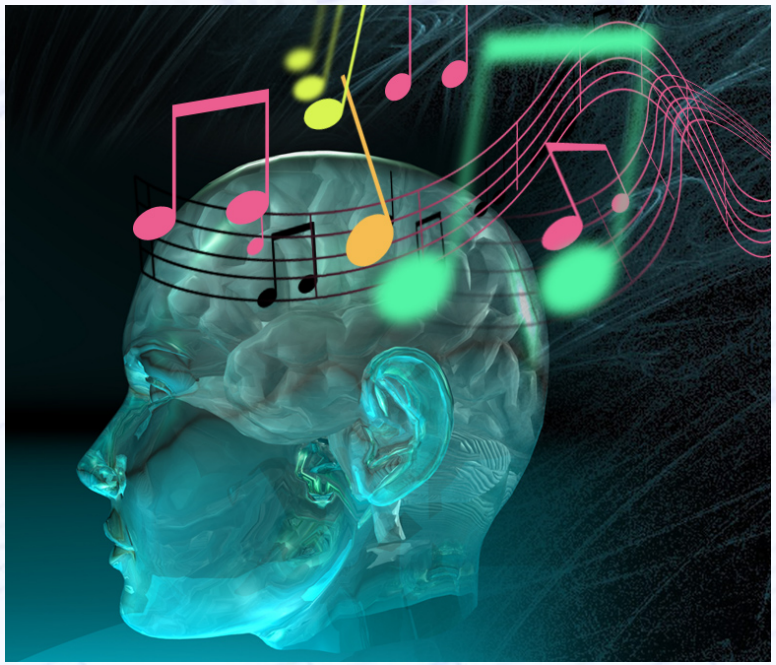


Neuroscience des émotions musicales

Isabelle Peretz

Professeure en psychologie

BRAMS, Université de Montréal

Conférencière invitée, Collège de France

Université de Montréal

COLLÈGE DE FRANCE 1530

Brams

L'émotion fait partie intégrante de l'expérience musicale

Les enquêtes révèlent que:

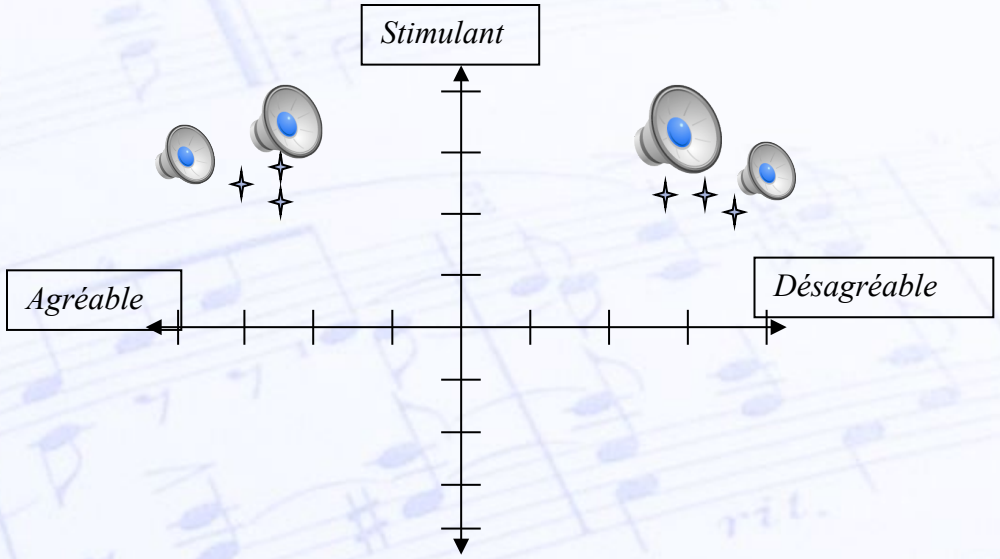
- ✓ La musique est une des plus grandes sources de plaisir (e.g., Dubé et Lebel, 2003)
- ✓ La musique est utilisée pour canaliser et modifier nos émotions (e.g., Tia De Nora, 2001)

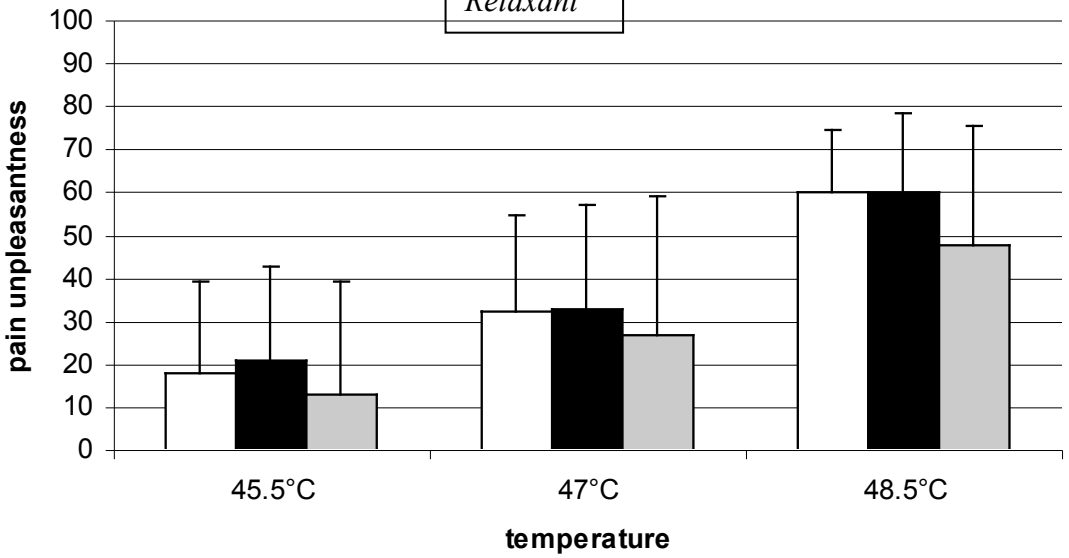
Antecedents	*Mean*	(SD)
Success	5.41	(0.75)
Good grades	5.28	(0.77)
Travelling	5.17	(0.77)
Romance	5.17	(0.77)
Boyfriend/Girlfriend	5.14	(0.77)
Sex	5.0	(0.96)
Sun	4.97	(0.84)
Music	4.93	(0.75)
Knowledge	4.84	(0.94)
Sleeping	4.83	(1.11)
Beach	4.78	(1.06)
Money	4.76	(1.14)
Conversation	4.53	(0.91)
Meeting new people	4.52	(0.98)
Clothes	4.5	(0.93)
Food	4.47	(0.93)
Moving into my own apartment	4.45	(1.23)
Shower	4.45	(1.05)
Equality	4.34	(1.10)
Peace on earth	4.34	(1.35)
Movie	4.33	(1.01)
Shopping	4.33	(1.07)
Dressing up	4.24	(0.93)
Seduction	4.23	(1.12)
Sports	4.19	(1.46)
Popularity	4.16	(0.85)
Parties	4.12	(1.03)
Learning	4.10	(1.18)
Christmas	4.00	(1.32)
Choculate	4.00	(1.28)
Exercising	3.98	(1.25)

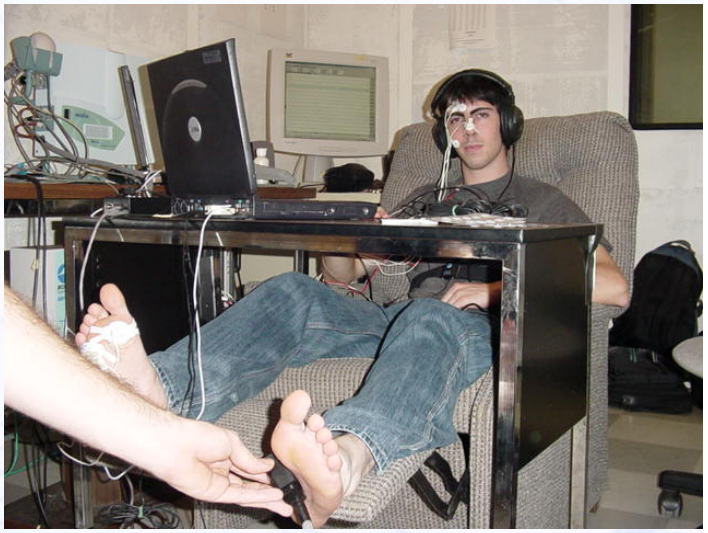
COGNITION AND EMOTION, 2003, *17* (2), 263–295

Quelques manifestations

Music-induced analgesia



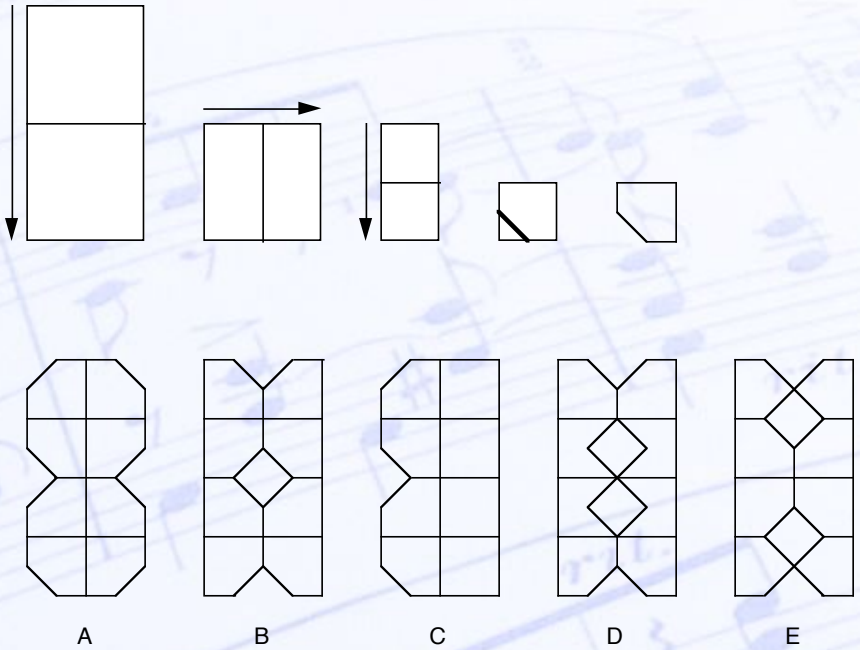


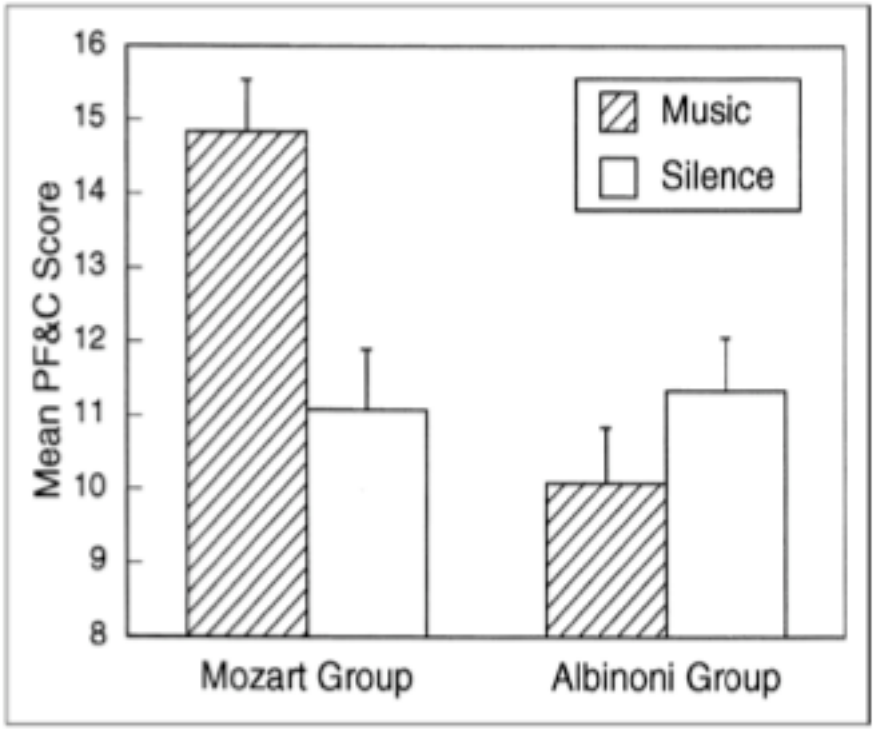


Thermal stimulation

Roy, Peretz & Rainville (2007) *Pain*

“The Mozart effect”





