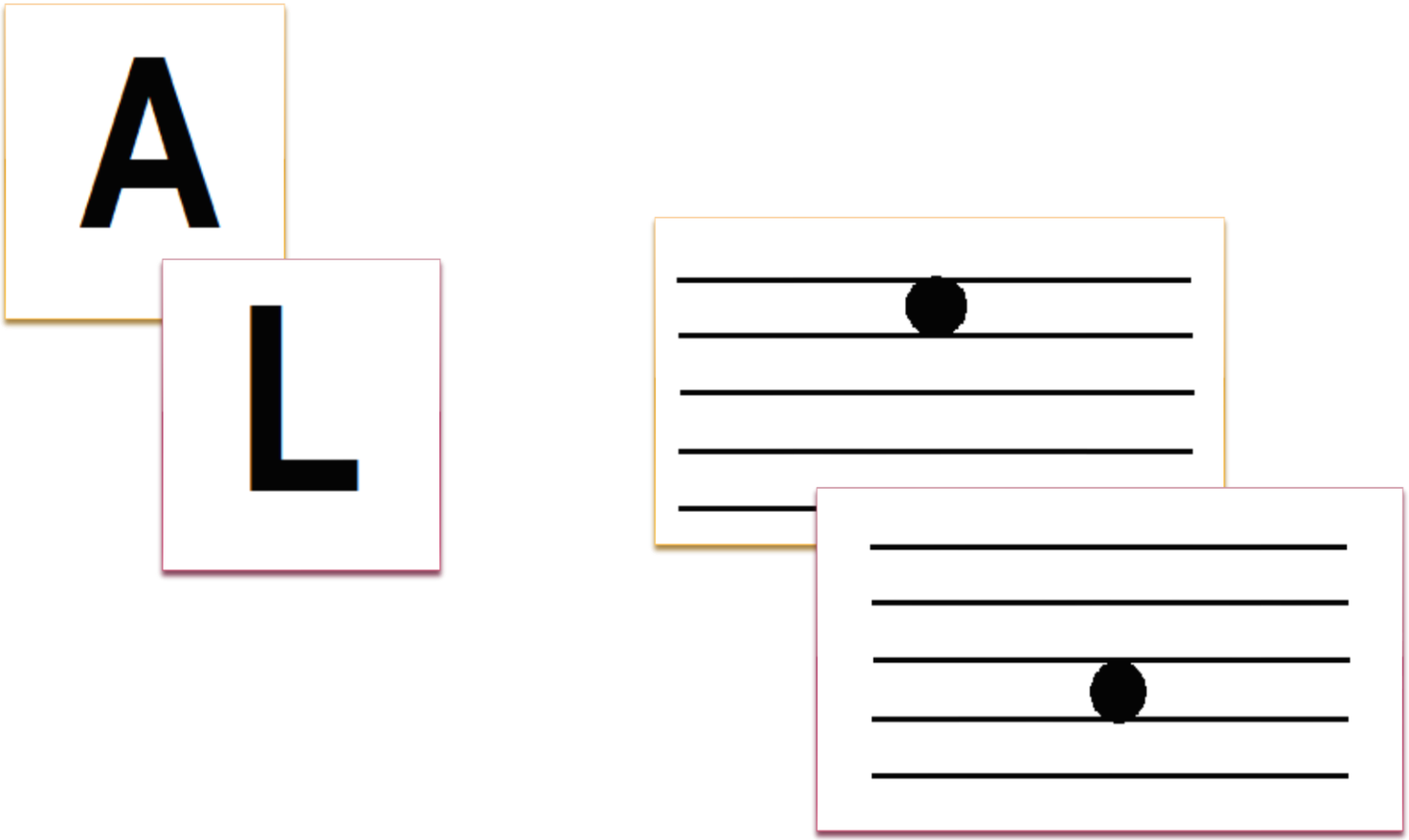
Fig. 2. Example stimuli of different length used in the letter selection task.

300 parole, 300 battute musicali.
In metà c'è il target

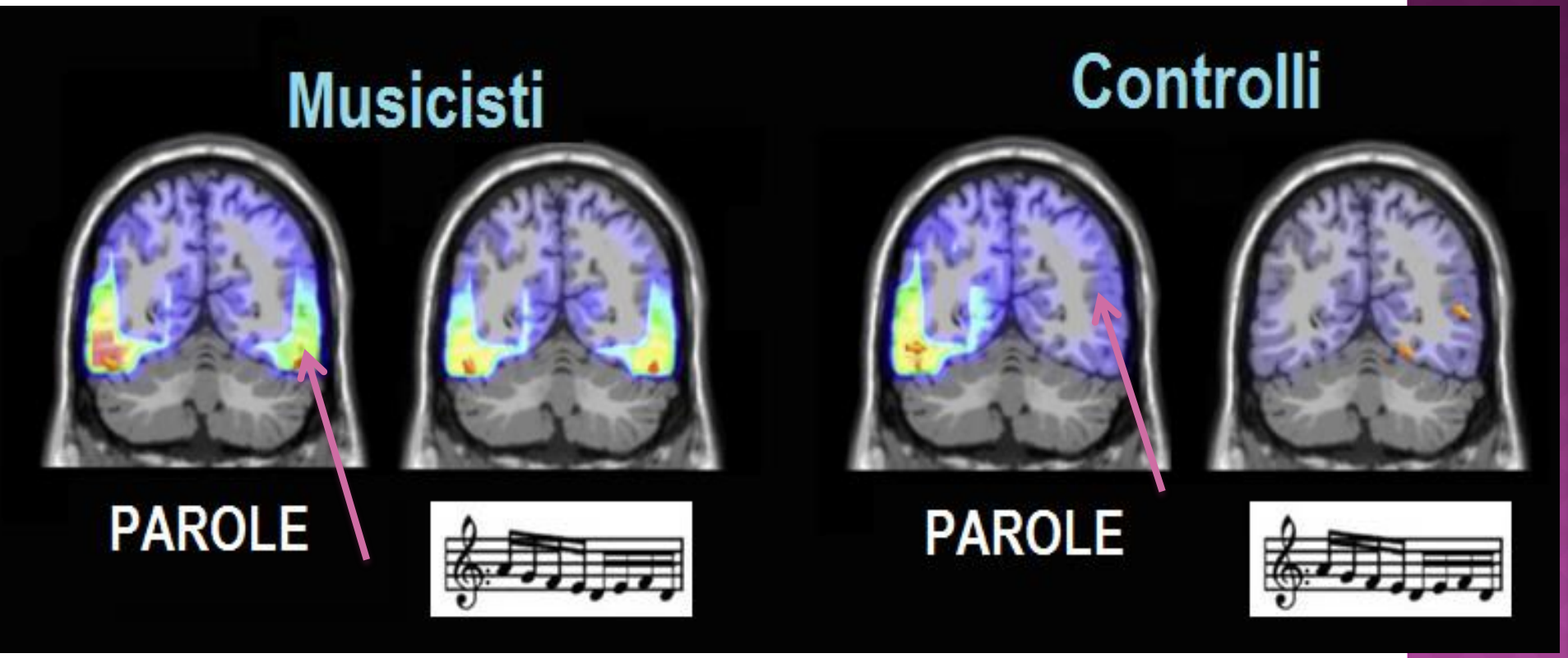
Stesso numero di note e lettere, metrica, lunghezza, frequenza d'uso, valore di immagine

Musical expertise affects neural bases of letter recognition

Alice Mado Proverbio [a,*], Mirella Manfredi [a], Alberto Zani [b], Roberta Adorni [a]



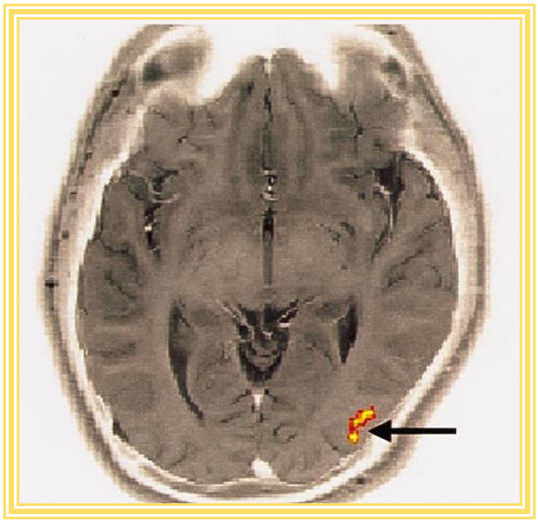
L'expertise musicale modula bilateralmente i sistemi di lettura occipito/temporali



which agrees with Nakada, Sergent, Schön, Wong & Gauthier's studies

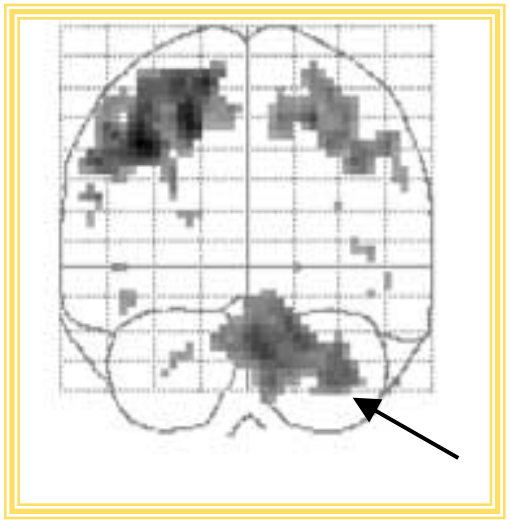
"VISUAL NOTE AREA"

- ***Nakada et al., 1998*** (fMRI)



→ *Transverse Occipital Sulcus (TOS) destro*

- ***Schön et al., 2002*** (fMRI)



→ *Corteccia occipito-temporale destra*

CAMERA DEI DEPUTATI N. 4673

PROPOSTA DI LEGGE

d'iniziativa del deputato MARROCU

Introduzione della pratica musicale e canora nelle scuole primarie

Presentata il 3 ottobre 2017

ONOREVOLI COLLEGHI ! – La presente proposta di legge nasce dall'esigenza di promuovere l'insegnamento della pratica musicale in modo progressivo coniugando la formazione di ordine intellettuale-disciplinare con quella artistica e musicale, a partire dalla scuola primaria, con il supporto di docenti adeguatamente formati e in possesso di titoli specifici nonché di giovani musicisti provenienti dalla carriera accademica abilitati alla professione didattica.

La proposta di legge intende:

a) favorire la diffusione della pratica della musica nell'ultimo triennio della scuola primaria.

Quello che si vuole introdurre con la tico della musica, quale valido strumento per contrastare il disagio giovanile, l'abbandono degli studi e la dispersione scolastica, nonché favorire l'inclusione e l'integrazione;

d) valorizzare lo studio pratico della musica.

La riforma dell'istruzione musicale in Italia è stata varata nel 1999 e oggi i conservatori di musica sono considerati, al pari delle università, istituzioni abilitate a rilasciare un titolo di studio del medesimo

come un adulto emotivamente azzoppato ».

Un'altra indagine scientifica importante è quella del dipartimento di psicologia dell'università di Milano-Bicocca condotta su quindici musicisti (pianoforte, violino, violoncello, tromba, clarinetto, flauto, organo, composizione, direzione d'orchestra) del conservatorio Verdi di Milano e su altrettante persone con nessuna competenza musicale.

La ricerca dimostra che chi è in grado di leggere il pentagramma ha una « marcia in più »: nel cervello dei musicisti, infatti, si attiva un'area del linguaggio solitamente « spenta » nelle altre persone.

La ricerca, pubblicata sulla rivista scientifica « *Neuropsychologia* » e condotta in collaborazione con il Consiglio nazionale delle ricerche presso il laboratorio di elettrofisiologia cognitiva della Bicocca, può avere applicazioni positive anche nella cura della dislessia.

« È noto che imparare a suonare bene uno strumento musicale – spiega Alice Mado Proverbio, docente di psicobiologia e psicologia fisiologica e coordinatrice dello studio – modifica la connettività cerebrale e la struttura funzionale del cervello, sia a livello di materia grigia che di materia bianca, velocizzando il *transfer* inter-emisferico, migliorando il controllo e la coordinazione motoria e l'elaborazione uditiva dei suoni ». « Noi abbiamo dimostrato che il cervello dei musicisti che hanno iniziato a studiare musica da piccoli, entro gli 8 anni, è anche più veloce nel riconoscere le parole. Per farlo, abbiamo confrontato l'elaborazione visiva delle note e delle parole in 30 persone destrimani, registrando la loro attività bioelettrica sincronizzata (Erp) in risposta a parole e note in un pentagramma ».

- Secondo i ricercatori fra i sei e gli otto anni di età ci sarebbe infatti una vera e propria «finestra sensibile», durante la quale un «allenamento musicale» riesce a interagire con il normale sviluppo cerebrale modificandolo in positivo, producendo cambiamenti a lungo termine con effetti vantaggiosi sulle abilità motorie, psicologiche e psicofisiche.
- «Favorire la diffusione della pratica musicale e canora nelle scuole primarie a partire dalla prima classe della scuola primaria con l'inserimento dello studio di uno strumento musicale o del canto individuale quale materia curricolare»
- «A partire dall'anno scolastico 2018/2019 per tutti i bambini iscritti alla prima classe della scuola primaria lezioni individuali di 30 minuti per 25 settimane. Il percorso poi proseguirà fino alla quinta classe.»

DISLESSIA FONOLOGICA

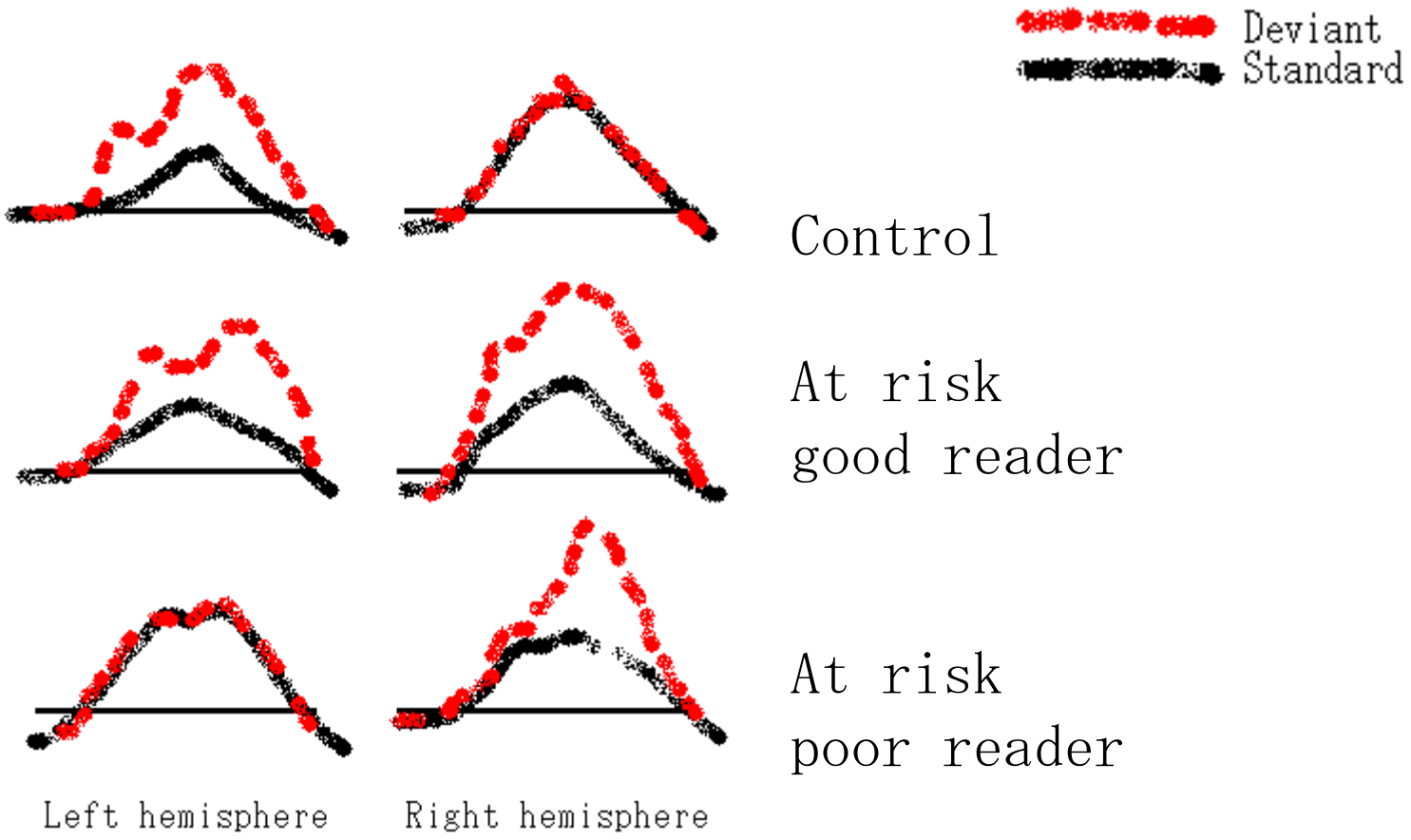
Deficit nella categorizzazione fonemica

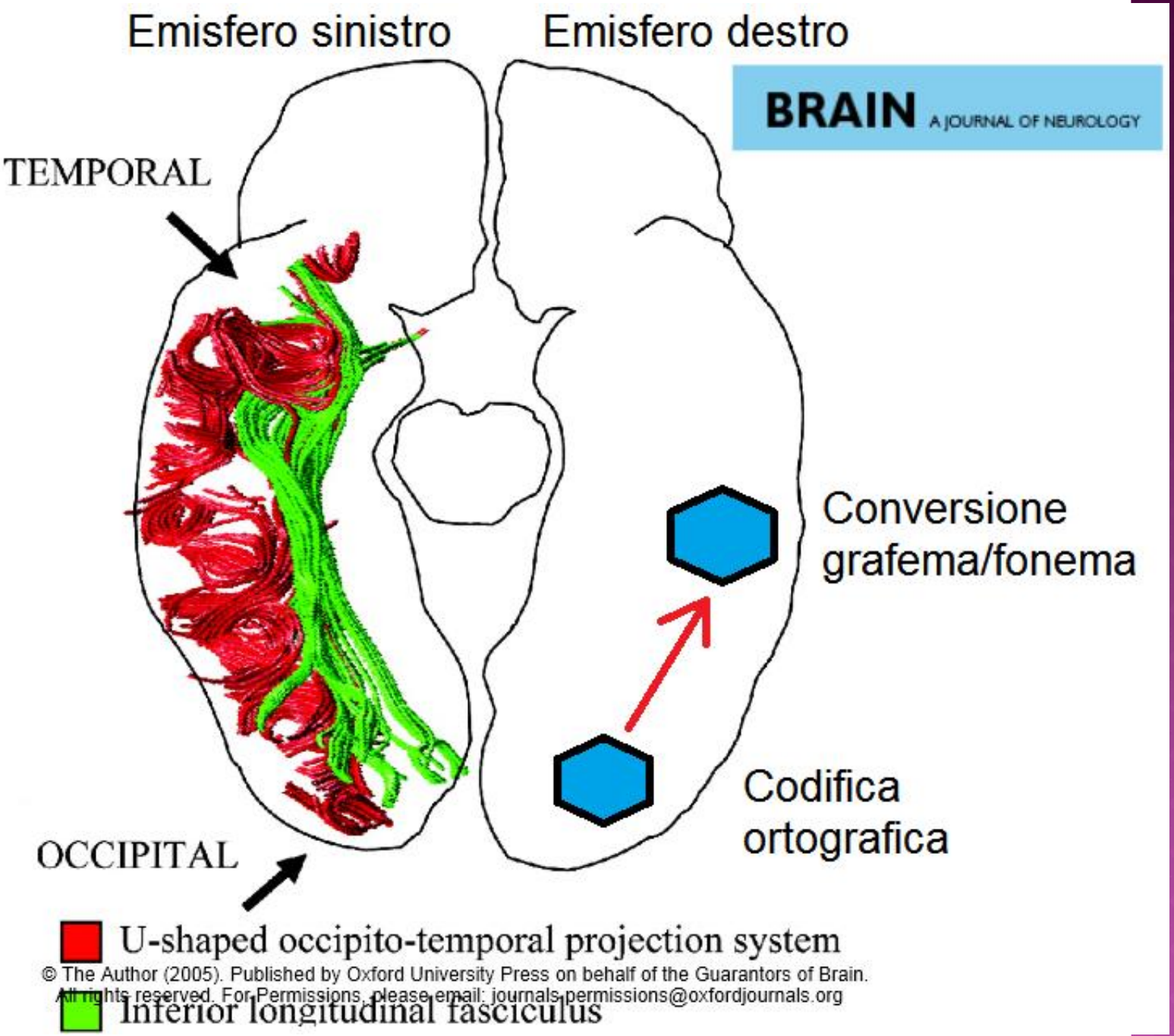
Heim et al., 1999, Nittrouer, 1999; Blomert, Serniclaes et al., 2004

Paavo Leppänen et al. (studio EU 5 paesi)

- 100 famiglie con predisposizione genetica (almeno 1 dislessico in famiglia)
- 100 famiglie non a rischio

Stimuli: fonemi standard e devianti





Dyslexia
An International Journal of Research and Practice

DYSLEXIA
Published online in Wiley Online Library
(wileyonlinelibrary.com). DOI: 10.1002/dys.1479

Auditory Temporal Processing Skills in Musicians with Dyslexia

Paula Bishop-Liebler[1]*, Graham Welch[1], Martina Huss[2],
Jennifer M. Thomson[3] and Usha Goswami[2]