Thompson, Schellenberg, & Husain (2001) Psychological Science

"The Mozart effect" = an emotional effect

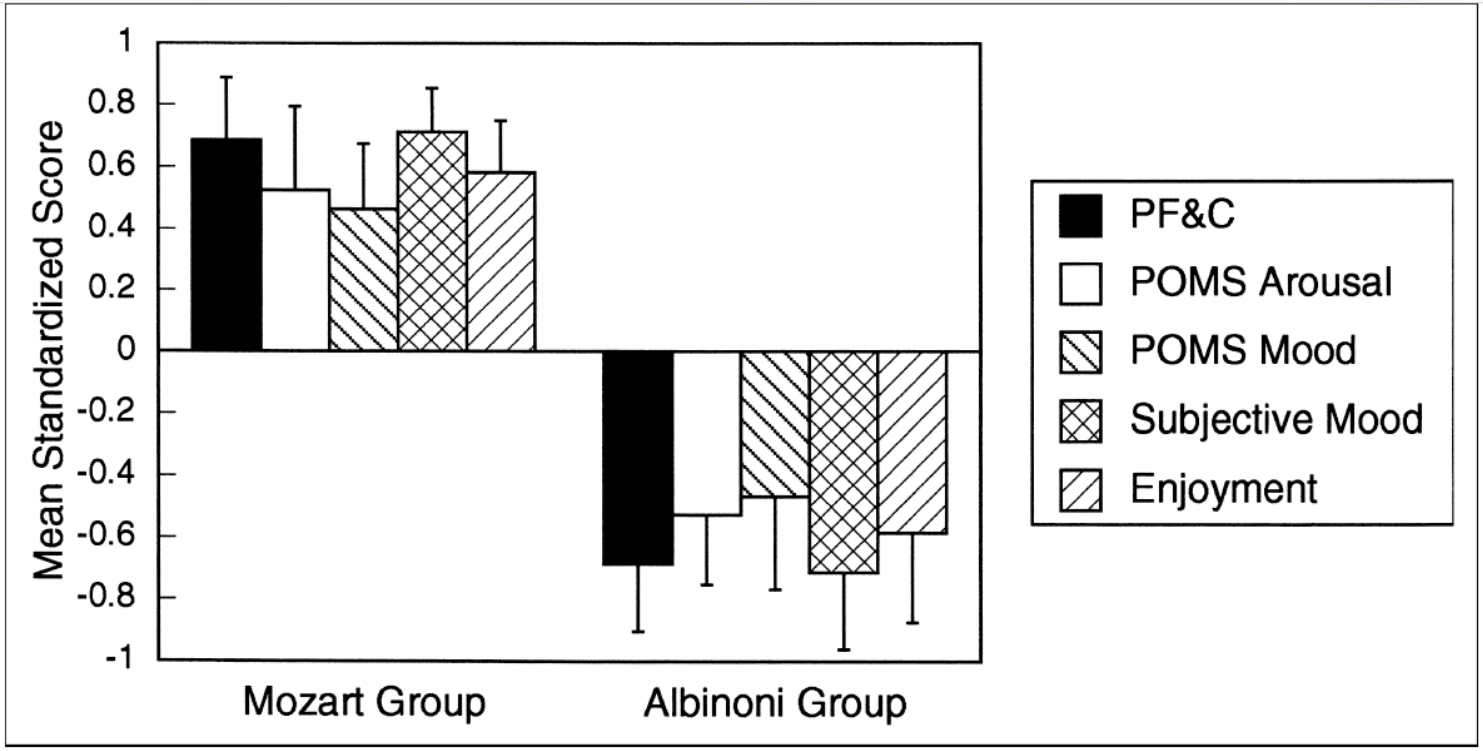


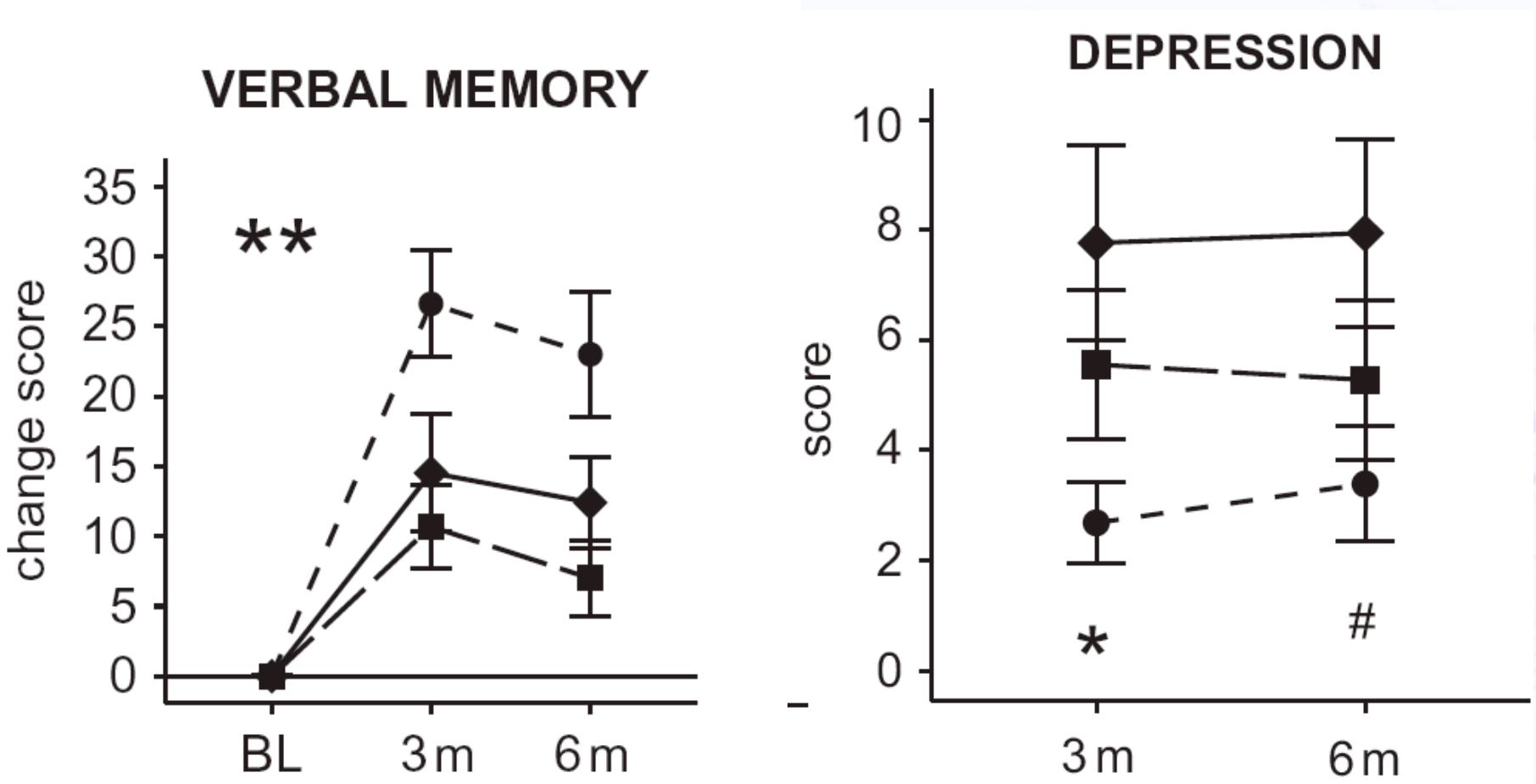
Fig. 2. Participants' mean standardized scores on five measures after listening to Mozart or to Albinoni. Scores are shown for the paper-folding-and-cutting (PF&C) task, Profile of Mood States (POMS) arousal subscale, POMS mood subscale (reverse coded), subjective mood-arousal ratings, and enjoyment ratings. Error bars illustrate standard errors.

Thompson, Schellenberg, & Husain (2001) Psychological Science

doi:10.1093/brain/awn013 Brain (2008), 131, 866–876

Music listening enhances cognitive recovery and mood after middle cerebral artery stroke

Teppo Särkämö,[1] Mari Tervaniemi,[1] Sari Laitinen,[2] Anita Forsblom,[2] Seppo Soinila,[3] Mikko Mikkonen,[1] Taina Autti,[4] Heli M. Silvennoinen,[4] Jaakko Erkkilä,[2] Matti Laine,[5] Isabelle Peretz[6] and Marja Hietanen[3]

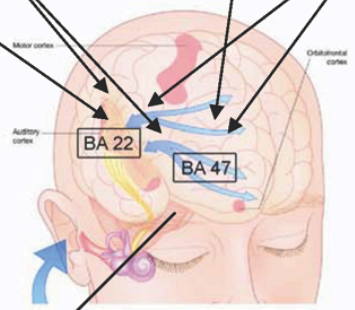


Voir aussi Soto et al. (2009) PNAS.

ETIOLOGY

Gene 1 | Gene 2 | Gene 3 | Env. 1 | Env. 2 | Env. 3

BRAIN



COGNITION

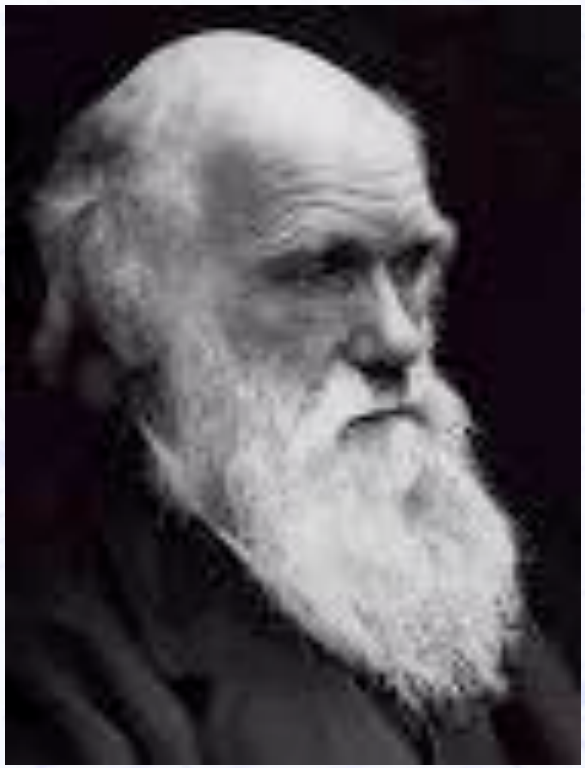
BEHAVIOR

Jugements *Indices corporels*

Effets indirects: douleur, effet Mozart, consommation,..

« Musical notes and rhythm were first acquired by the male and female progenitors of mankind for the sake of charming the opposite sex » (p.572.*The descent of man)*

For Spencer (1857),
music employs and exagerates the natural language of emotions through exageration of vocal characteristics inherent in the physiology of the human species
(The origin and function of music)



Darwin 1809-1882

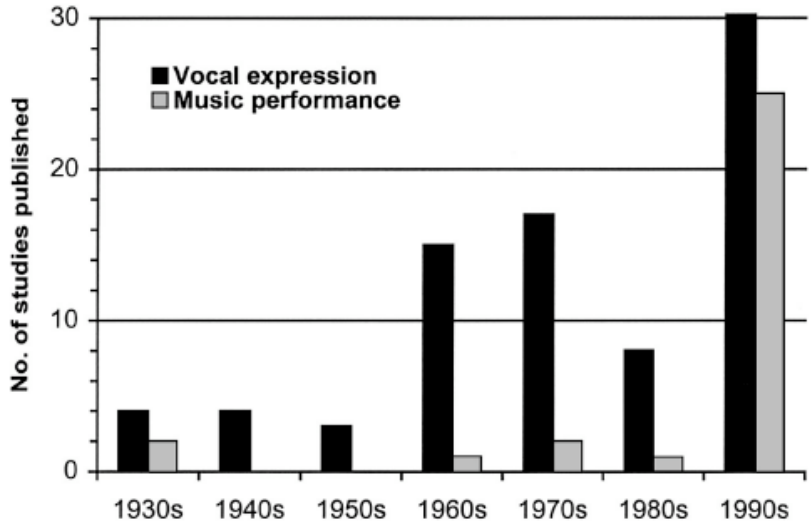
Kivy (1950) Charles Darwin on music. *J. of the American Musicological Society.*

Psychological Bulletin
2003, Vol. 129, No. 5, 770–814

0033-2909/03/$12.00 DOI: 10.1037/0033-2909.129.5.770

Communication of Emotions in Vocal Expression and Music Performance: Different Channels, Same Code?

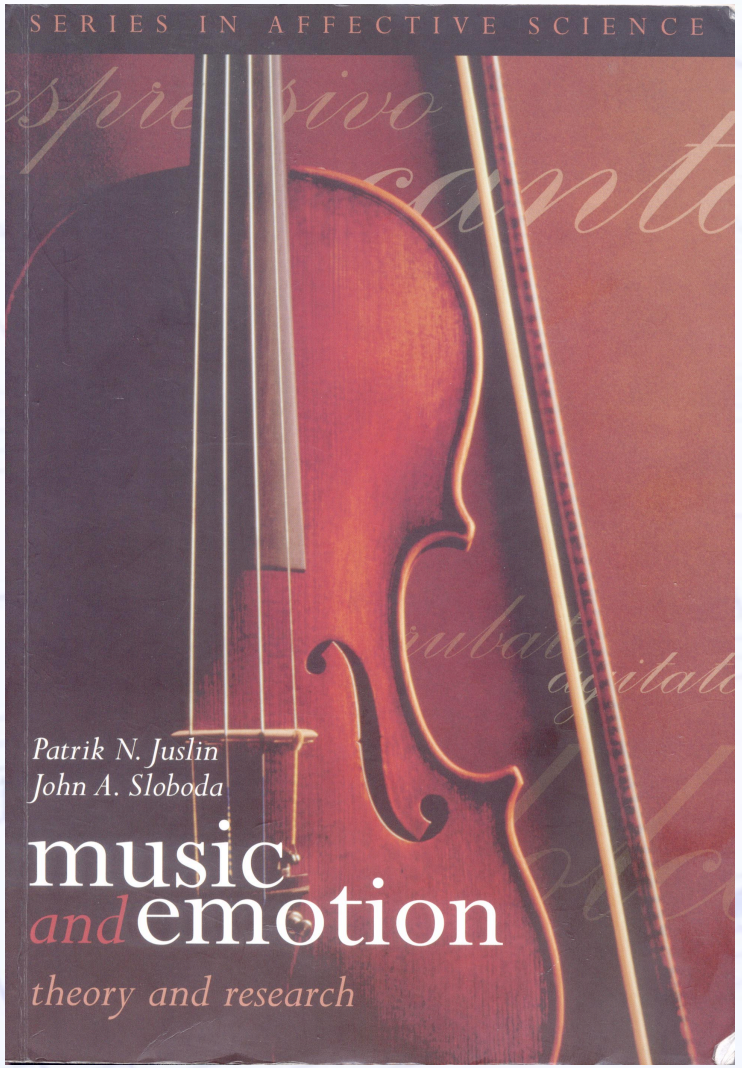
Patrik N. Juslin and Petri Laukka
Uppsala University



in music). Juslin (in press) argued that what makes a particular music performance of, say, the violin, so expressive is the fact that it sounds a lot like the human voice while going far beyond what the human voice can do (e.g., in terms of speed, pitch range, and timbre). Consequently, we speculate that many musical instruments are processed by brain modules as superexpressive voices.

La musique comme inducteur d'émotions:

- ✓ Fonctionnel très tôt (inné)
- ✓ Reconnaissance rapide et systématique
- ✓ Fractionnement par type d'émotion
- ✓ Médiation limbique
- ✓ Universaux



Premier traité en 2001

Préférence innée pour le chant dirigé vers l'enfant

Courtoisie de Sandra Trehub

Masataka (1999) *Developmental Psychology;*
Nakata & Trehub (2004) *Infant Behavior & Development*

A developmental study of the affective value of tempo and mode in music

Simone Dalla Bella[a], Isabelle Peretz[a,*], Luc Rousseau[b], Nathalie Gosselin[a]

4 conditions:

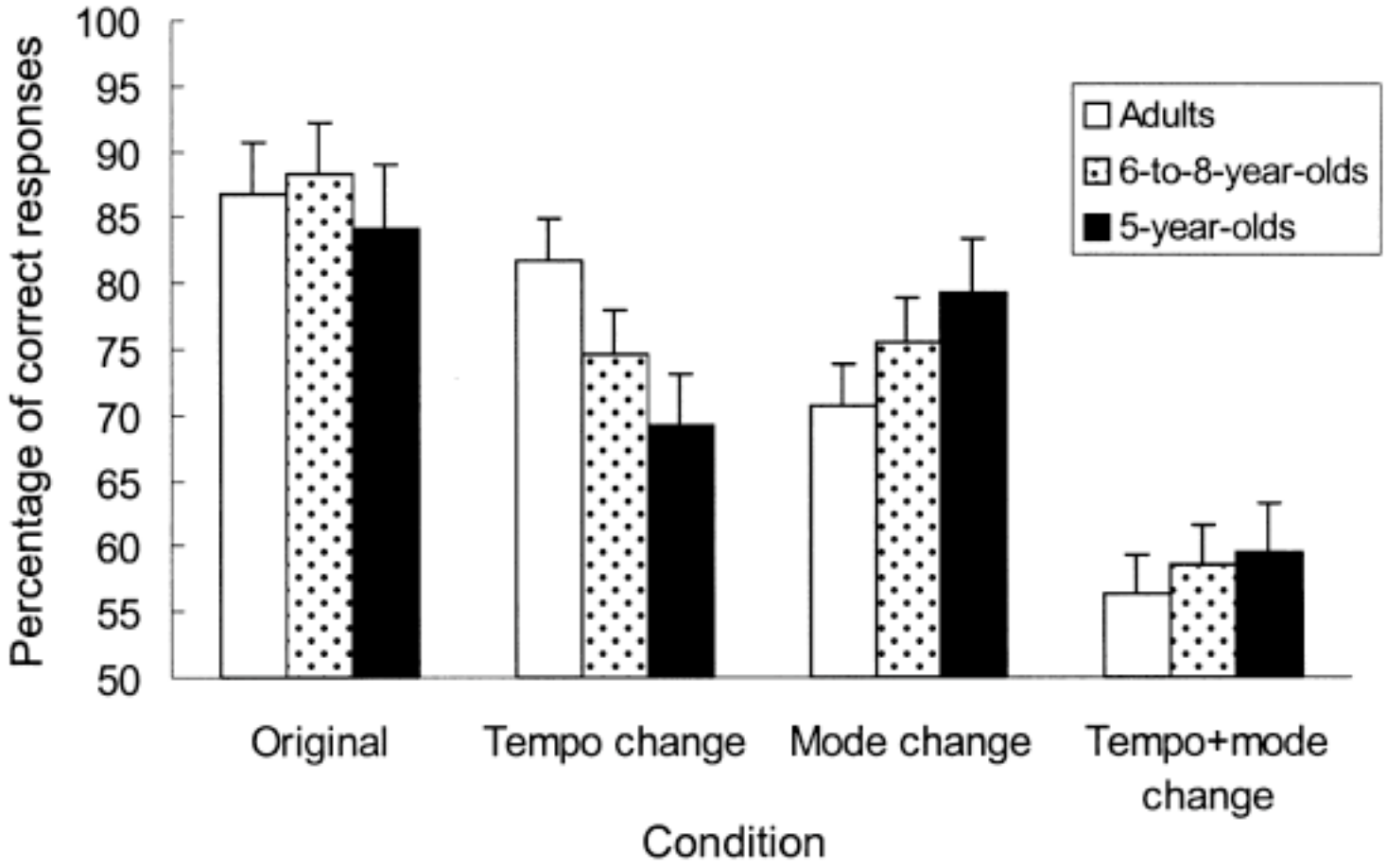
original

tempo (unique)

mode (inversé)

tempo+mode

Cognition 80 (2001) B1–B10


Percentage of correct responses
100
95
90
85
80
75
70
65
60
55
50
Adults
6-to-8-year-olds
5-year-olds
Original
Tempo change
Mode change
Tempo+mode change
Condition

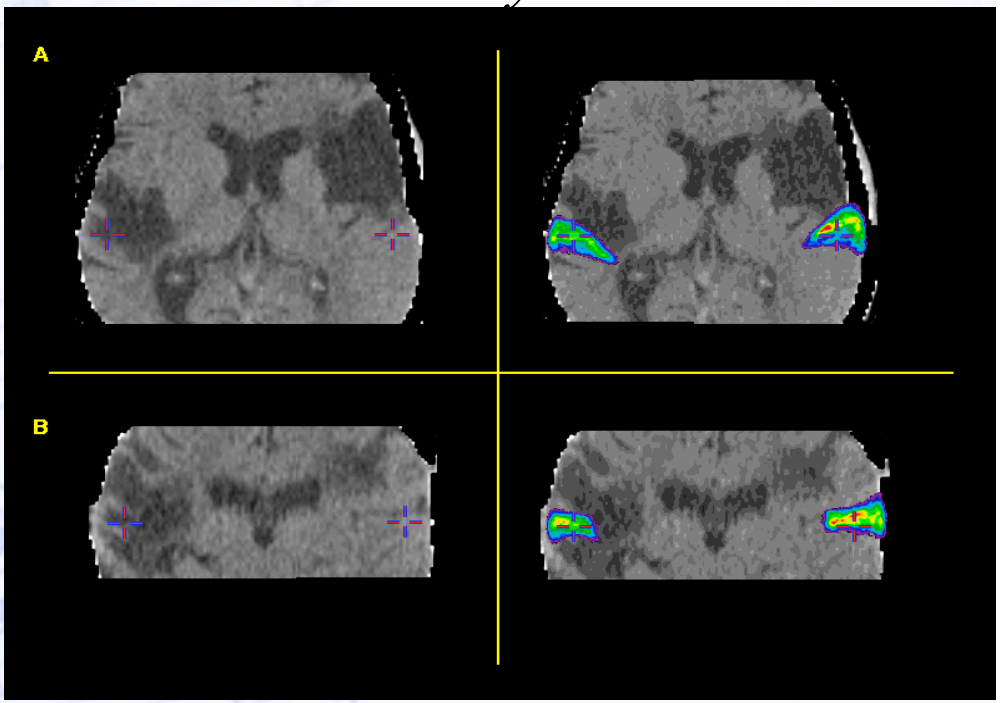
Associations fortes, systématiques et rapides

Un quart de seconde est suffisant

Peretz, Gagnon & Bouchard (1998) Cognition

Le seul pouvoir des associations ?