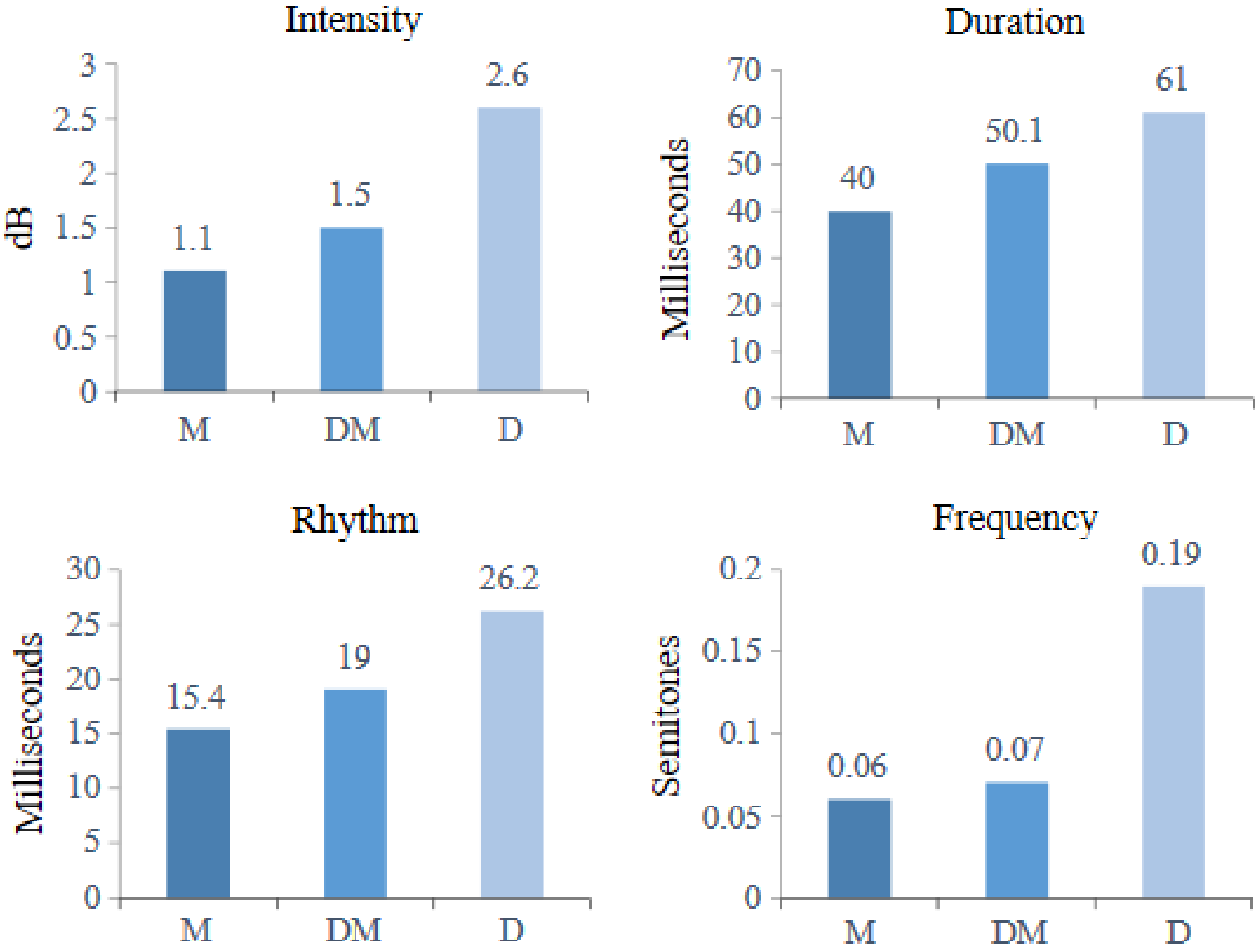


Figure 2. Auditory thresholds by group for the different auditory tasks.

Table 5. Group performance on the phonological tasks

	Musicians	Dyslexic musicians	Dyslexics
Phonological awareness (CTOPP)	114.0	95.8	87.0
(S.D.)	(5.7)	(12.8)	(11.5)
Rapid naming (CTOPP)	110.2	90.5	83.2
(S.D.)	(9.8)	(13.8)	(13.3)
Digit memory	112	89.5	86.9
(S.D.)	(14.2)	(10.3)	(12.7)

Mean scores presented in standard scores ($M = 100$, S.D. = 15), CTOPP = Comprehensive Test of Phonological Processing.

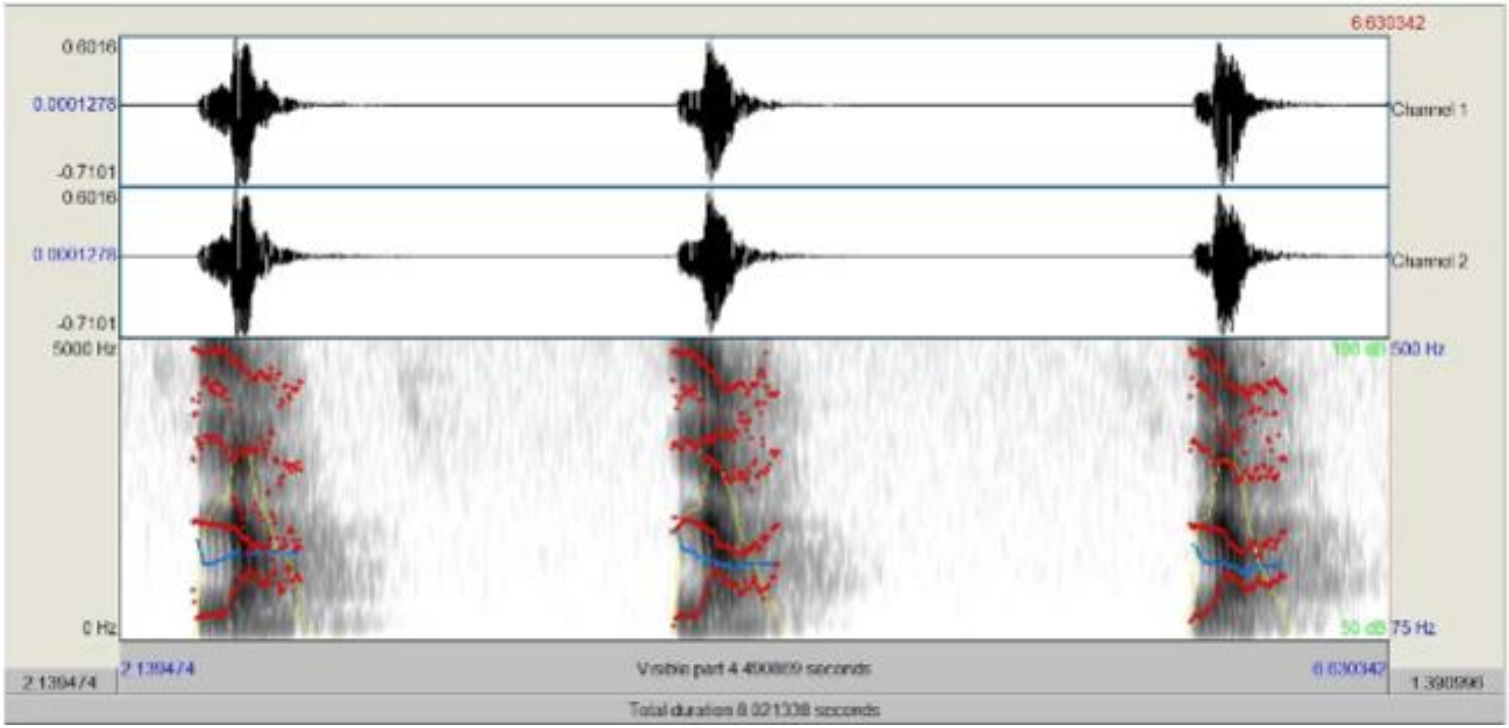
SCIENTIFIC REPORTS

Received: 03 March 2016
Accepted: 05 July 2016
Published: 25 July 2016

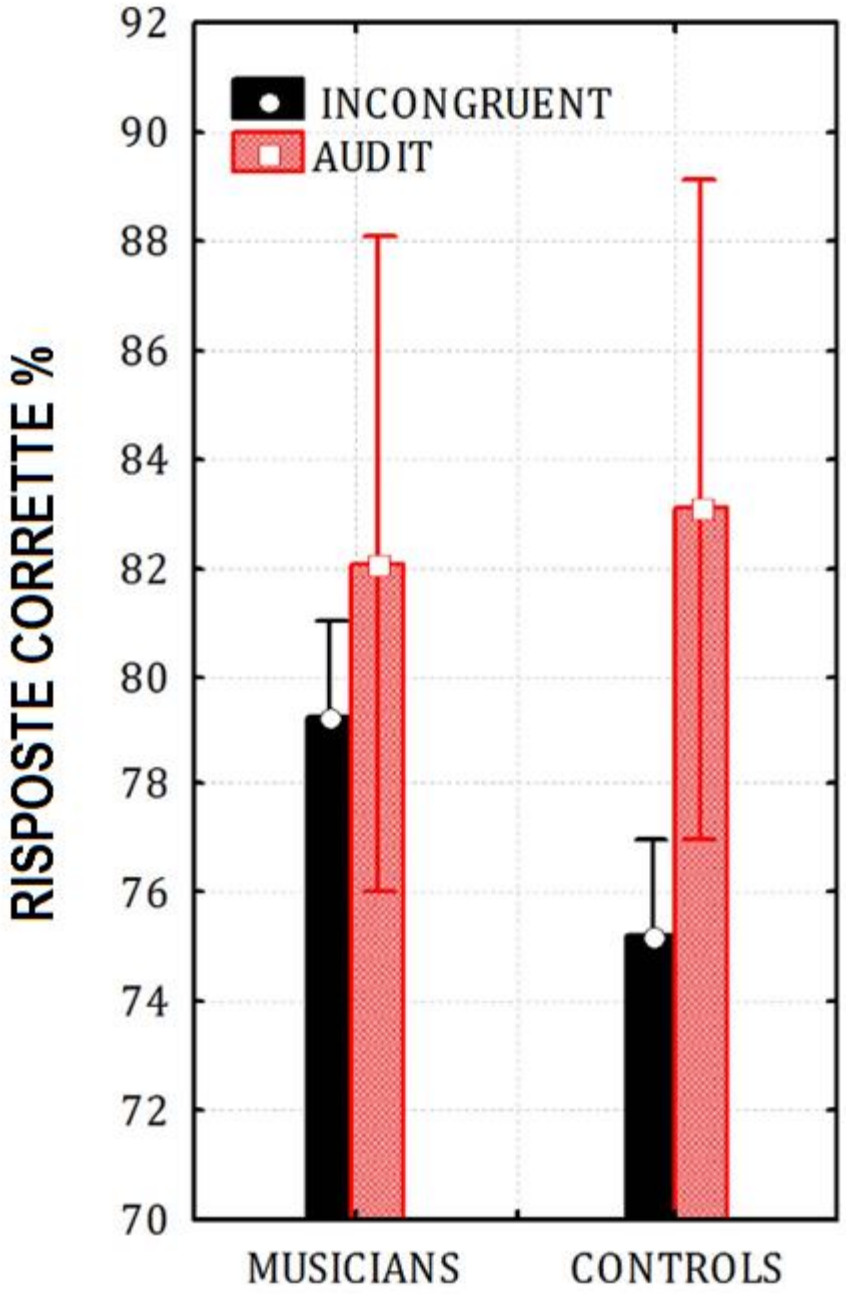
Skilled musicians are not subject to the McGurk effect

Alice M. Proverbio[1], Gemma Massetti[1], Ezia Rizzi[1,2] & Alberto Zani[2]

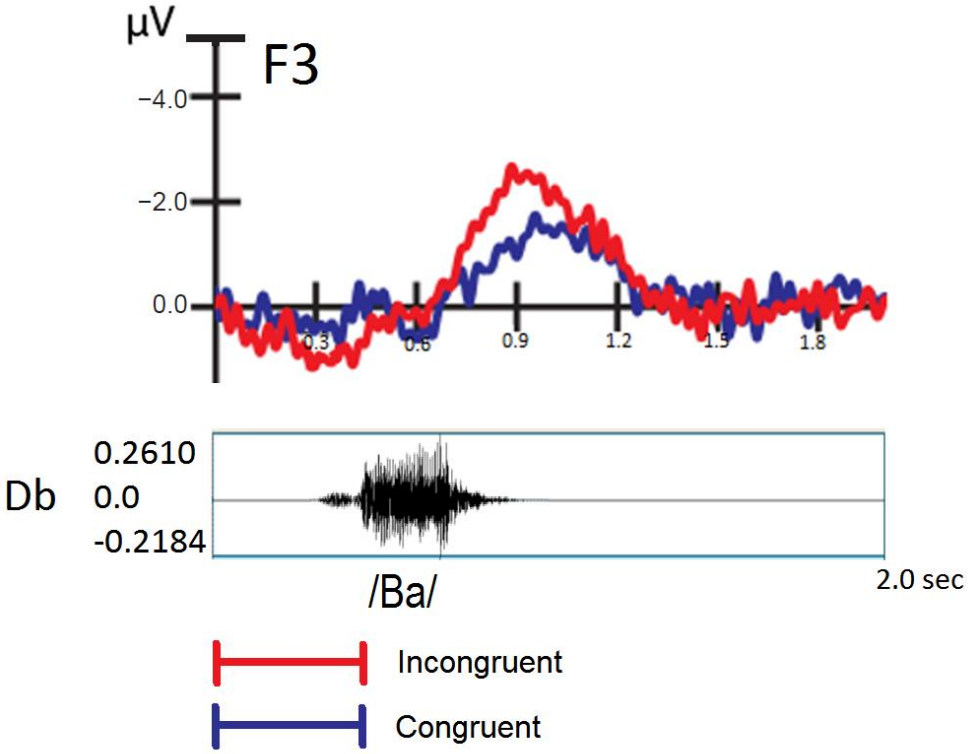
phoneme /LA/

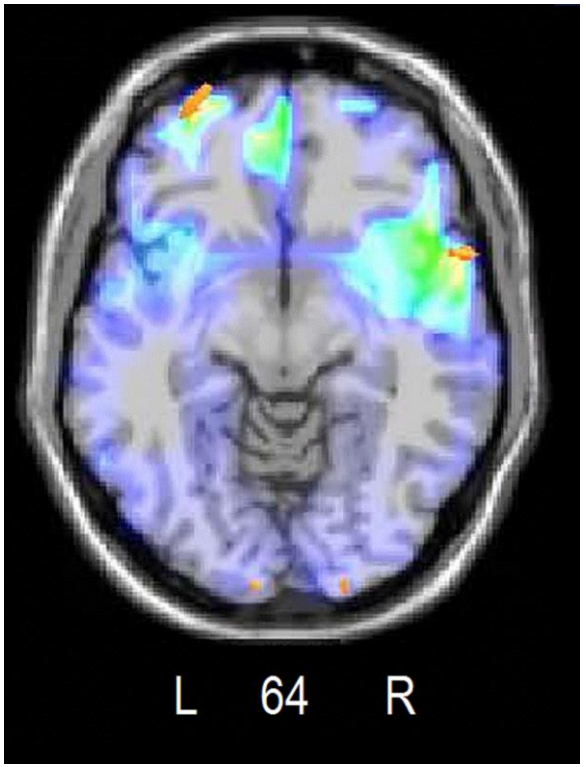


Cello	Piano
Cello	Piano
Clarinet	Piano
Clarinet	Piano
Contrabass	Piano
Flute	Piano
Flute	Piano
Flute	Saxophone
Flute	Saxophone
Flute	Saxophone
Flute	Trombone
Flute	Trumpet
Flute	Trumpet
Harp	Viola
Horn	Viola
Mandolin	Violin
Oboe	Violin
Percussion	Violin
Percussion	Violin
Percussion	Violin



- **Giro temporale superiore destro e frontale superiore coinvolti nell'integrazione AV**





WHAT MUSIC DOES TO THE HUMAN BRAIN

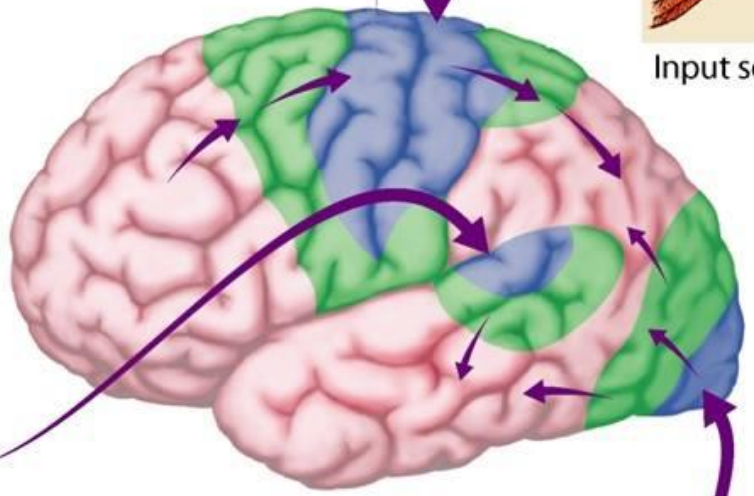
- Let's explore it by comparing the musician vs. non-musician brain

La musica stimola l'intero cervello

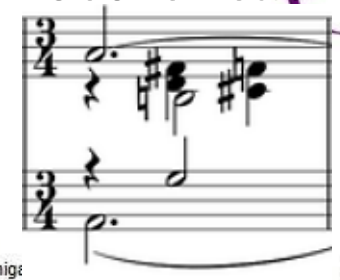
Output motorio

Input somatosensoriale

Udito



Score reading

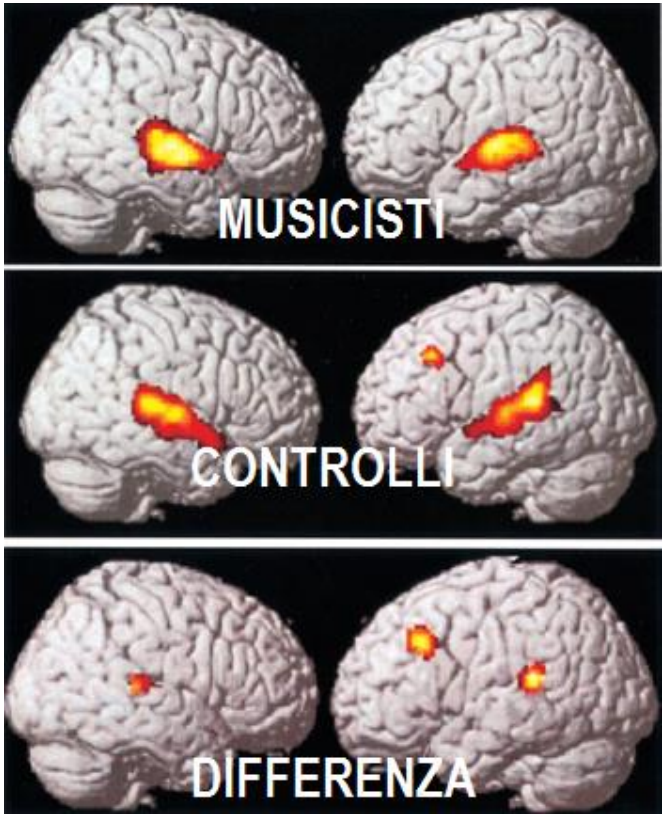


Visione

Functional anatomy of musical perception in musicians. Onishi et al., 2001

Region (Brodmann's area)	Tailrach cood *x* (mm)
Areas more strongly activated in the musicians than in the control subjects	
Left superior temporal gyrus (BA22)	−57
Right superior temporal gyrus (BA22)	52
Left middle frontal gyrus (BA9)	−40
Correlation between the age of inception of musical training and the degree of activation	
Left superior temporal gyrus (BA22)	−55

Attivazione cerebrale durante ascolto concerto BMV 989 di Bach



SCHLAUG: THE BRAIN OF MUSICIANS

TABLE 1. Midsagittal area measurements of the corpus callosum (CC) in mm^2 (mean ± SD)

	Total CC Area	Anterior CC Area[a]
All musicians ($n = 30$)	687 ± 85	371 ± 46
Musicians with commencement of musical training ≤7 years of age	709 ± 81	384 ± 42
Musicians with commencement of musical training >7 years of age	637 ± 77	340 ± 43
Nonmusician controls ($n = 30$)	649 ± 88	344 ± 48

Corpo calloso

Integrazione e coordinazione inter-emisferica

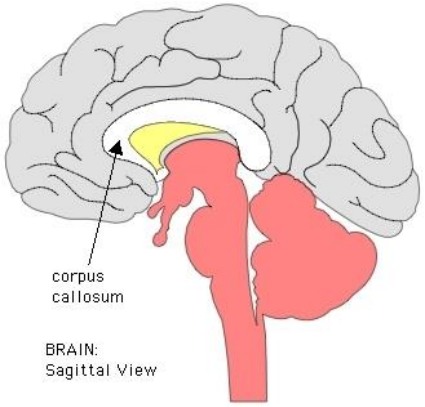
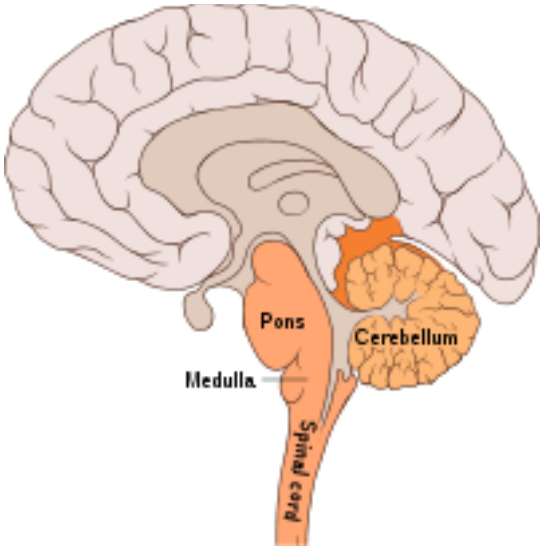