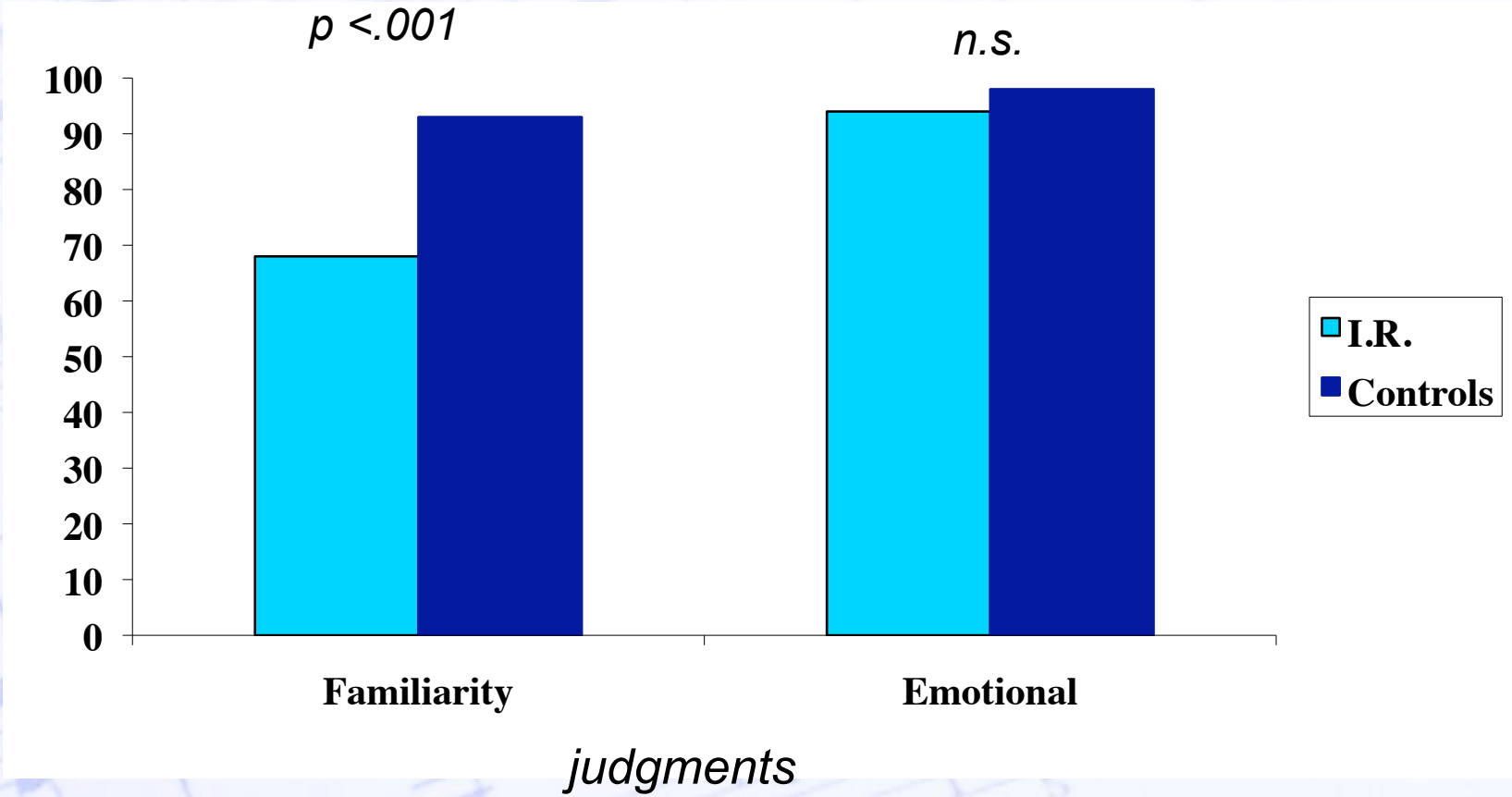
As a result of bilateral lesions to the auditory cortex



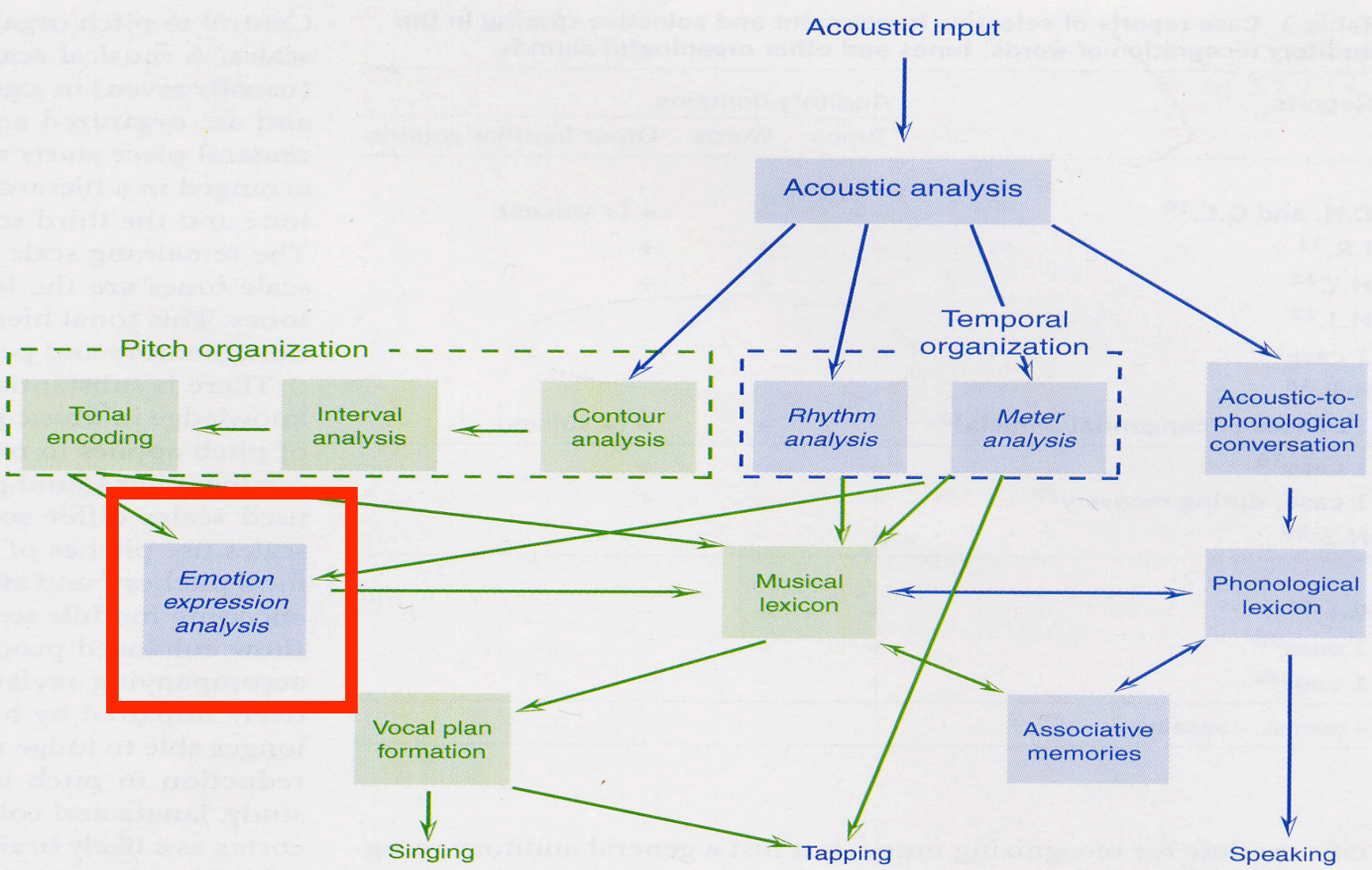
Peretz, Gagnon & Bouchard (1998) Cognition

I.R.: Emotion without memory

« Je sais pas ce que c'est. Mais c'est tellement triste que ça me fait penser à Albinoni »



Peretz & Gagnon (1999), Neurocase.



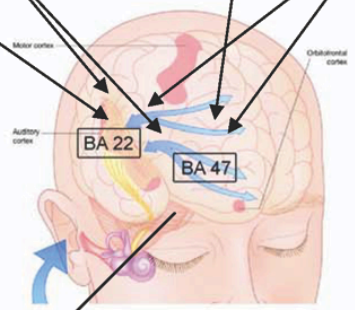
Peretz & Coltheart (2003) *Nature Neuroscience*

Ivelisse Robles

ETIOLOGY

Gene 1 | Gene 2 | Gene 3 | Env. 1 | Env. 2 | Env. 3

BRAIN



COGNITION

Juslin & Västjäll (2008) Behavioral and Brain Sciences

BEHAVIOR

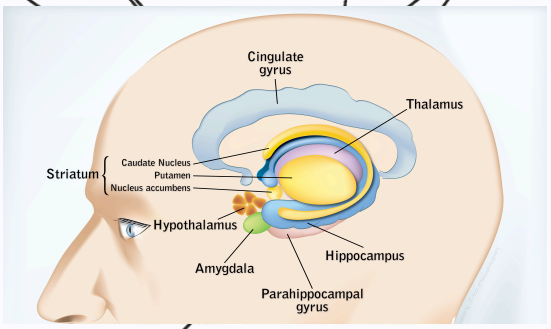
Jugements *Indices corporelles*

Effets indirects

ETIOLOGY

Gene 1 | Gene 2 | Gene 3 | Env. 1 | Env. 2 | Env. 3

BRAIN



COGNITION

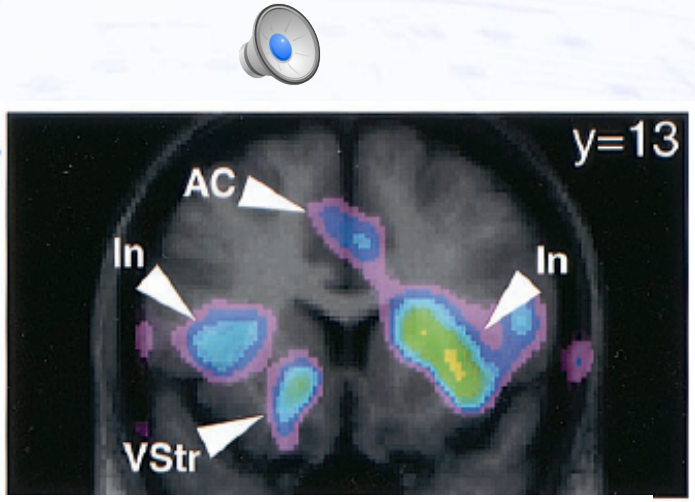
BEHAVIOR

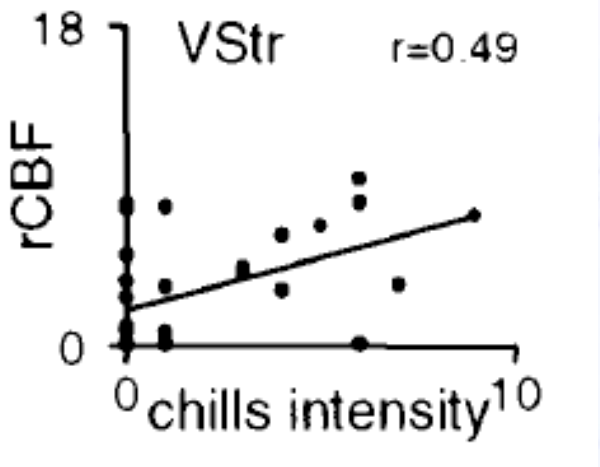
Jugements *Indices corporelles*

Effets indirects

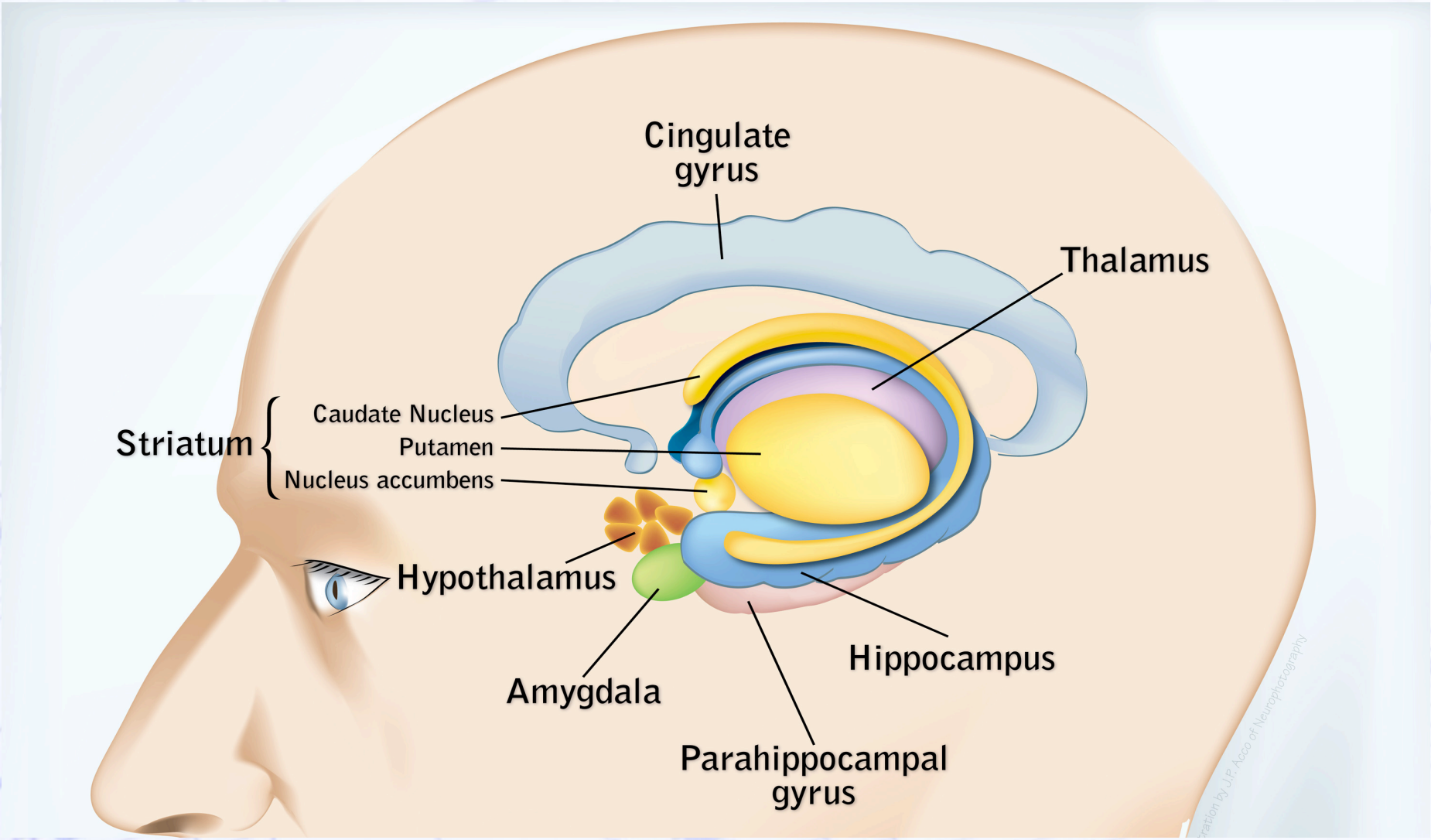
Music activates similar brain structures to other euphoria-inducing stimuli

- ✓ Cerebral blood flow measured (by PET) in response to self-selected music that elicits "chills"
- ✓ As intensity of chills increases, CBF increases in the brain regions related to reward/motivation (e.g., ventral striatum)
- ✓ Same brain structures respond to other euphoria-inducing stimuli (chocolate, sex, cocaine)
- ✓