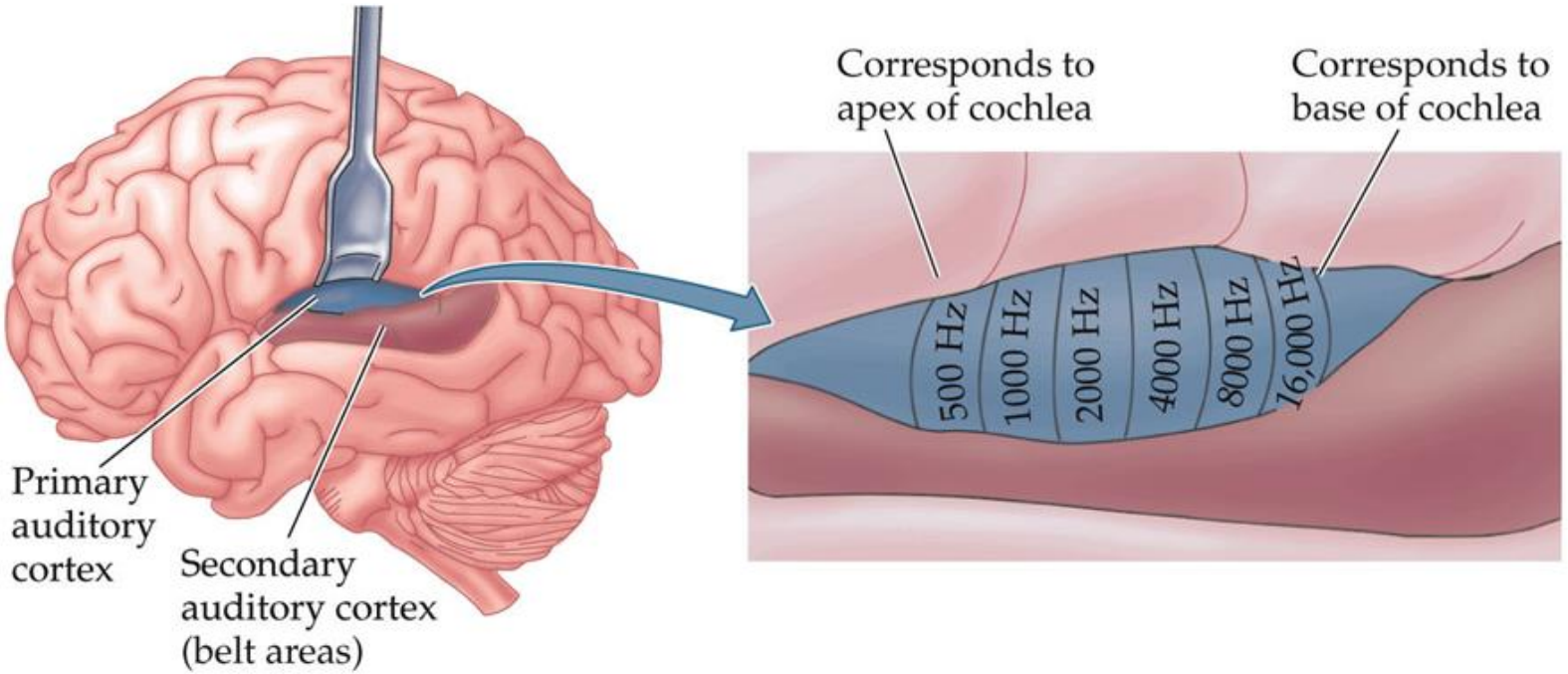
TABLE 2. Morphometric data on cerebellar volume (means ± SD) in musicians and nonmusicians % cerebellar volume of total brain volume

	%CV	aCV (in cc)
Male musicians (n = 32)	10.30 (0.64)	145.3 (9.7)
Male nonmusicians (n = 24)	9.85 (0.68)*	139.6 (15.4)
Female musicians (n = 24)	10.43 (0.65)	134.7 (12.1)
Female nonmusicians (n = 15)	10.43 (0.82)	131.8 (12.9)

Cervelletto
Temporizzazione e fluidità del movimento



PITCH ANALYSIS



EJN European Journal of Neuroscience

FENS Federation of European Neuroscience Societies

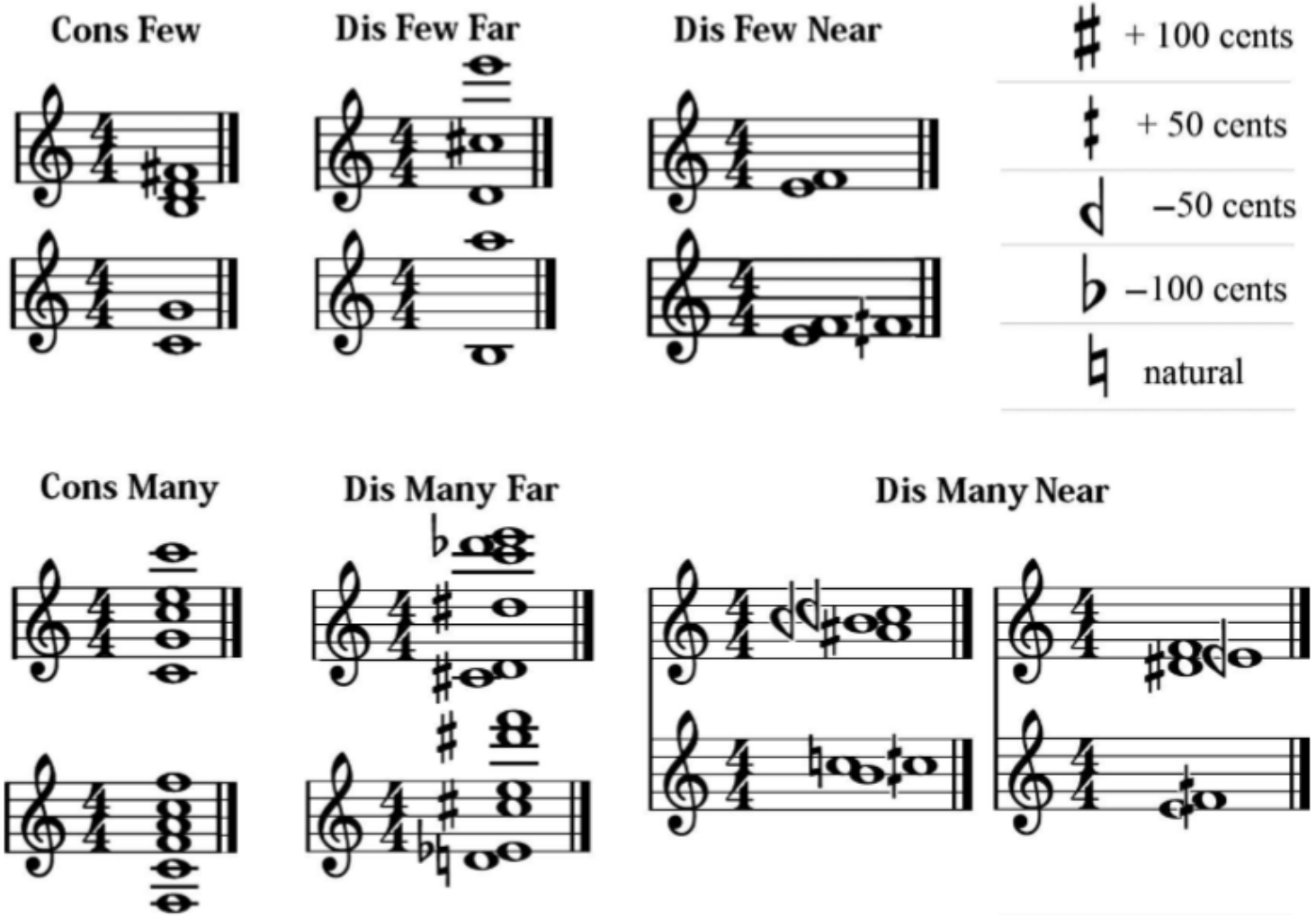
European Journal of Neuroscience, Vol. 44, pp. 2340–2356, 2016

doi:10.1111/ejn.13330

COGNITIVE NEUROSCIENCE

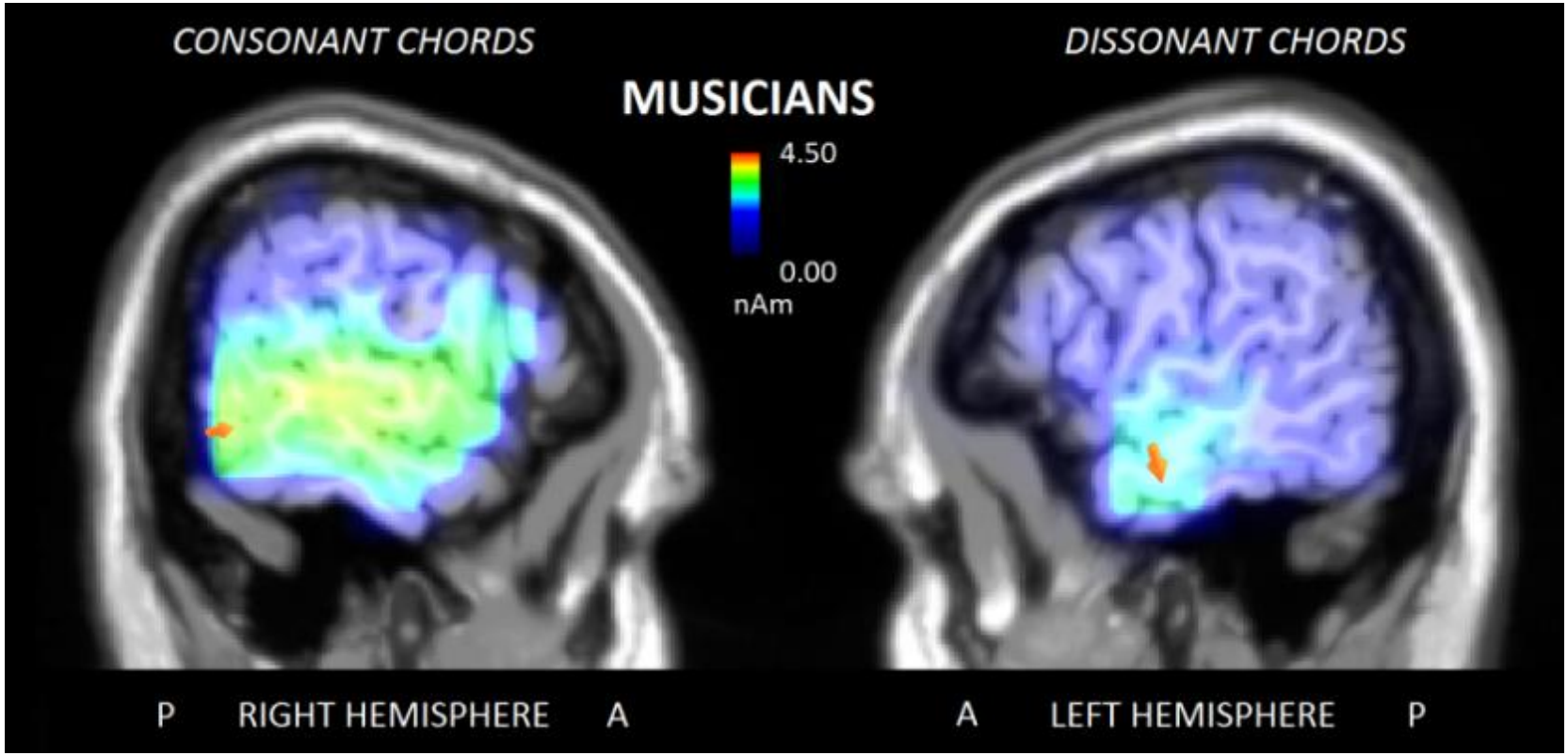
Brain processing of consonance/dissonance in musicians and controls: a hemispheric asymmetry revisited

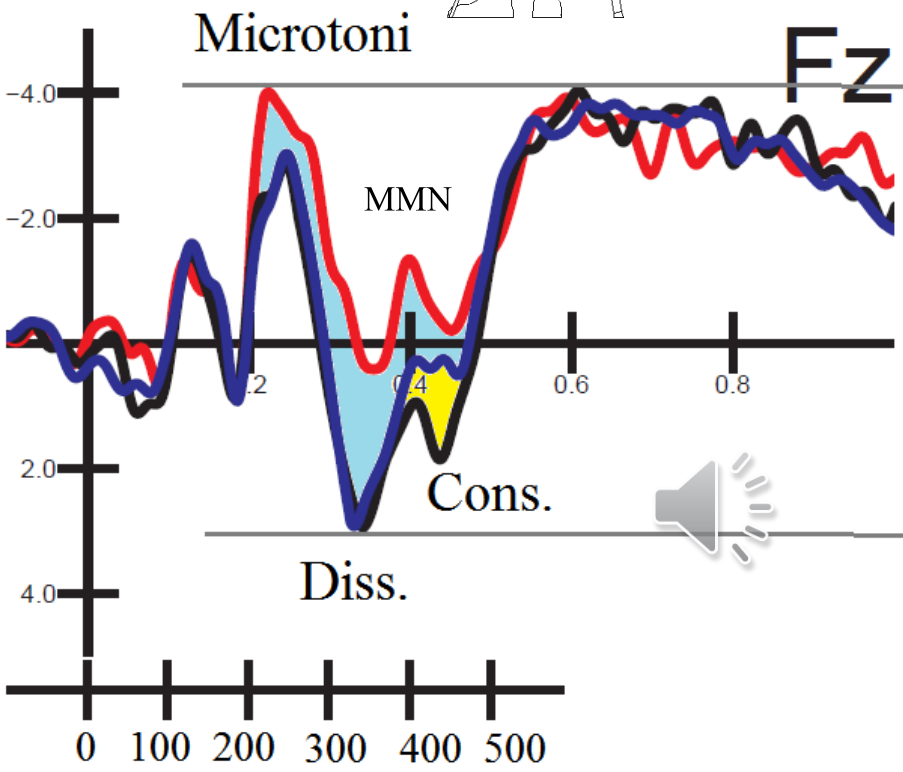
Alice Mado Proverbio, Andrea Orlandi and Francesca Pisanu

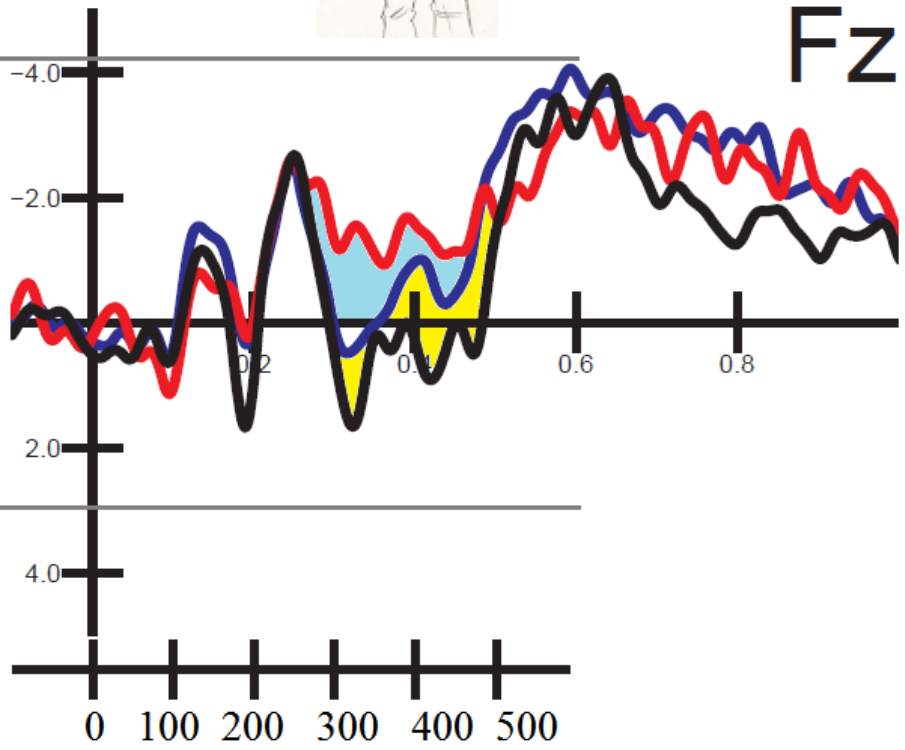


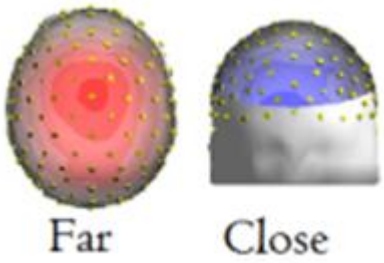
Some example of stimuli for each of the various categories. Cons, consonant chords; dis, dissonant chords.

138 ms after chord onset




Microtoni
Fz
MMN
Cons.
Diss.
−4.0
−2.0
2.0
4.0
0
100
200
300
400
500
0.6
0.8


Fz
−4.0
−2.0
2.0
4.0
0
100
200
300
400
500
0.6
0.8


Far
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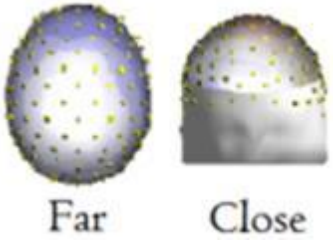

Far
Close

CONTROLLO MOTORIO

Pollice mano sinistra
D1 inattivo
Mignolo sinistro D5
molto più stimolato
rispetto ai controlli

La pratica musicale a lungo termine aumenta l'area della corteccia motoria responsabile del controllo delle dita dei violinisti (Elbert et al., 1995) e dei pianisti (Meister et al., 2005).

Increased Cortical Representation of the Fingers of the Left Hand in String Players

Thomas Elbert, Christo Pantev, Christian Wienbruch,
Brigitte Rockstroh, Edward Taub

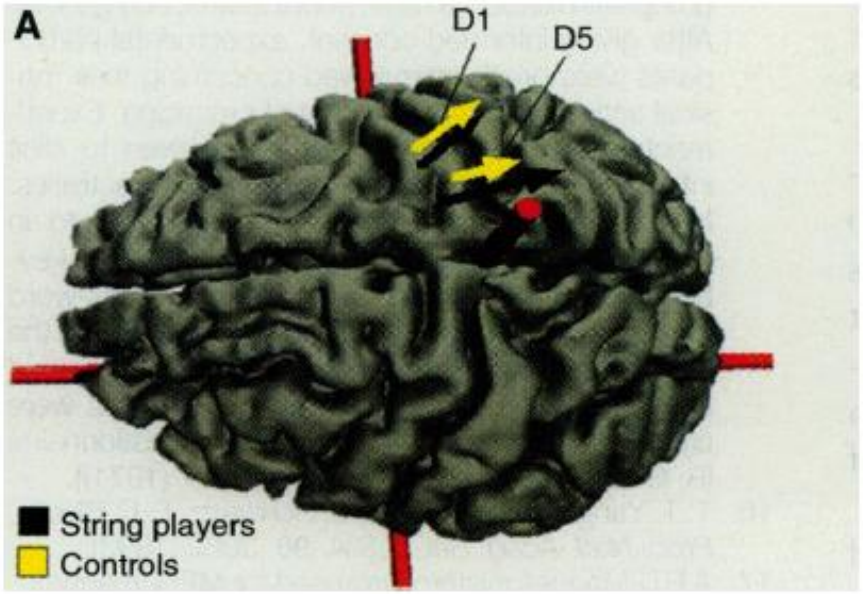
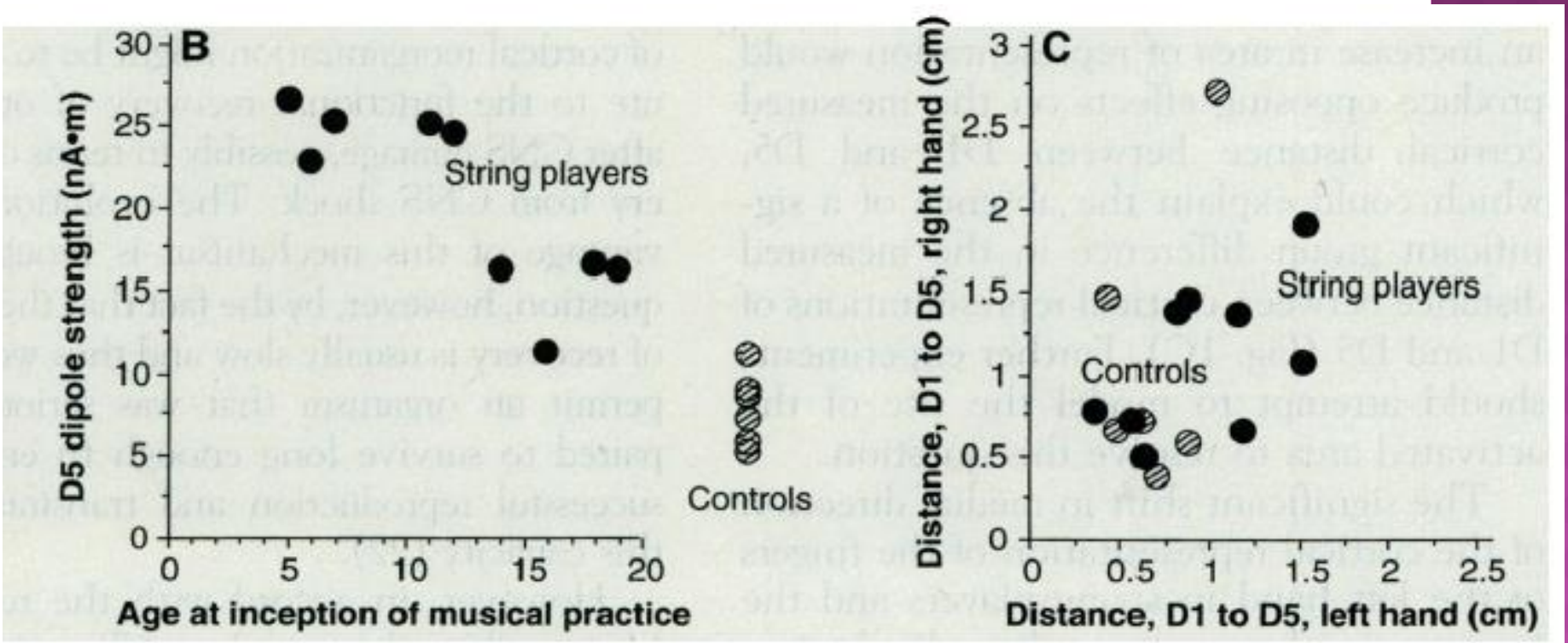