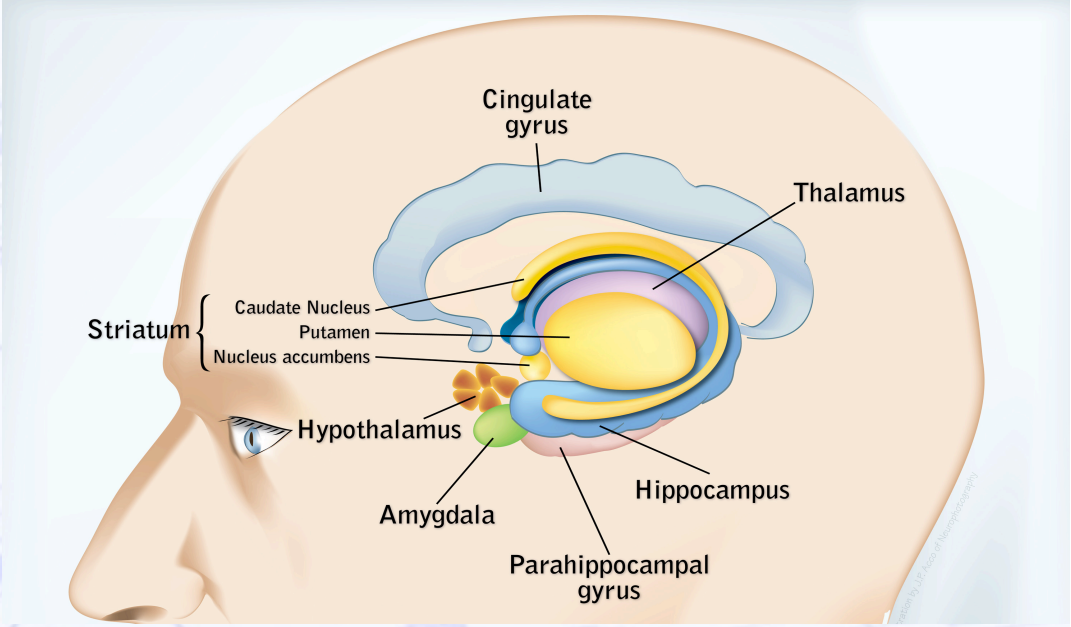
Blood & Zatorre (2001) PNAS



Ventral striatum related to opioid-mediated reward, to dopamin-mediated motivation

The amygdala and perception of danger

- Conditioned fear in both rats and humans
- Uncontrollable rage reactions in both animals and humans
- Recognition of fearful expressions in faces
- Recognition of fearful vocal expressions (screams, yells) and speech prosody. *Not always.*



Scary music recruits similar brain structures (the amygdala) as other fear-related stimuli

In collaboration with

Nathalie Gosselin
PhD thesis

Séverine Samson
Lille-Paris

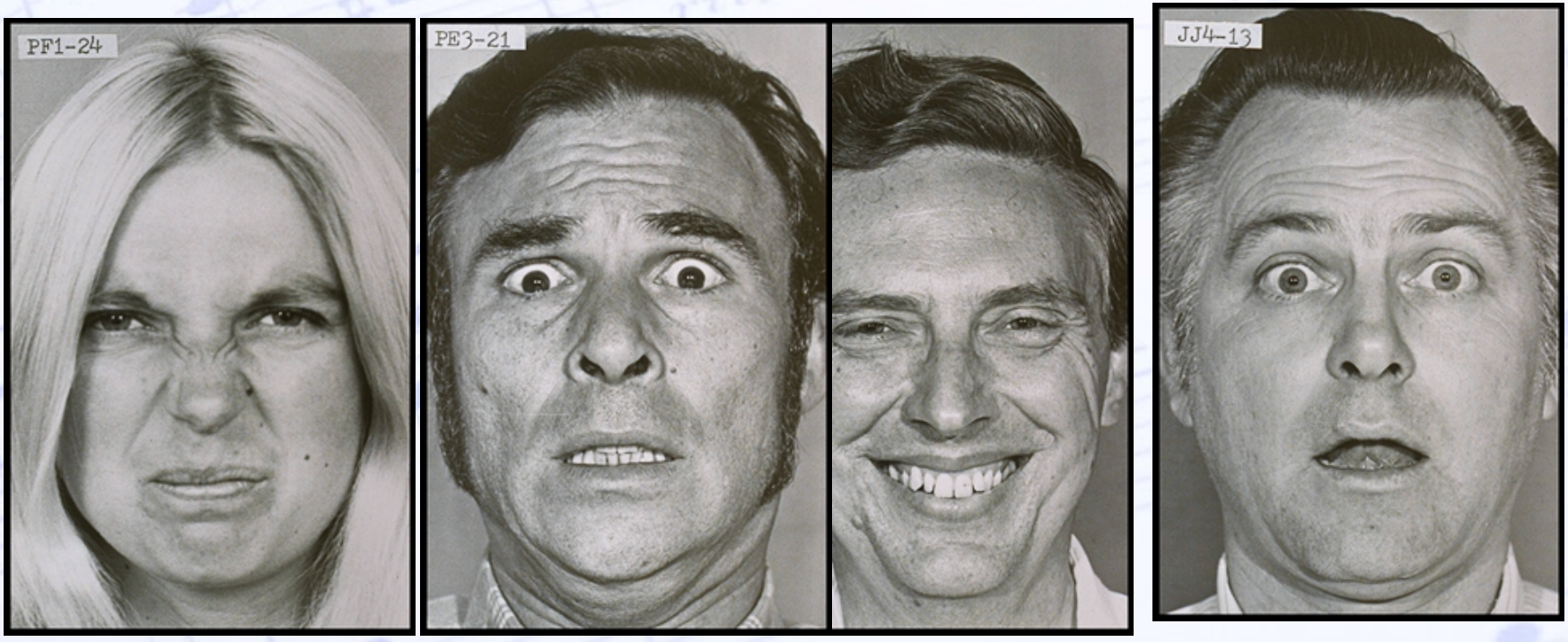
Ralph Adolphs
U. of Iowa, Caltech

The power of music

Courtoisie de Daniele Schön, 2007

La méthode d'évaluation standard

Ekman's faces:
gaieté, surprise, peur, tristesse, colère et dégout



Musical clips for research

- Non-familier, conventionnel
- Inspiré de musique de films
- Écrit pour le piano
- Exécuté par un ordinateur

joyeux

triste

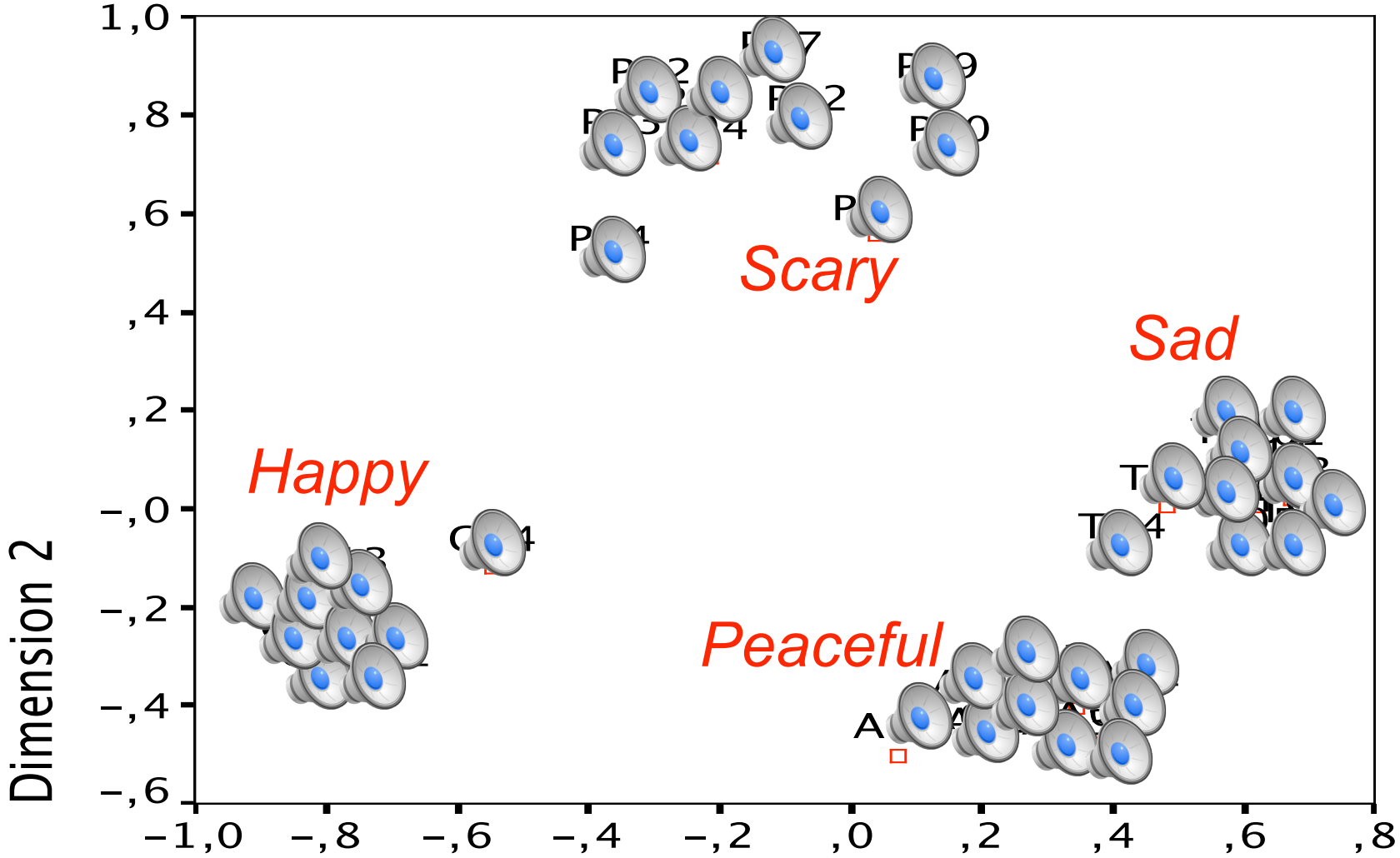
inquiétant

apaisant

Vieillard, Peretz, Gosselin et al. (2008) Emotion & Cognition

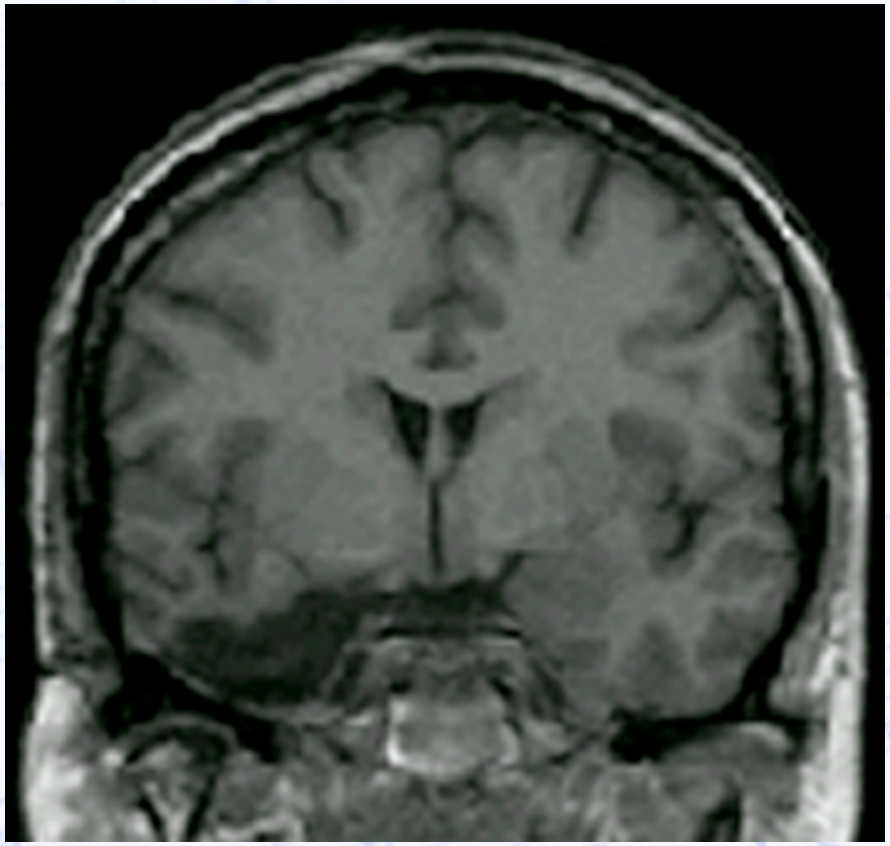
Les clips peuvent être téléchargés librement

www.umontreal.brams.ca/peretz



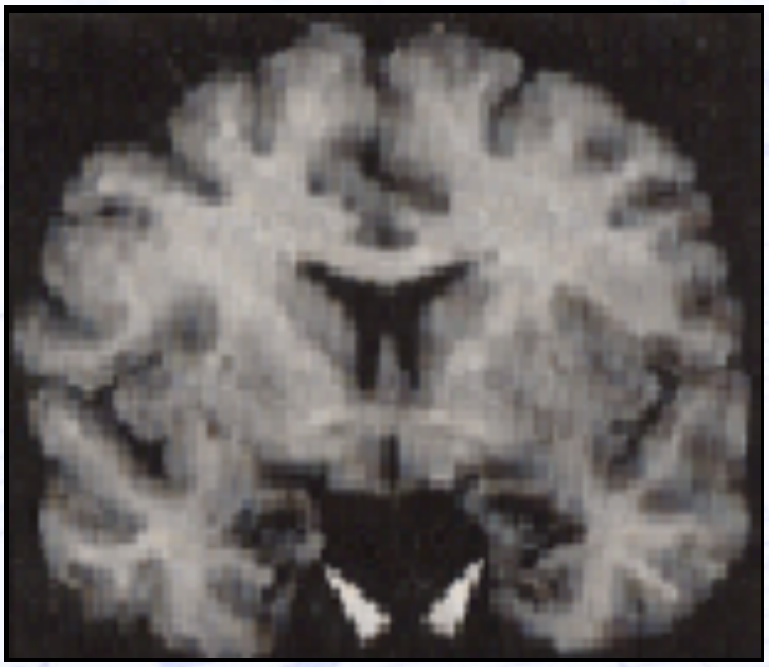
Vieillard et al (2008) Emotion & Cognition

Musique, amygdale, et peur



Unilateral resection in 16 epileptic patients

SM



Case of Adolphs, Damasio & Tranel

Gosselin et al (2005) Brain; Gosselin et al (2007) Neuropsychologia

Music, the amygdala, and fear

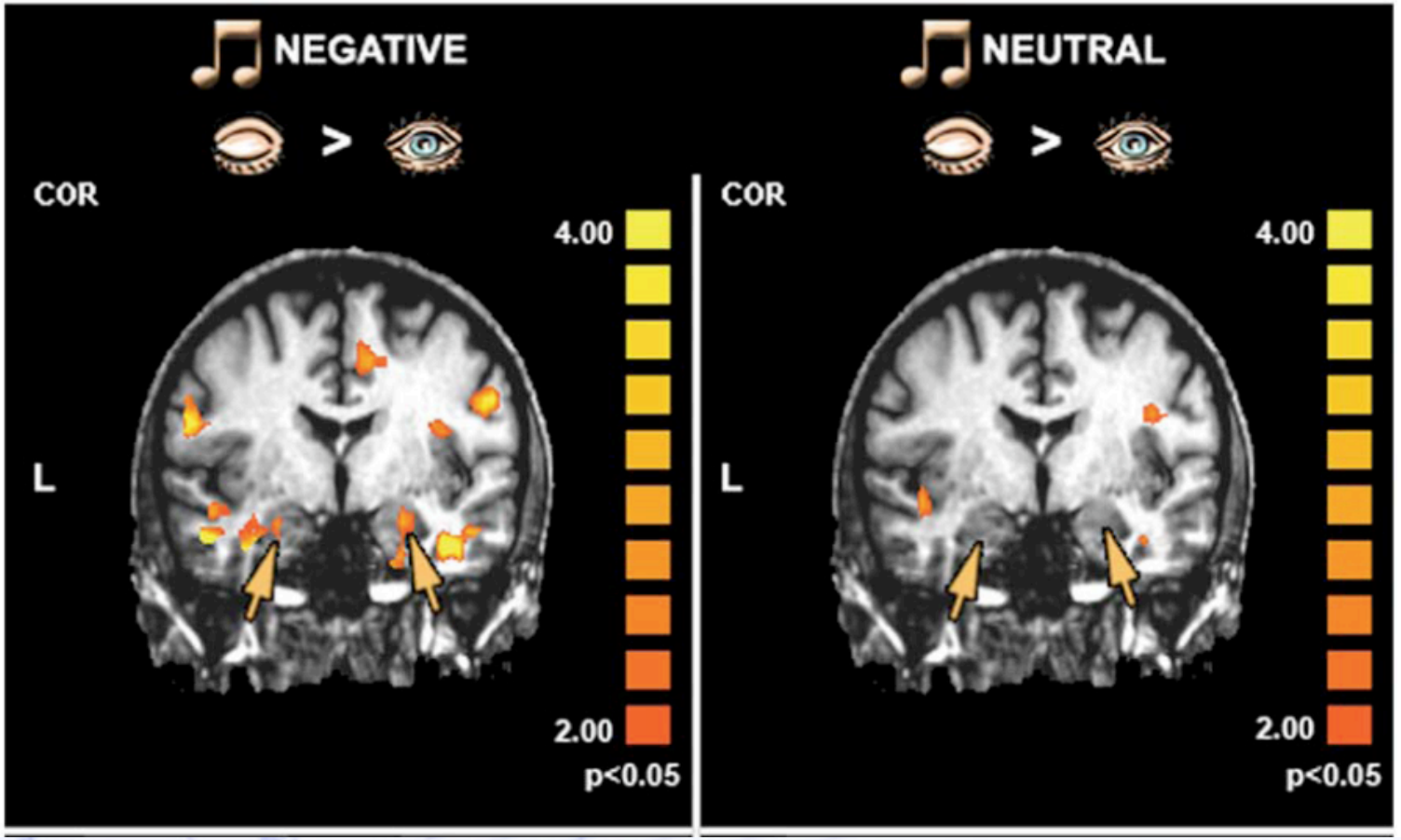
Gosselin et al (2005) Brain; Gosselin et al (2007) Neuropsychologia

OPEN ACCESS Freely available online

PLoS one

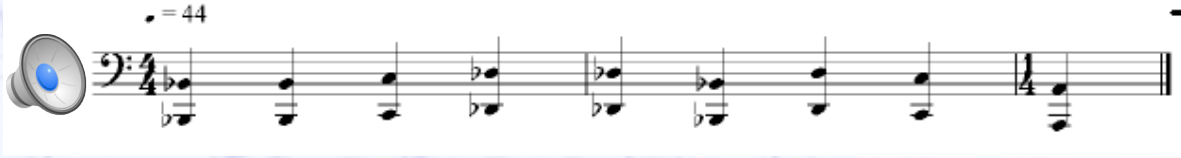
Eyes Wide Shut: Amygdala Mediates Eyes-Closed Effect on Emotional Experience with Music

Yulia Lerner[1,2], David Papo[2], Andrey Zhdanov[2], Libi Belozersky[2], Talma Hendler[2,3]*

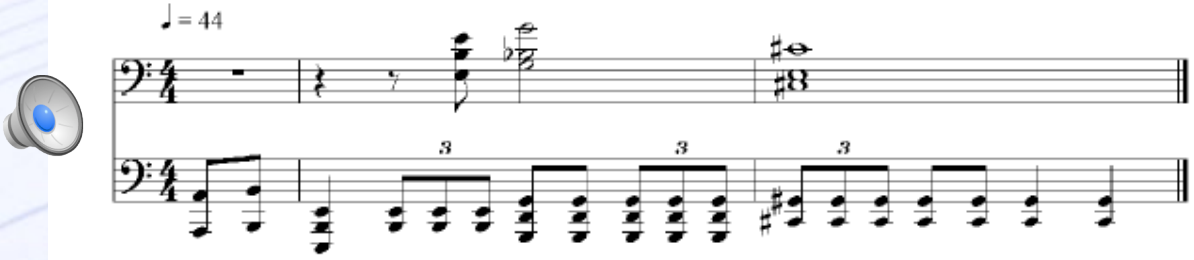


- Dissonance ?
- irrégularité ?