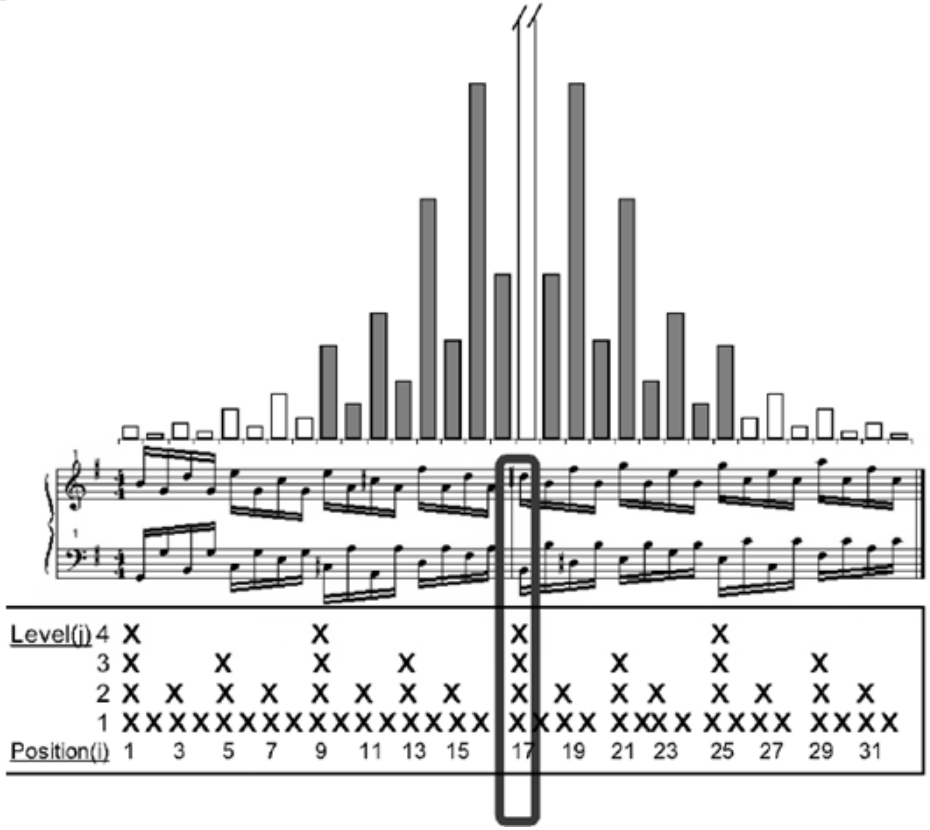
Fig. 1. (**A**) Equivalent current dipoles elicited by stimulation of the thumb (D1) and fifth finger (D5) of the left hand are superimposed onto an MRI (magnetic resonance imaging) reconstruction of the cerebral cortex of a control, who was selected to provide anatomical landmarks for the interpretation of the MEG-based localization. The arrows represent the location and orientation of the ECD vector for each of the two digits averaged across musicians (black) and controls (yellow). The length of the arrows represents the mean magnitude of the dipole moment for the two digits in each group. The average locations of D5 and D1 are shifted medially for the string players compared to

During the experimental session, somatosensory stimulation was delivered to the first digit and, in separate runs, to the fifth digit of either hand. Stimulation consisted of light superficial pressure applied by means of a pneumatic stimulator



PIANIFICAZIONE, PROGRAMMAZIONE

P. Q. Pfordresher. C. Palmer. M. K. Jungers/Cognitive Science 31 (2007)



Il cervello di un musicista è in grado di produrre 1200 movimenti al minuto: ogni movimento viene programmato 500 millisecondi prima dell'esecuzione

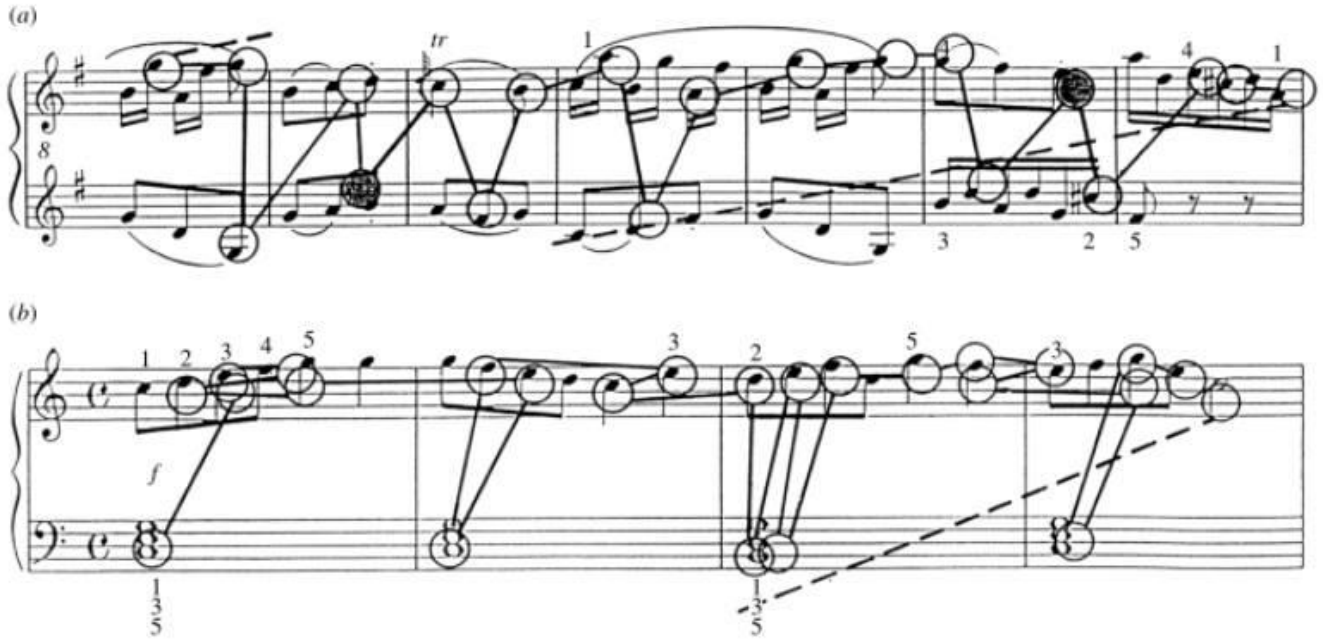


Figure 2. (*a*) One line of a piece by Scarlatti, showing the positions of fixations on the page during sight-reading by a professional subject (D.T.). Circles indicate fixation position and adjoining lines indicate saccades. Filled circles indicate that the next

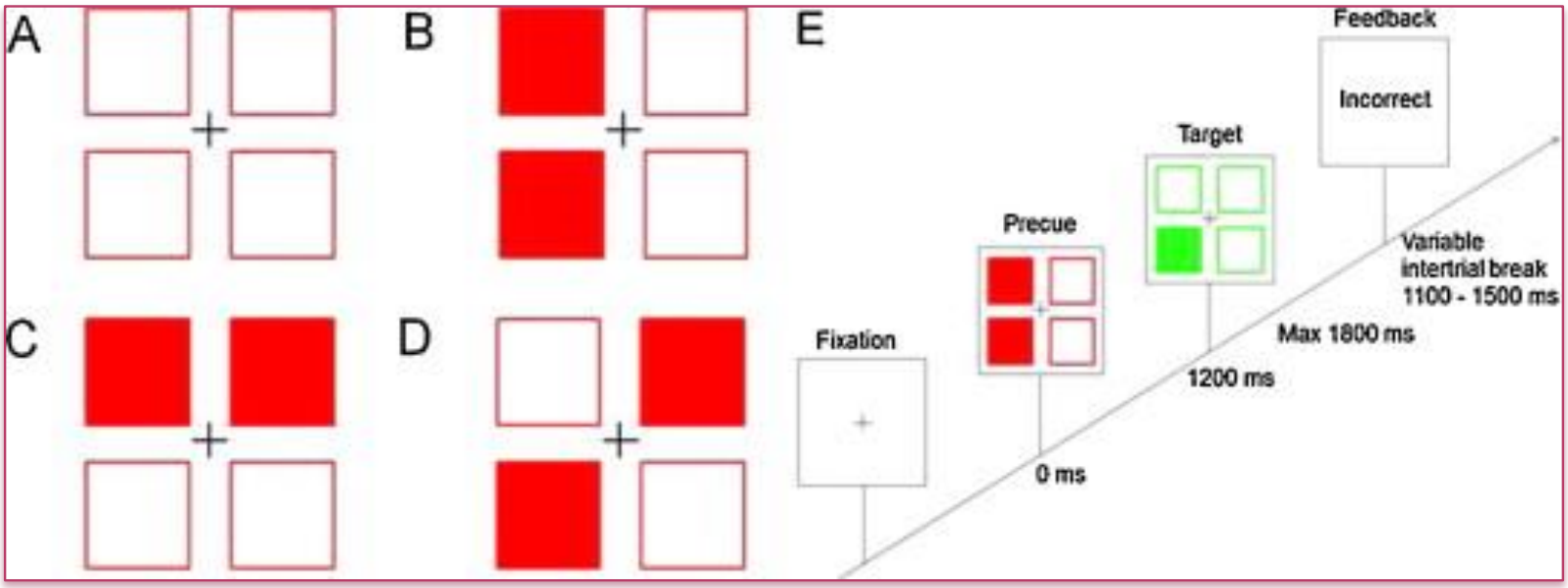
Movimenti oculari durante la lettura dello spartito. Dove guardiamo mentre suoniamo? Non più di 2-7- note in avanti.
Il ritardo tra ciò che suoniamo e ciò che leggiamo (eye-hand span) si aggira tra gli 0.7 e i 1.3 secondi.

I cerchietti indicano la saccade oculare, la linea trattegiata uno sguardo ai tasti.

The effects of musical training on movement pre-programming and re-programming abilities: An event-related potential investigation

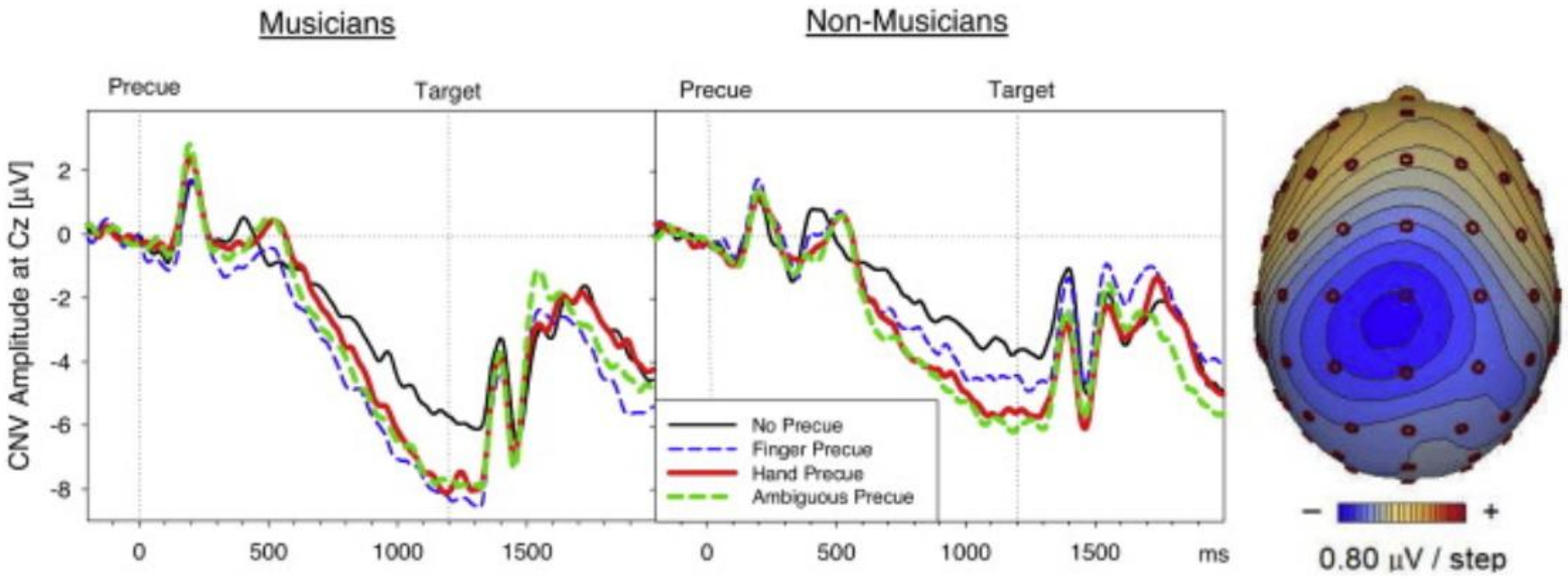
Melis Anatürk, Ines Jentzsch

Volume 106, March 2015, Pages 39–49 Biological Psychology



A. Nessuna informazione
B. Mano di risposta (sinistra o destra)
C. Dito di risposta (indice o medio)
D. Informazione ambigua (conflittuale)

CNV cortical motor programming



Abilità musicale, connettività ed intelligenza

- Fluid Intelligence
  - The ability to think on the spot and solve novel problems
    - The ability to perceive relationships
    - The ability to gain new types of knowledge
- Crystallized Intelligence
  - Factual knowledge about the world
    - The skills already learned and practiced
    - Examples
      - Arithmetic facts
      - Knowledge of the meaning of words
      - State capitals

◆ Human Brain Mapping 00:00–00 (2015) ◆

The "Silent" Imprint of Musical Training

Carina Klein,[1]* Franziskus Liem,[1] Jürgen Hänggi,[1]
Stefan Elmer,[1†] and Lutz Jäncke[1,2,3,4,5†]

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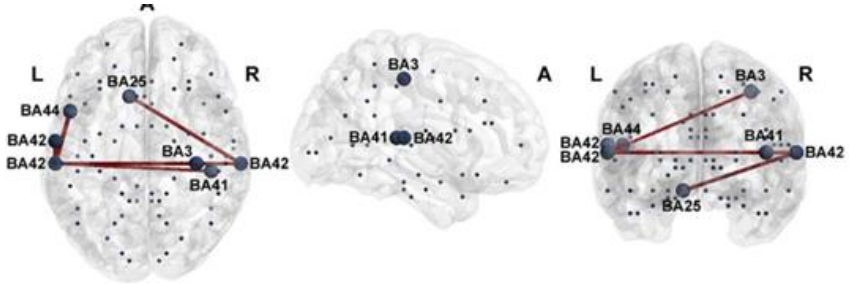
whole-brain functional connectivity during resting state in a sample of 15 string players and 15 nonmusicians.

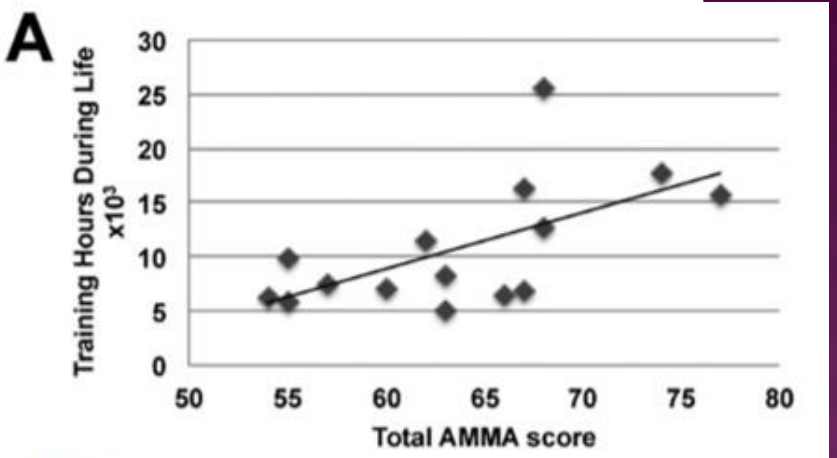
Musicians demonstrate **increased intra- and interhemispheric functional connectivity** between those brain regions that are typically involved in music perception and production, such as the auditory, the sensorimotor, and prefrontal cortex as well as Broca's area.

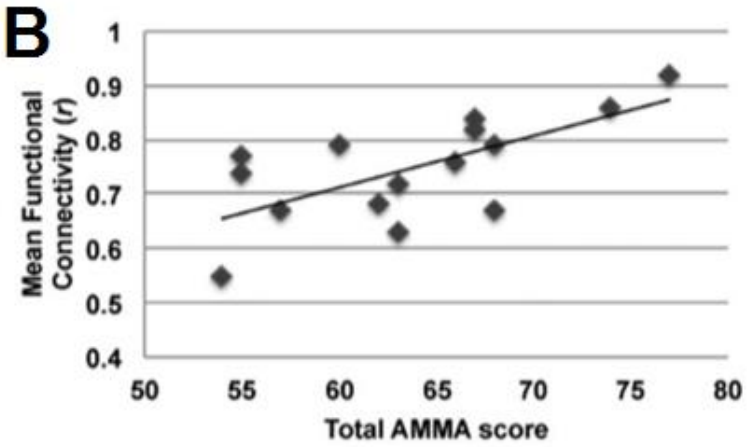
Connectivity within this specific network was positively related to musical skill and the total number of training hours.

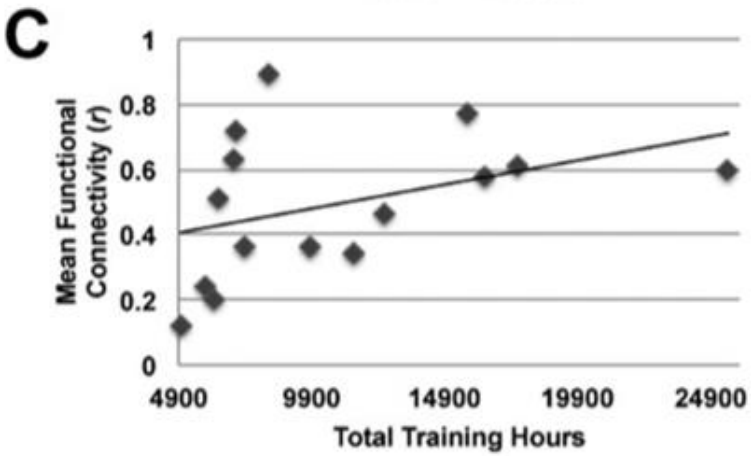
L'attitudine musicale è stata misurata con il test AMMA: i soggetti devono decidere se due brevi sequenze di pianoforte sono uguali o ritmicamente/armonicamente diverse

A) I punteggi al test correlano con il numero di ore di studio (x mille)
B) Con la connettività
C) Il numero di ore di training con la connettività









BENESSERE, PIACERE, EFFETTO ANALGESICO

L'ascolto della musica stimola i sistemi di sensazione del piacere

Si attiva il **Nucleo accumbens**

Sistema della ricompensa nigro-striatale e VTA

Aumento di oppiodi circolanti

Table 1. Evidence for the contribution of dopamine and opioids to musical pleasure

Study	Outcome measures	Conditions	Participants	Main findings
[17]	Self-reported thrills and chills	Self-selected music; naloxone vs placebo	Musicians and non-musicians (n=249)	Thrills ↓ by the mu-opioid-antagonist, naloxone
[28]	rCBF using PET; self-reported chills	self-selected music, neutral music, noise, and rest	Music students (n=10)	Chills ↑ rCBF in ventral striatum and midbrain
[29]	rCBF using PET; self-reported musical pleasure	Experimenter-selected music vs rest	Non-musicians (n=10)	Music ↑ rCBF in NAc, insula, hippocampus
[31]	rCBF using fMRI, network connectivity; self-reported pleasantness	Experimenter-selected music vs scrambled versions of same	Non-musicians (n=13)	Music ↑ rCBF in NAc, VTA and insula; strong connectivity of NAc, VTA, hypothalamus and insula.
[32]	rCBF using fMRI; self-reported pleasantness	Experimenter-selected music, pleasant vs unpleasant	Non-musicians (n=11)	Pleasant music ↑ rCBF in ventral striatum; ↓ rCBF in amygdala, hippocampus, parahippocampal gyrus and temporal poles
[33]	D_2 binding using ligand-based PET; self-reported chills	Self-selected vs neutral music	Unselected for musical ability (n = 10)	Chills ↑ D_2 binding in NAc; Anticipation ↑ D_2 binding in caudate
[35]	rCBF using fMRI; self-reported affective valence, arousal, familiarity, autobiographical association; directed attention	Experimenter-selected music	Unselected for musical ability (n=13)	Pleasant familiar music ↑ rCBF in insula, ventral striatum (caudate nucleus), mPFC

Note: Arrows indicate significant increases or decreases relative to baseline and/or control conditions. Abbreviations: D_2, dopamine D2 receptor; mPFC, medial prefrontal cortex; NAc, nucleus accumbens; PET, positron emission tomography; rCBF, regional cerebral blood flow; VTA, ventral tegmental area.