No correlations with judgments



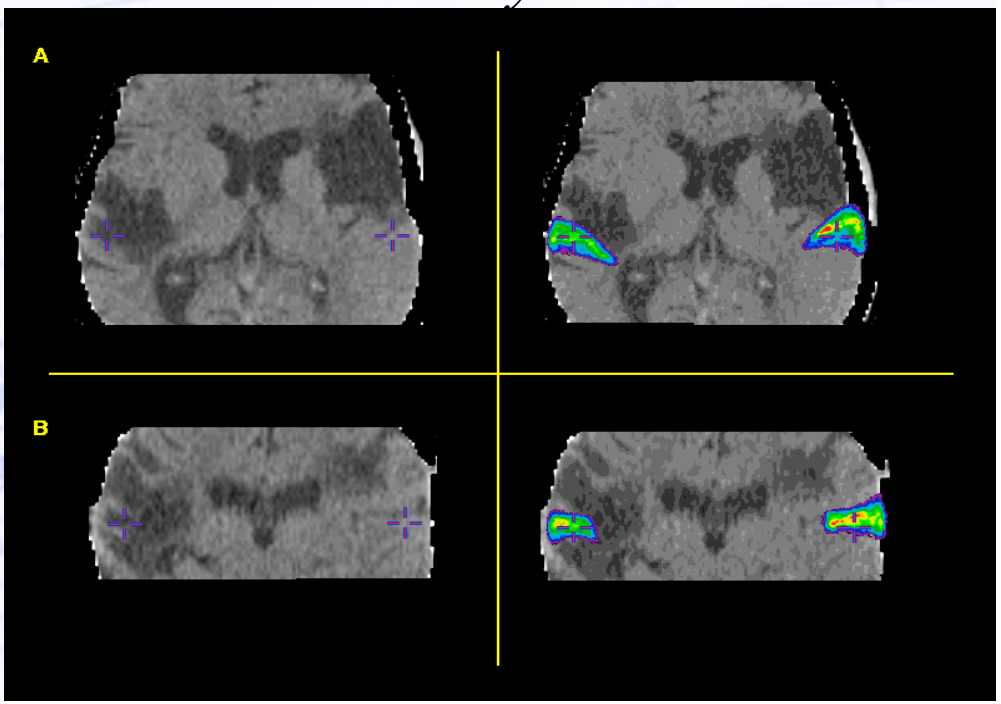
Ratings (1-5)		
Dissonance	*Expected*	Regular
1	1	1

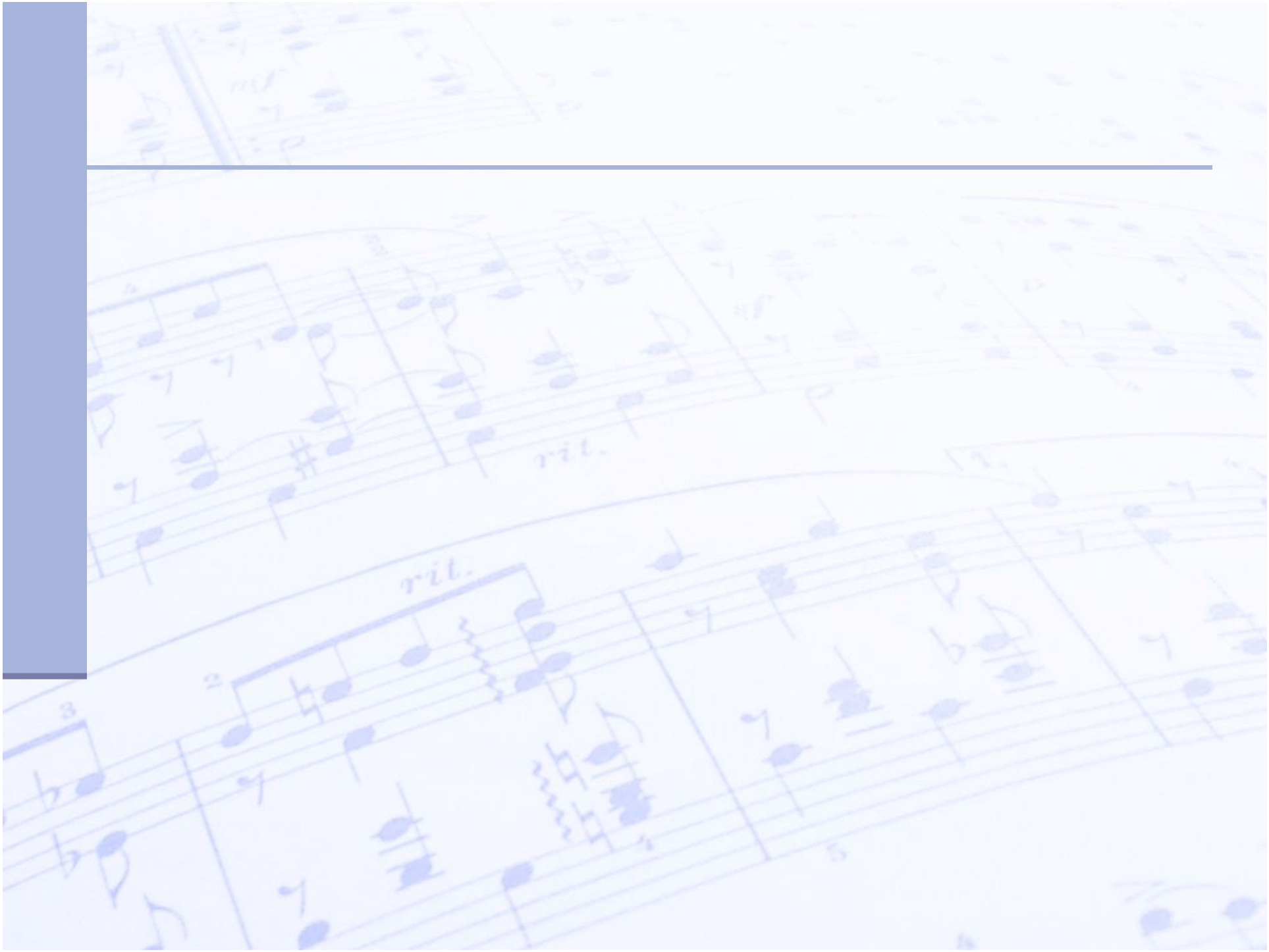


4	5	4

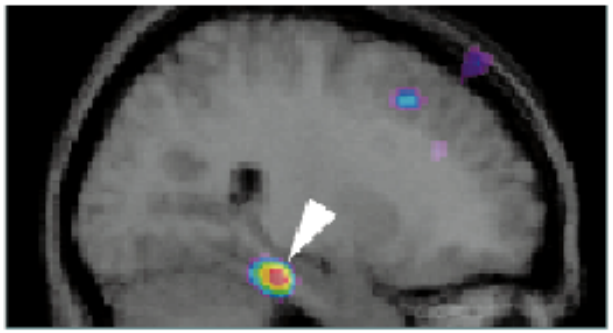
Dissonance requires cortical mediation

As a result of bilateral lesions to the auditory cortex



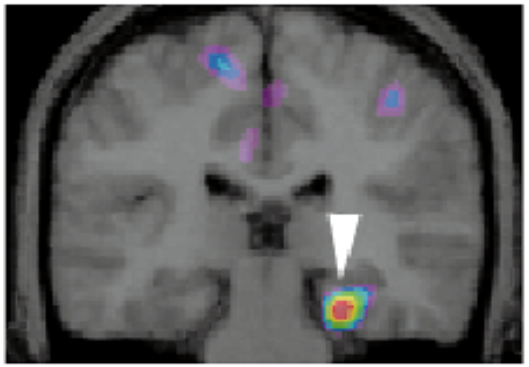


a



x=25

b



y=-28

Table 1. Regression of rCBF with dissonance level.

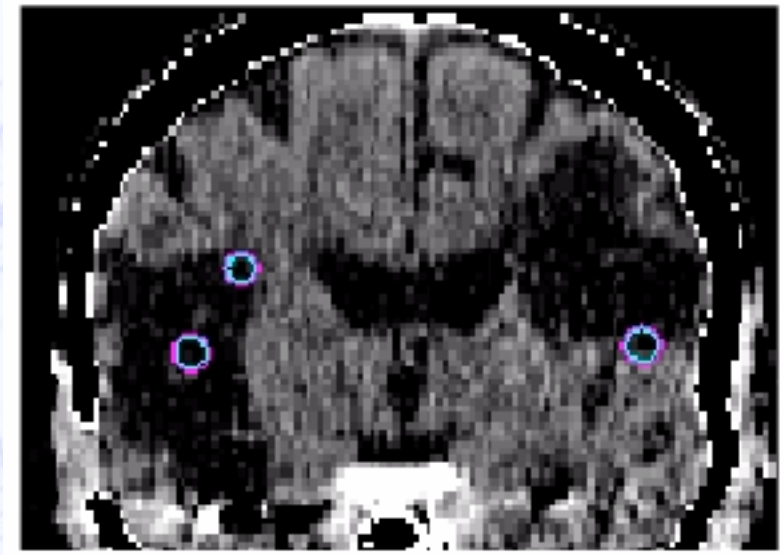
Region	Brodmann Area	Coordinates x	y	z
Positive Correlations				
R. parahippocampal gyrus	28/36	25	−28	−21

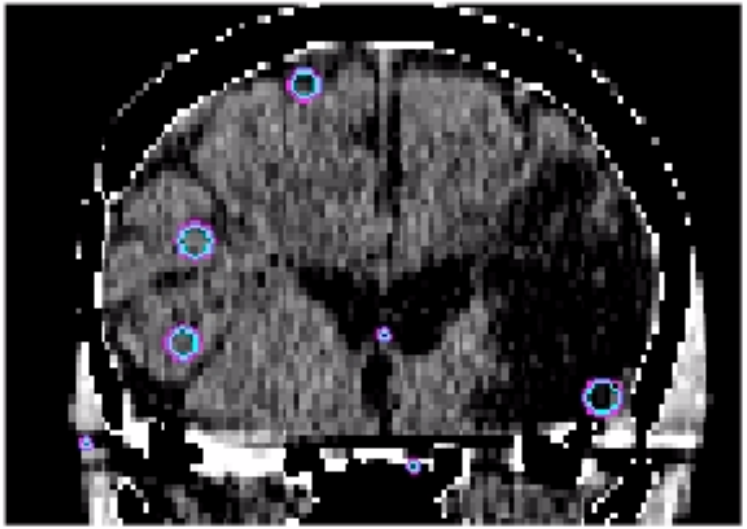
Emotional responses to pleasant and unpleasant music correlate with activity in paralimbic brain regions

Anne J. Blood, Robert J. Zatorre, Patrick Bermudez and Alan C. Evans

nature *neuroscience* • volume 2 no 4 • april 1999

Brain mapping of I.R.'s lesions and PET activation areas



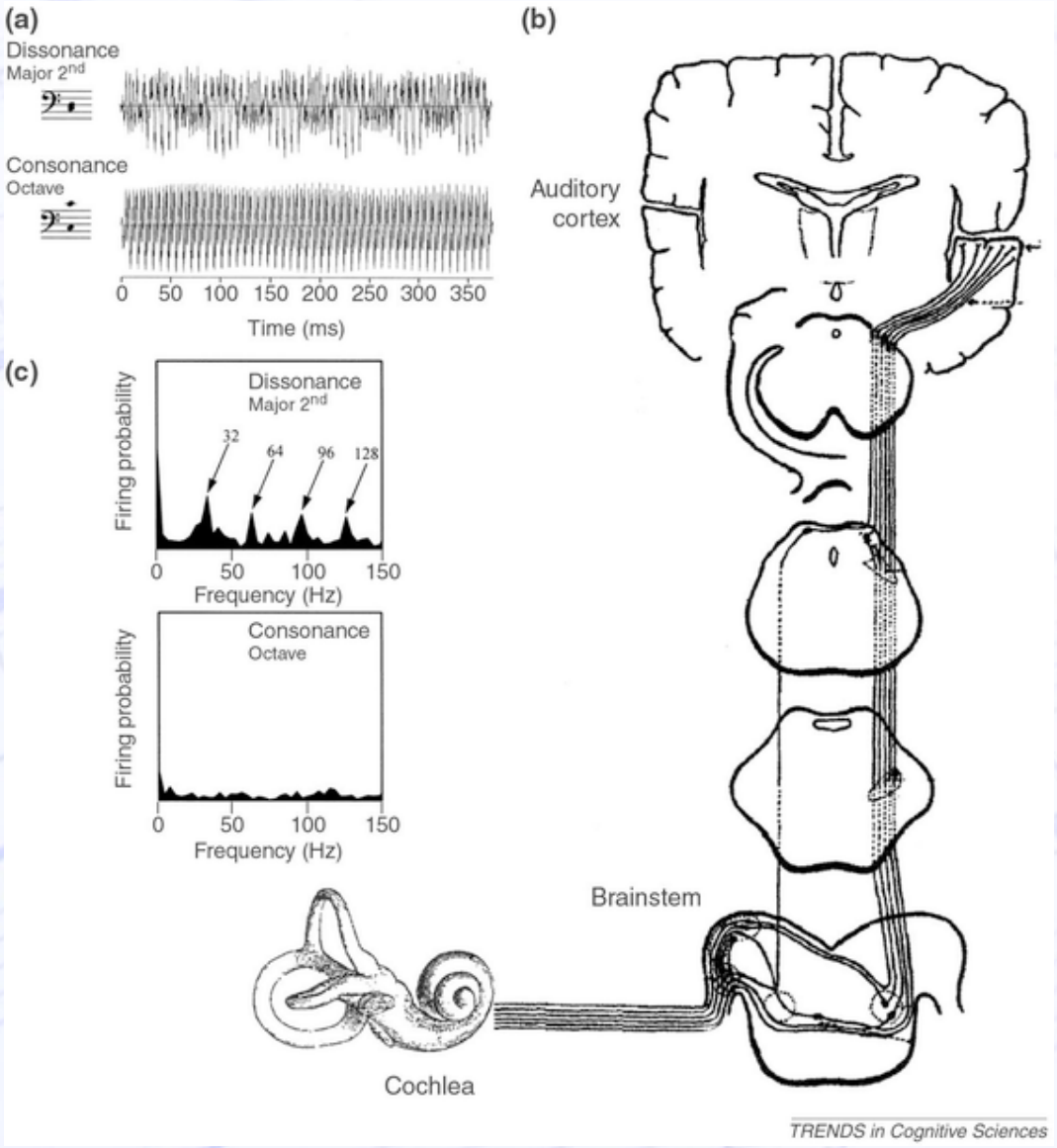


Perceptual areas:

average of all musical conditions (cons.+ diss.) - noise

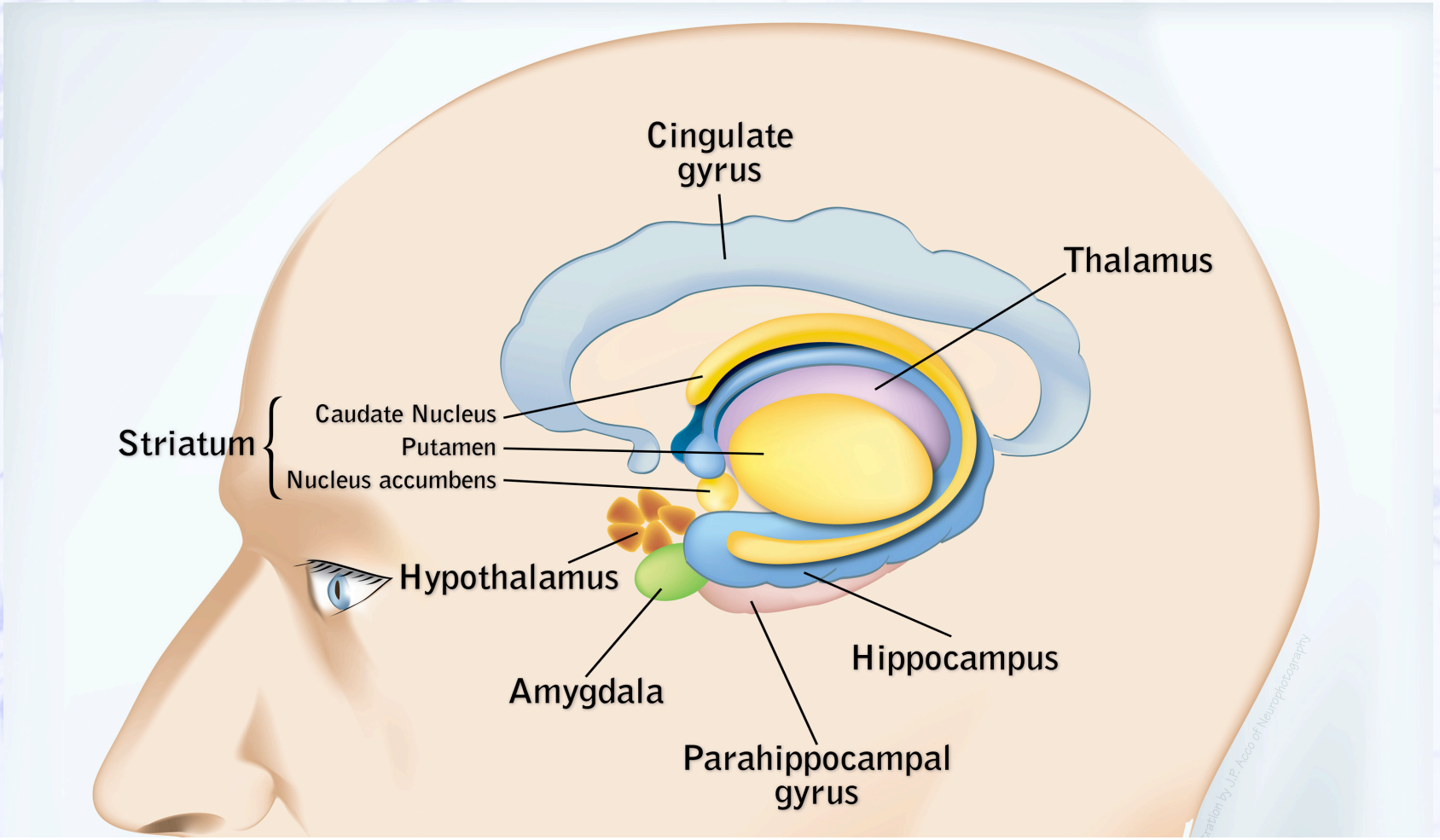
Peretz, Blood, Penhune & Zatorre (2001) *Brain.*

Different firing for dissonance in the auditory cortex



From: Fishman et al. (2001) J. of Neurophysiology

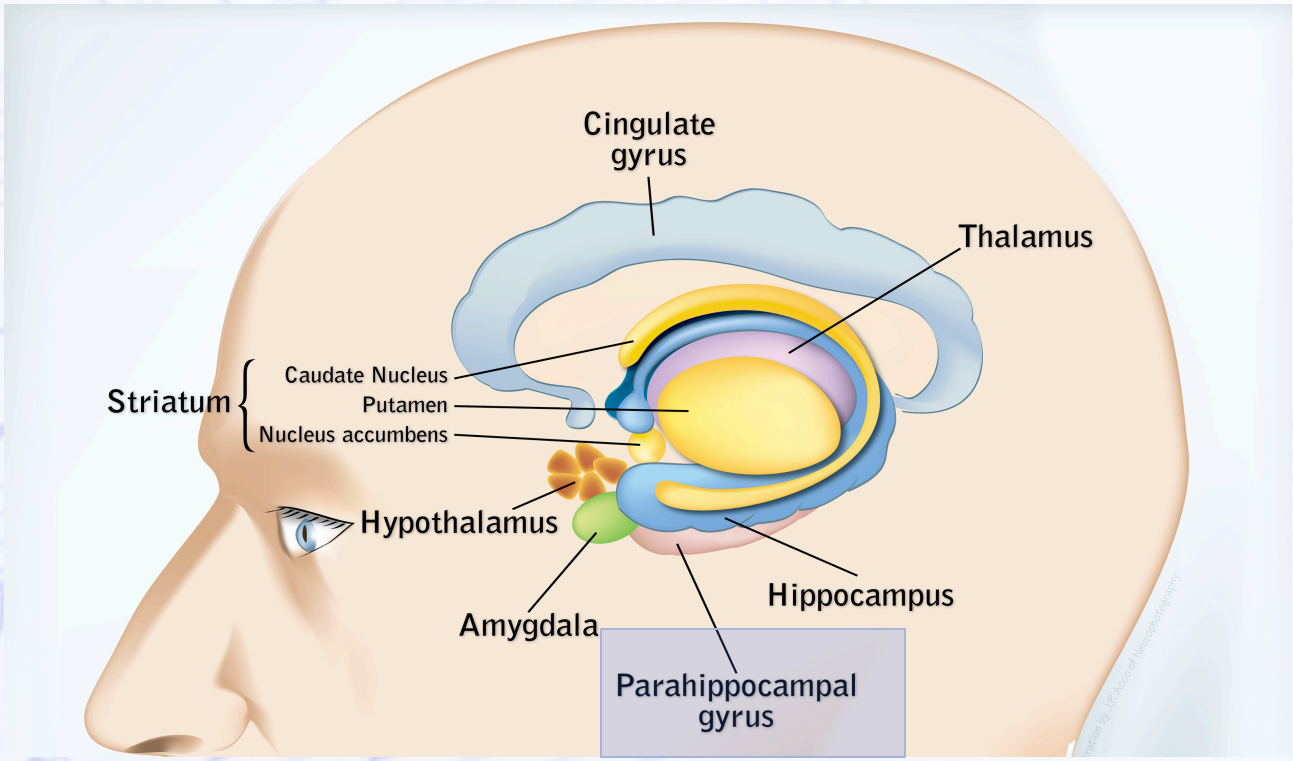
Cortical mediation



doi:10.1093/brain/awl240 *Brain* (2006), **129**, 2585–2592

Emotional responses to unpleasant music correlates with damage to the parahippocampal cortex

Nathalie Gosselin,[1] Séverine Samson,[2,3,6] Ralph Adolphs,[7] Marion Noulhiane,[3,6] Mathieu Roy,[1] Dominique Hasboun,[3,4] Michel Baulac[2,5] and Isabelle Peretz[1]



Emotional evaluation of dissonance

- Same pool of classical excerpts (half “happy”, half “sad”).Half in their original (consonant) version; half in a dissonant version. Dissonance was created by shifting the melodic voice by 1 semitone.

Vivaldi (consonant)

Haendel (consonant)

Vivaldi (dissonant)

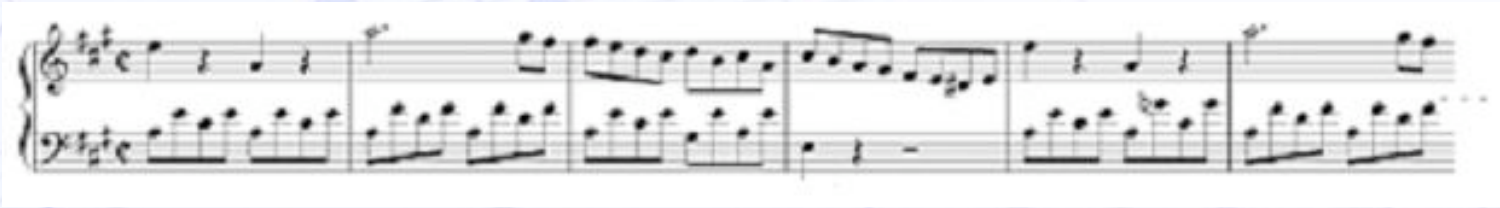
Haendel (dissonant)

- Emotional responses to dissonance are typically expressed in “pleasant-unpleasant” judgments

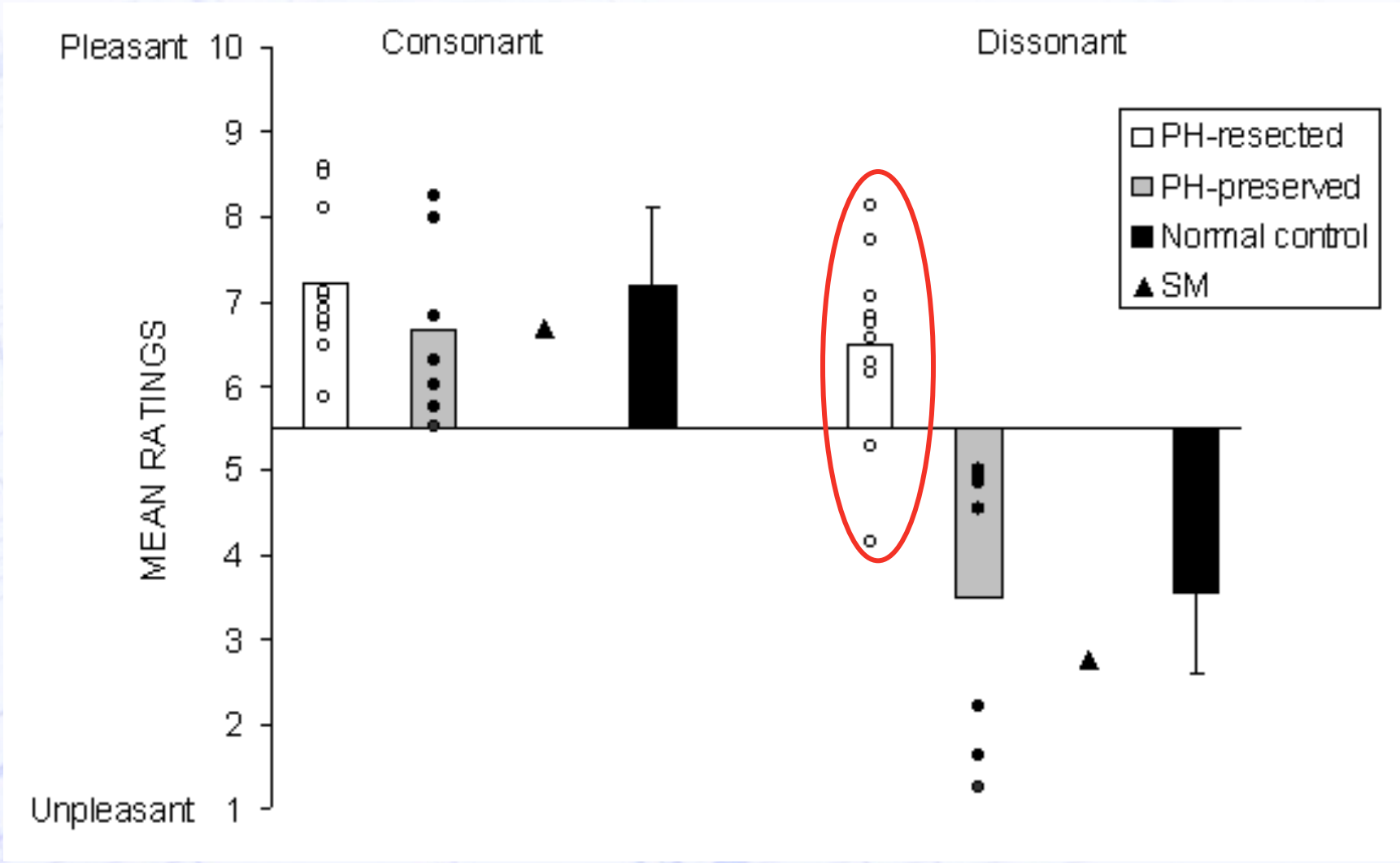
judgments on a 10 point-scale + “Happy-sad” judgments, as a control task.

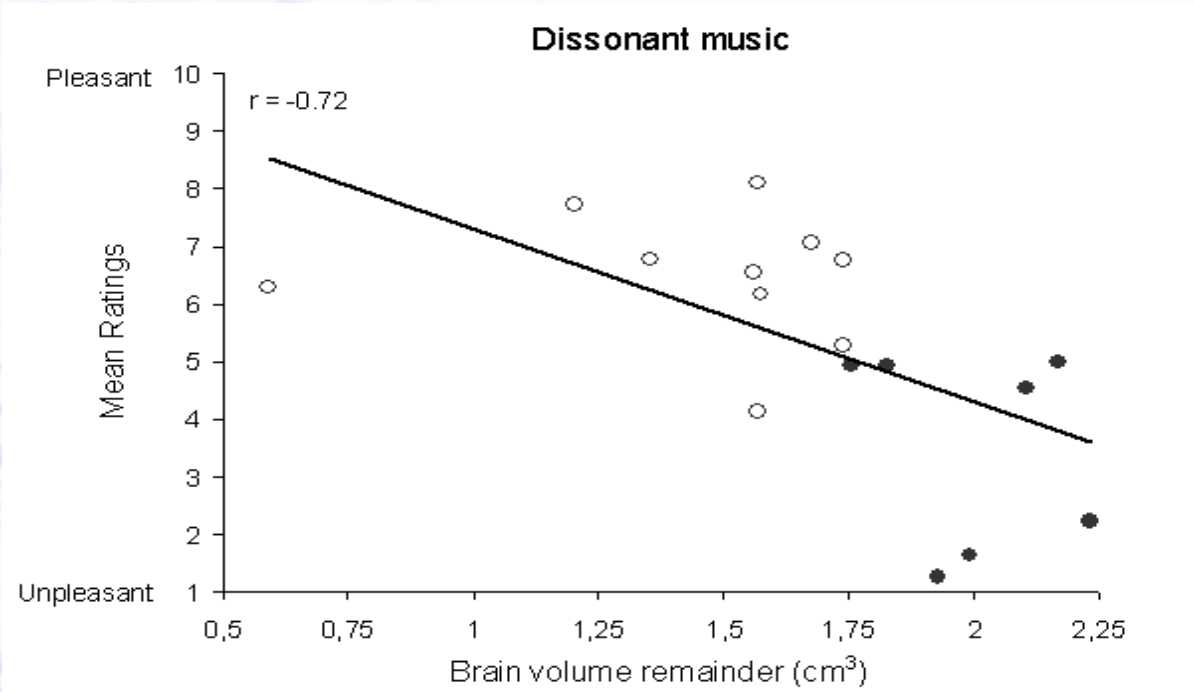
Perceptual task

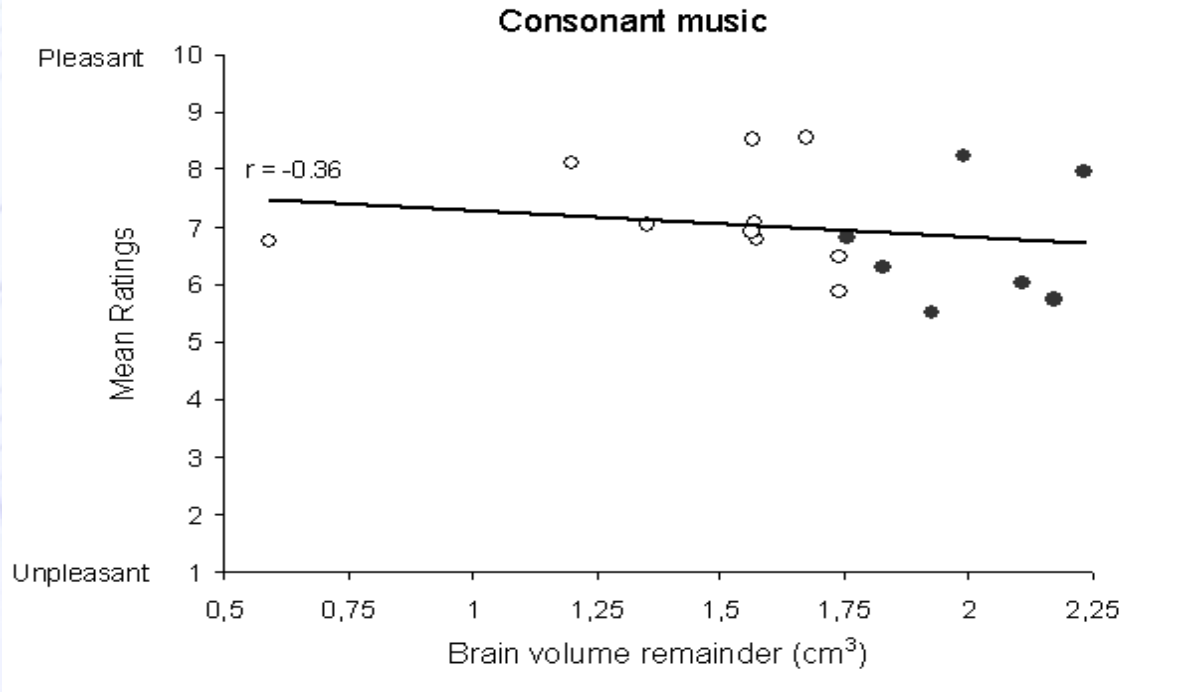
Error detection task



All subjects performed equally well on this task


Pleasant
Unpleasant
10
9
8
7
6
5
4
3
2
1
MEAN RATINGS
Consonant
Dissonant
PH-resected
PH-preserved
Normal control
SM


Dissonant music
Pleasant
Unpleasant
r = -0.72
Mean Ratings
10
9
8
7
6
5
4
3
2
1
0,5
0,75
1
1,25
1,5
1,75
2
2,25
Brain volume remainder (cm3)


Consonant music
Pleasant
Unpleasant
r = -0.36
Mean Ratings
10
9
8
7
6
5
4
3
2
1
0,5
0,75
1
1,25
1,5
1,75
2
2,25
Brain volume remainder (cm3)

L'évitement de la dissonance

- ✓ Réponse innée chez l'humain (e.g. Masataka, 2006)
- ✓ Spécifique à l'humain (McDermott & Hauser, 2004)
- ✓ Apparenté aux cris de détresse ?

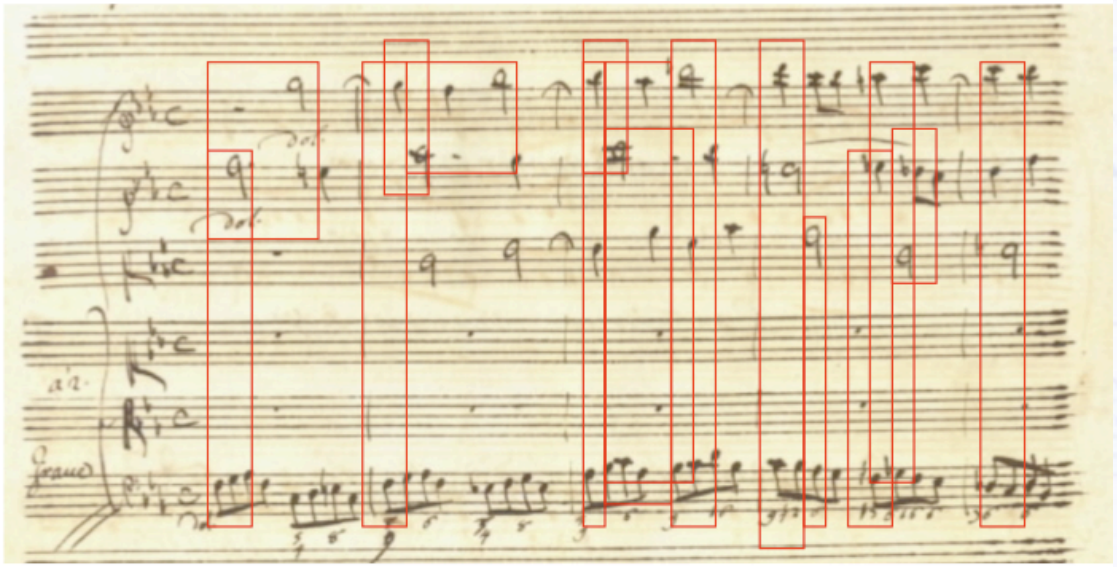


Figure 33 : Premières mesures du Stabat Mater Dolorosa de Pergolèse (1736).

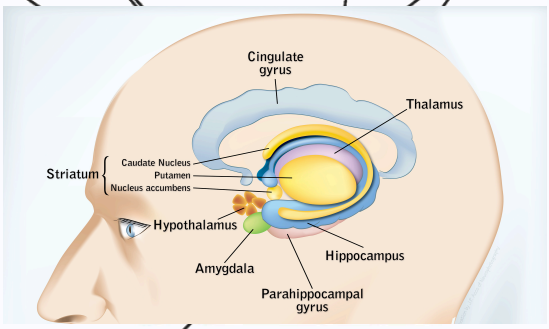
En rouge, intervalles de seconde qui, joués, isolément sont dissonants.

Courtoisie de Delphine Dellacherie

Peretz (2008) *Behavioral & Brain Science*

ETIOLOGY

Gene 1 | Gene 2 | Gene 3 | Env. 1 | Env. 2 | Env. 3



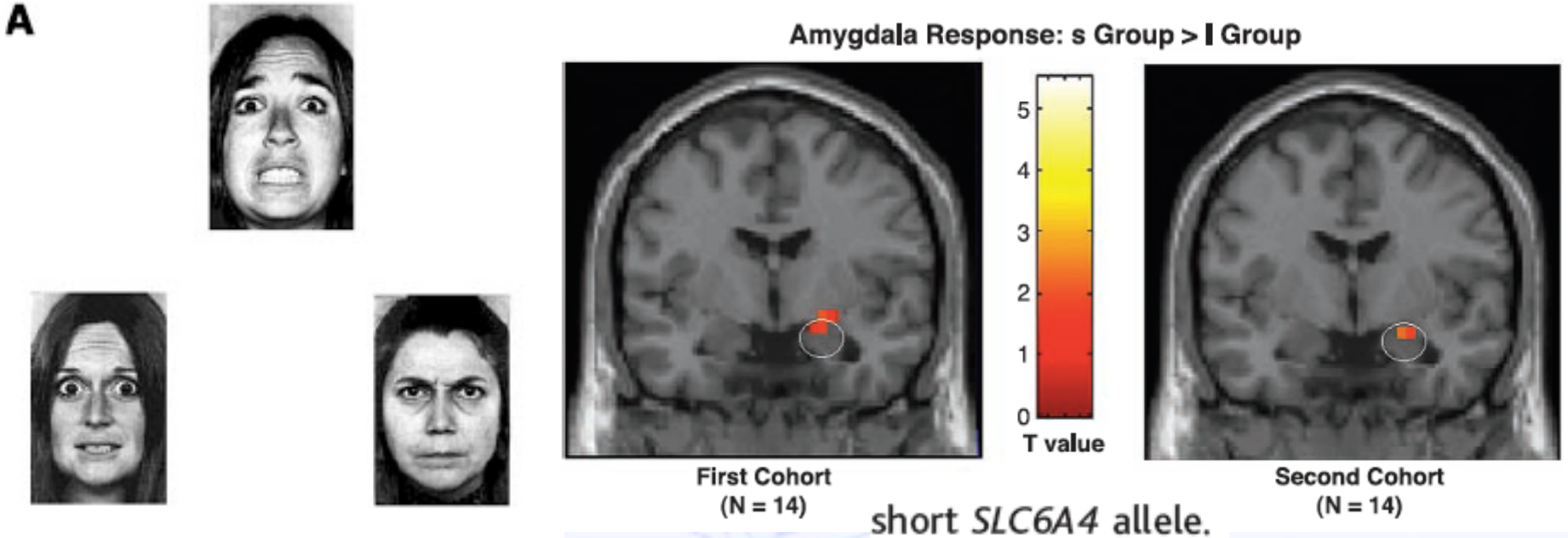
BRAIN

COGNITION

BEHAVIOR

Serotonin Transporter Genetic Variation and the Response of the Human Amygdala

Ahmad R. Hariri,[1] Venkata S. Mattay,[1] Alessandro Tessitore,[1] Bhaskar Kolachana,[1] Francesco Fera,[1] David Goldman,[2] Michael F. Egan,[1] Daniel R. Weinberger[1]*



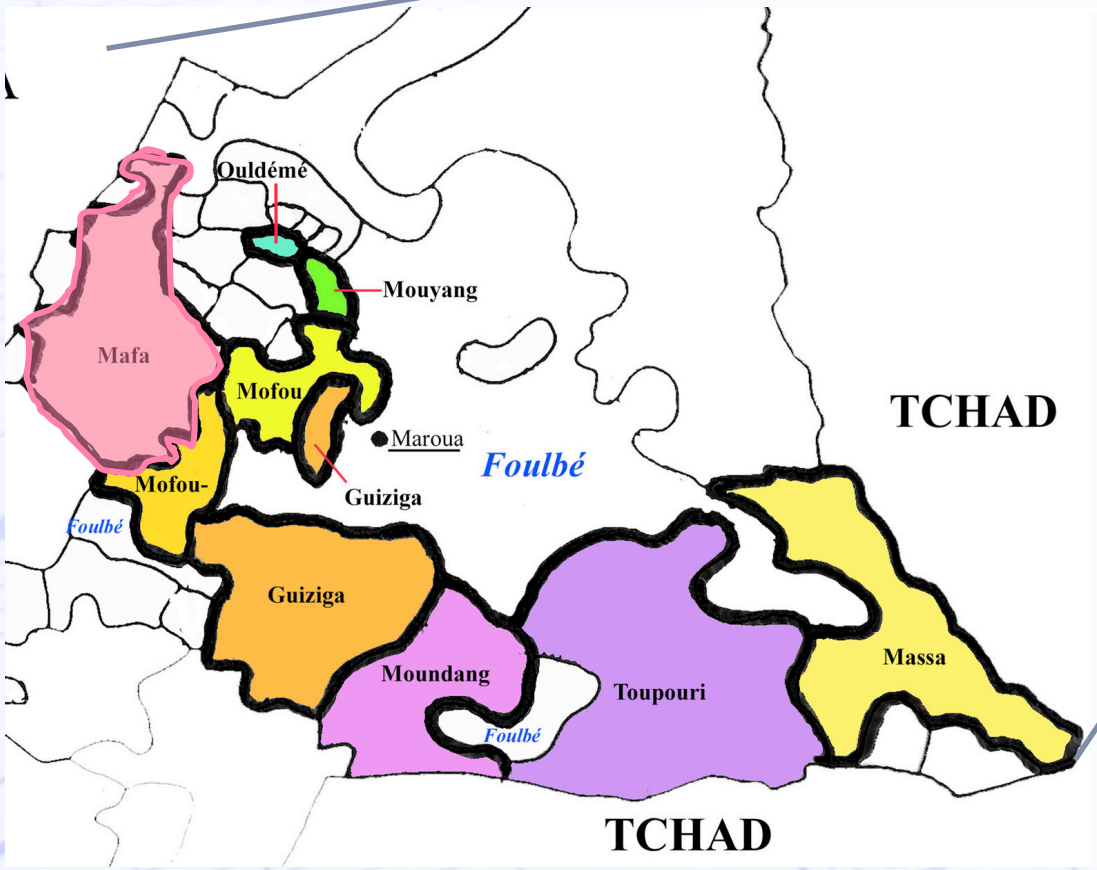
short *SLC6A4* allele.

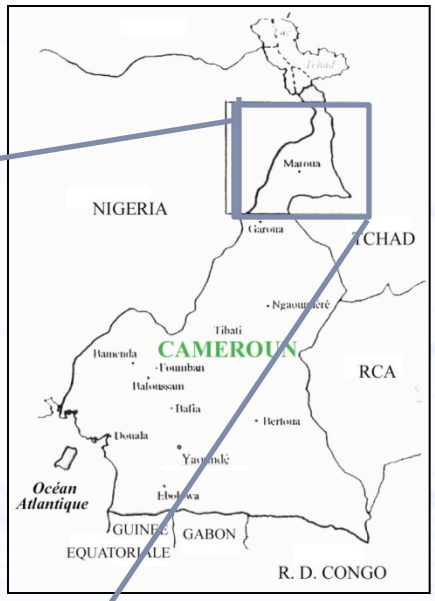
SCIENCE VOL 297 19 JULY 2002

Influence de l'environnement (culture)

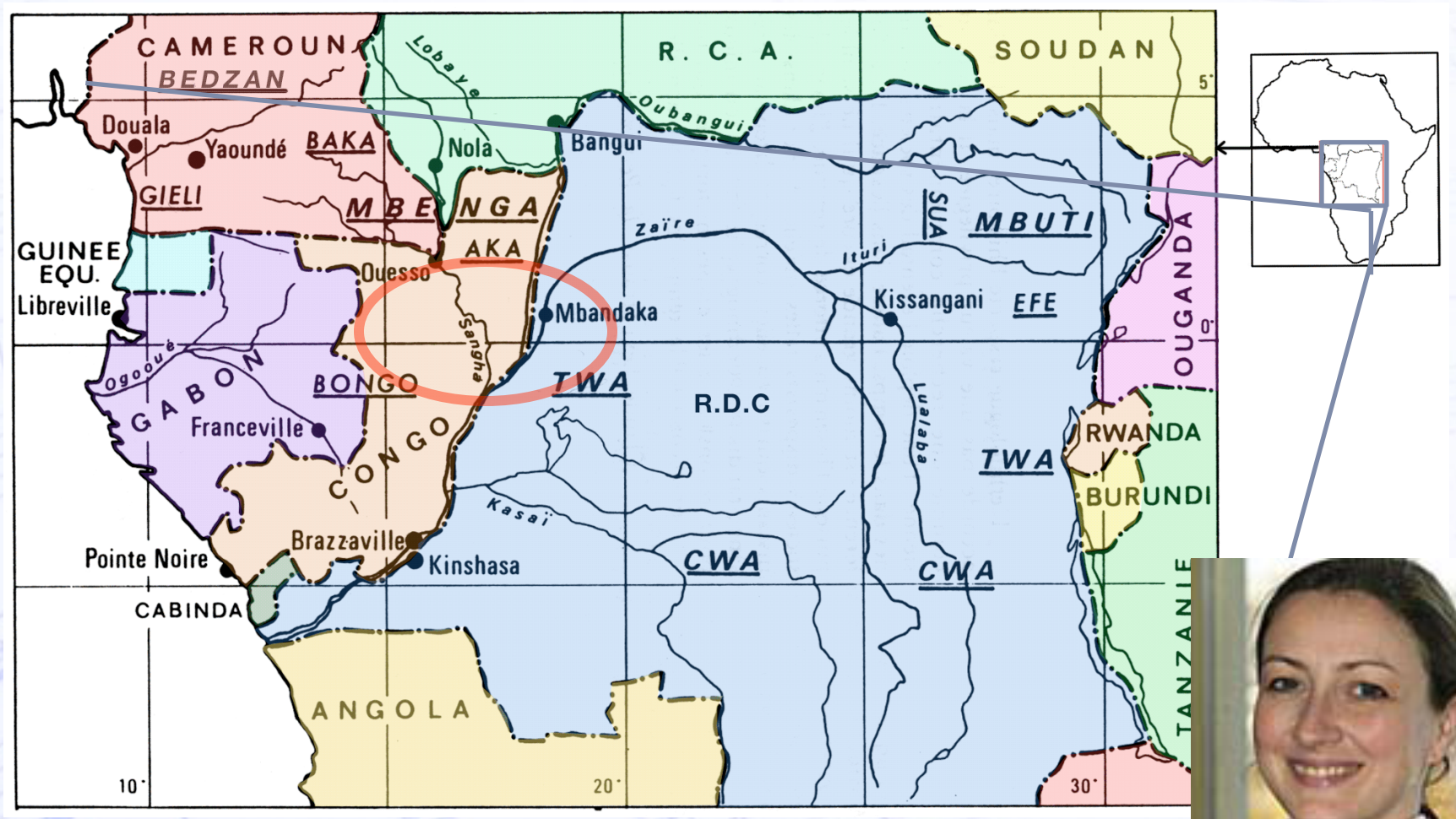
à la recherche des universaux

Fritz et al. (2009) *Current Biology*


Ouldémé
Mouyang
Mafa
Mofou
Maroua
Foulbé
TCHAD
Mofou-
Foulbé
Guiziga
Guiziga
Moundang
Toupouri
Massa
Foulbé
TCHAD

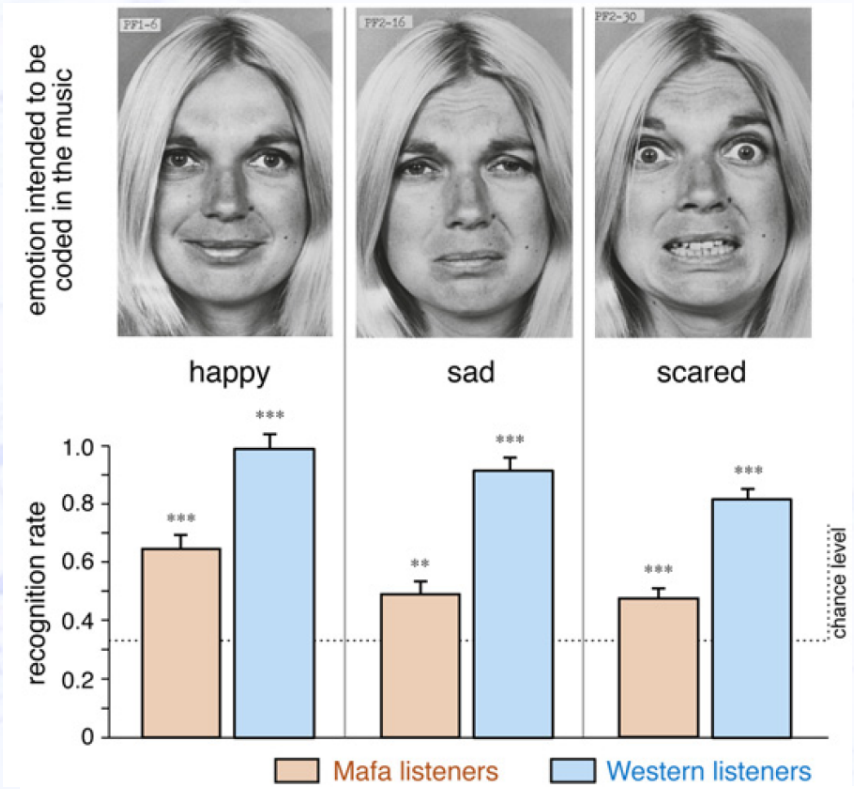

Maroua
NIGERIA
Garoua
TCHAD
Ngaoundéré
Tibati
Bamenda
CAMEROUN
Foumban
RCA
Baloumsam
Bafia
Douala
Bertoua
Yaoundé
Océan Atlantique
Ebolowa
GUINEE EQUATORIALE
GABON
R. D. CONGO

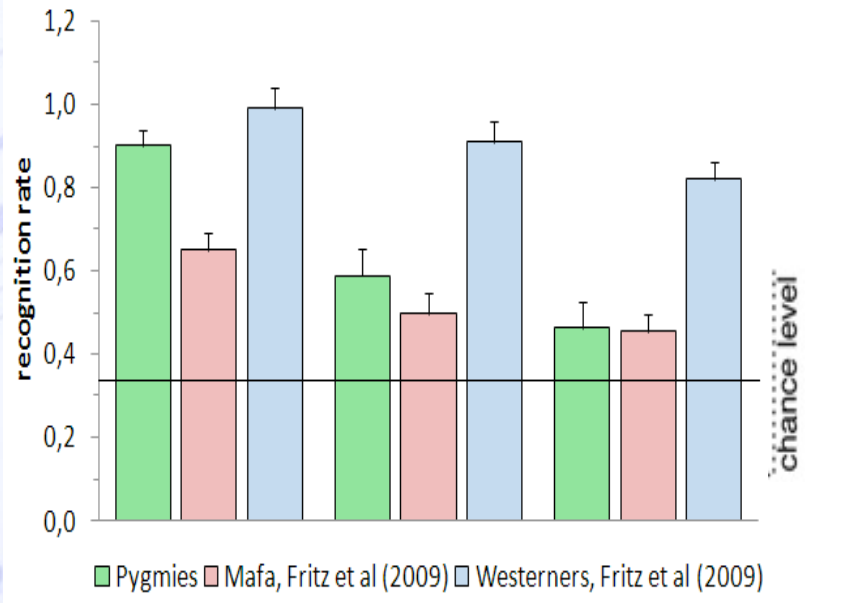
African pygmies (Mikaya) from North Congo



Nathalie Fernando

- Les Mikaya vivent dans la forêt (dite impénétrable)
  - Pas d'électricité
  - Relativement isolés de la culture occidentale.
- Leur musique est vocale (polyphonie) et percussive

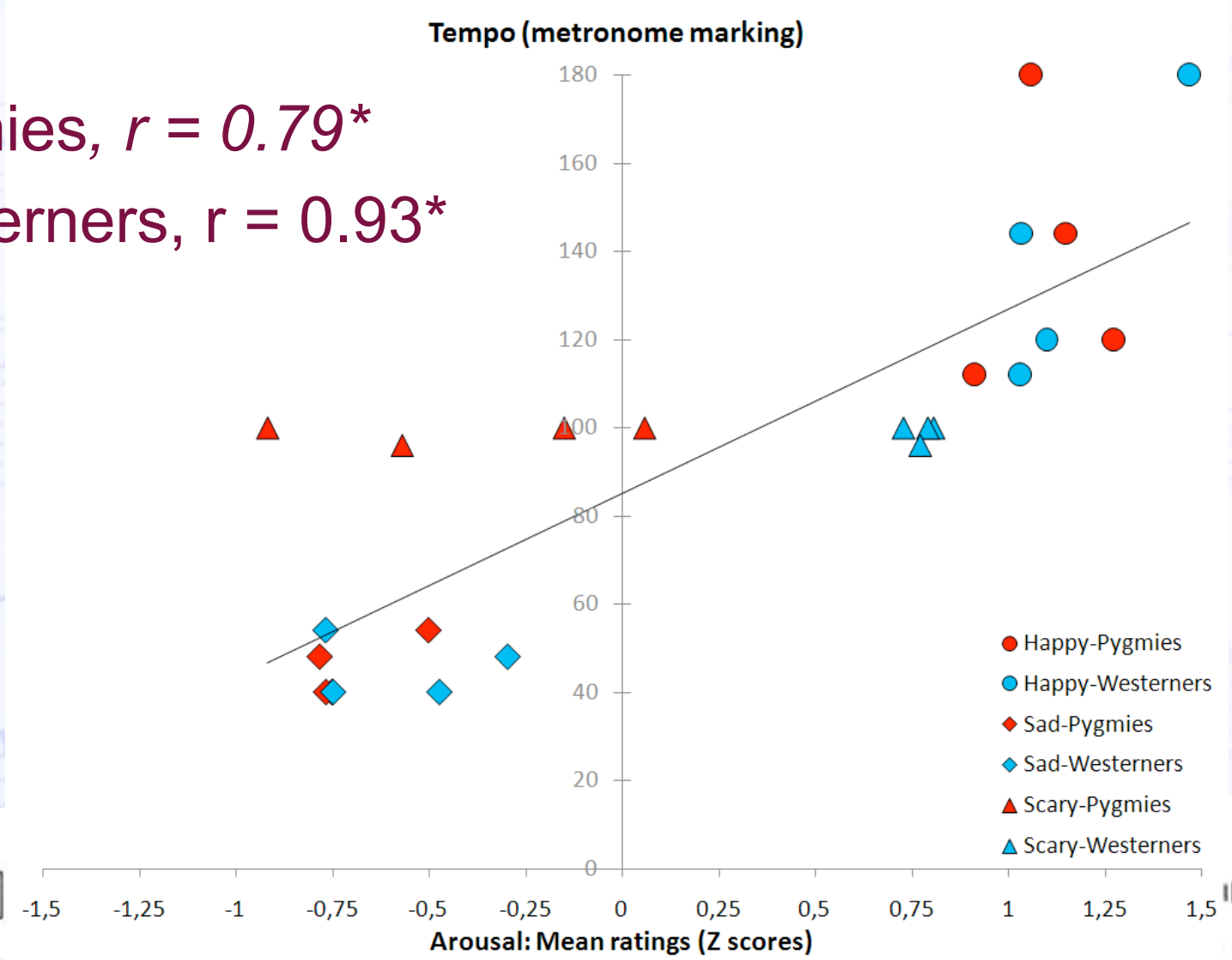

emotion intended to be coded in the music
happy
sad
scared
recognition rate
1.0
0.8
0.6
0.4
0.2
0
***
***
**
***
***
chance level
Mafa listeners
Western listeners

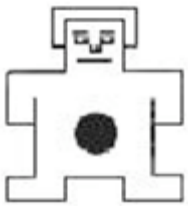

recognition rate
1,2
1,0
0,8
0,6
0,4
0,2
0,0
chance level
Pygmies
Mafa, Fritz et al (2009)
Westerners, Fritz et al (2009)

Correlation: Arousal ratings - tempo

Pygmies, *r = 0.79**

Westerners, r = 0.93*



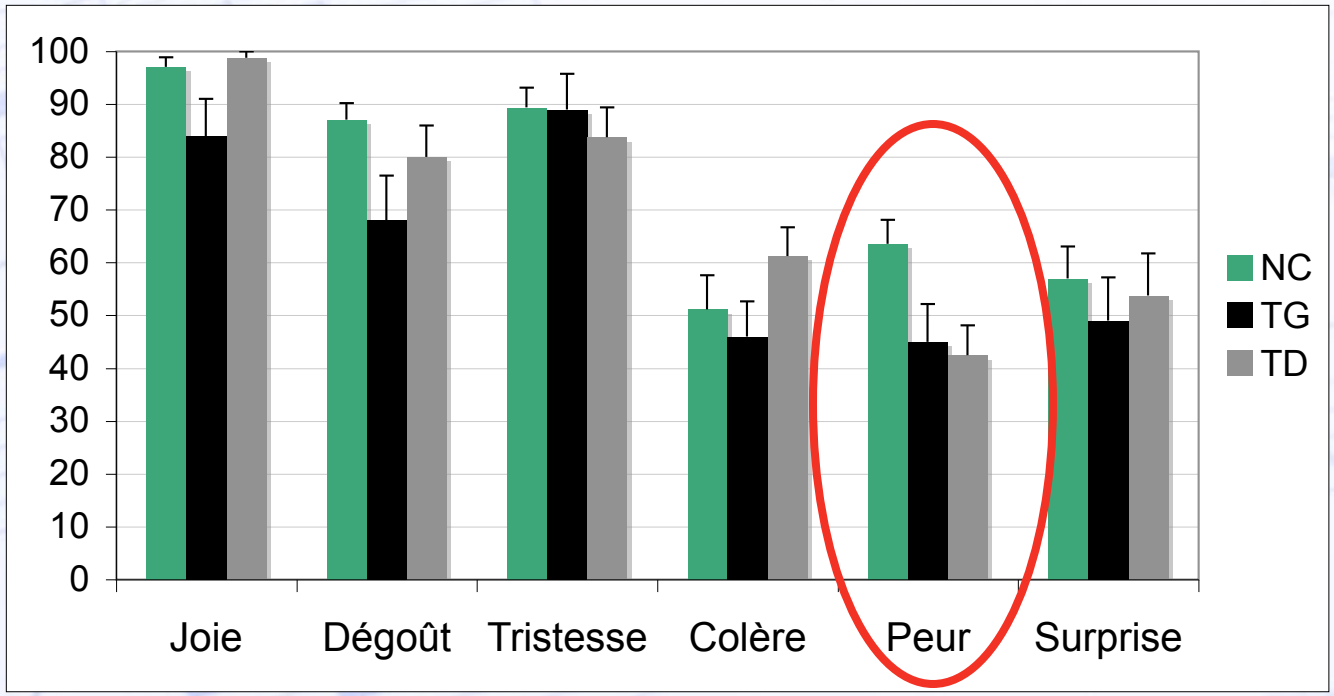


Psychological Bulletin
2003, Vol. 129, No. 5, 770–814

0033-2909/03/$12.00 DOI: 10.1037/0033-2909.129.5.770

Communication of Emotions in Vocal Expression and Music Performance: Different Channels, Same Code?

Patrik N. Juslin and Petri Laukka
Uppsala University

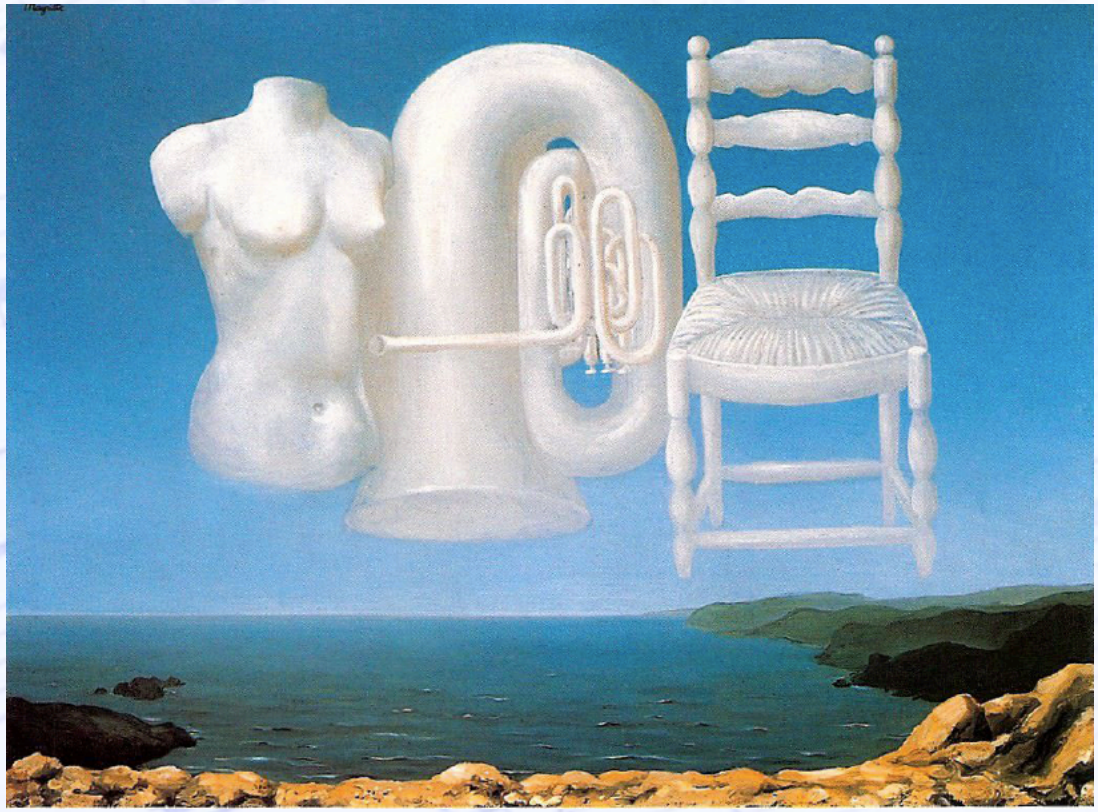


Dellacherie et al., in prep.

Cultural Recycling of Cortical Maps

Stanislas Dehaene[1,2,3,4,*] and Laurent Cohen[1,2,5,6]

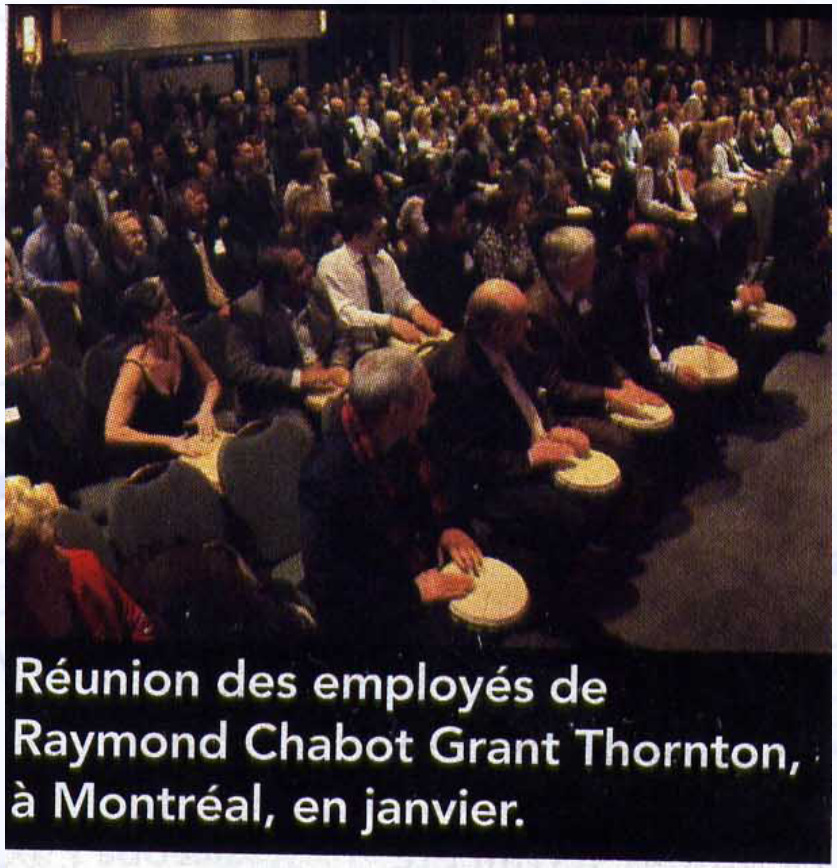
Neuron 56, October 25, 2007



Peretz, sous presse

Questions en cours et futures

- ✓ Comparaison des circuits neuronaux des émotions musicales et vocales (W. Aubé et J. Armony, en cours)
- ✓ Etude trans-culturelle du chant maternel (N. Fernando, en cours)
- ✓ Effet du contexte social (contagion)
- ✓ Intégration Multi-sensorielle des émotions



Réunion des employés de Raymond Chabot Grant Thornton, à Montréal, en janvier.

Pour plus d'information

www.brams.umontreal.ca/peretz

Et l'aide financière: