

# **Musique et cerveau**

***état des recherches actuelles et  
implications pour les métiers de la musique***

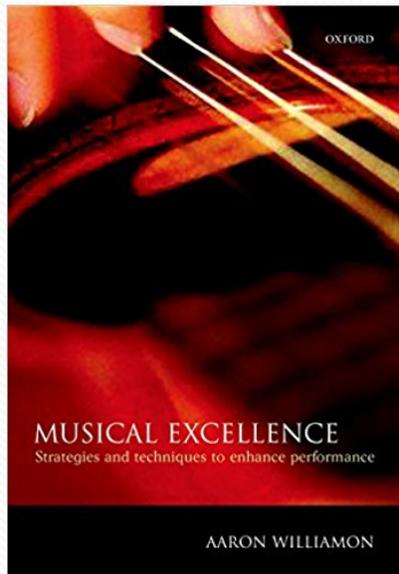


***La musique nous parle du cerveau,***

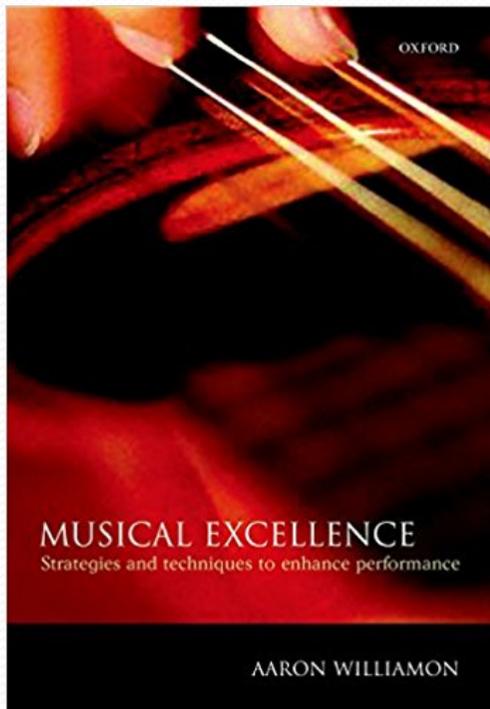
***et***

***l'effet qu'elle a sur le cerveau nous permet  
de mieux comprendre la musique***

# Musique ↔ Cerveau



# Musique et cerveau





Aaron  
Williamon





## Centre for Performance Science

Home >> Centre for Performance Science

[CPS Home](#) [About](#) [People](#) [Projects](#) [Courses](#) [Contact](#)

# CURRENT RESEARCH

## PERFORMANCE SIMULATOR





Clarinet 1 (Level 3)

## In the hall of the Mountain-King

E. Grieg arr T. Sexton

*Allegretto marcato e molto marcato* ♩ = 138

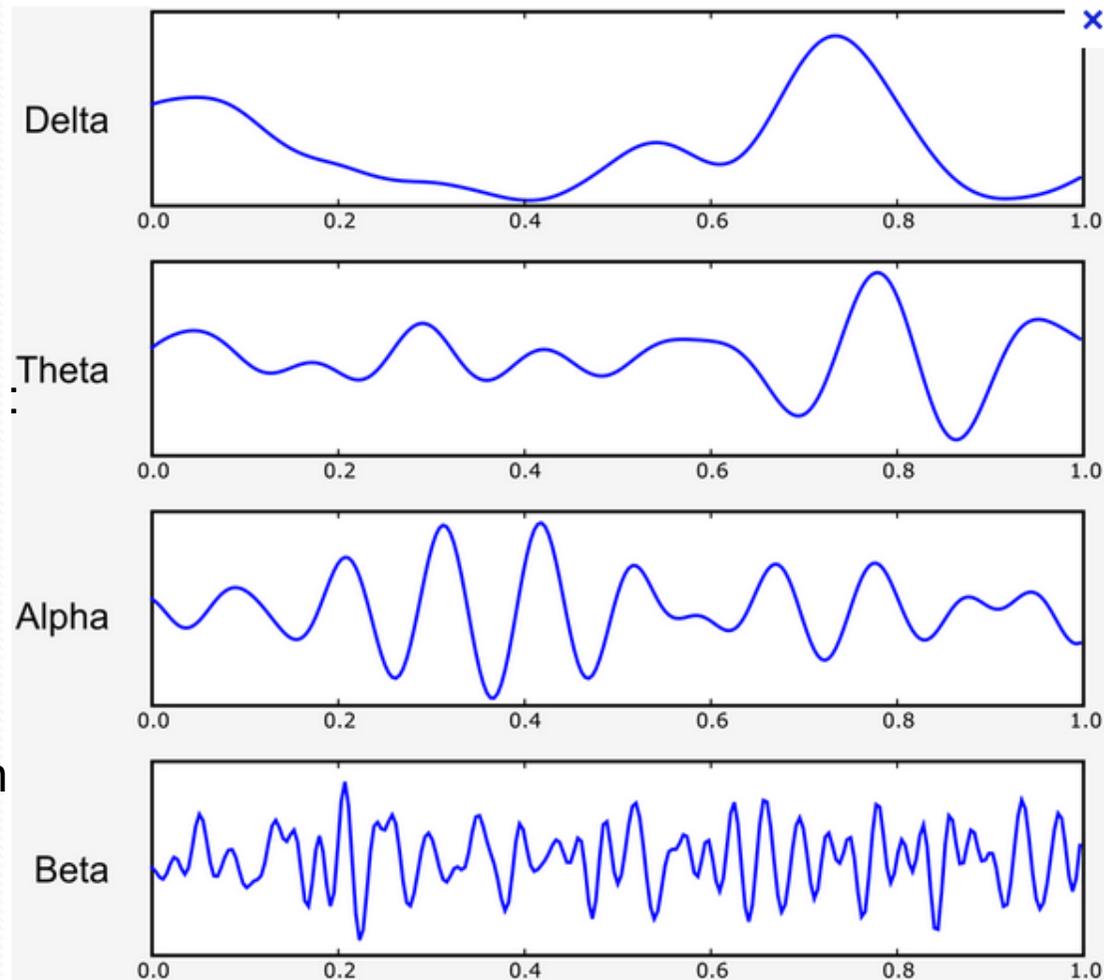
A

The first staff of musical notation is shown. It begins with a treble clef, a key signature of one flat (B-flat), and a common time signature (C). The first measure contains a whole rest. The second measure is a whole note chord consisting of a quarter rest followed by a quarter note G4. The third measure is a whole note chord consisting of a quarter rest followed by a quarter note A4. The fourth measure is a quarter note G4. The fifth measure is a quarter note A4. The sixth measure is a quarter note B4. The seventh measure is a quarter note C5. The eighth measure is a quarter note B4. The ninth measure is a quarter note A4. The tenth measure is a quarter note G4. The eleventh measure is a quarter note F4. The twelfth measure is a quarter note E4. The thirteenth measure is a quarter note D4. The fourteenth measure is a quarter note C4. The fifteenth measure is a quarter note B3. The sixteenth measure is a quarter note A3. The seventeenth measure is a quarter note G3. The eighteenth measure is a quarter note F3. The nineteenth measure is a quarter note E3. The twentieth measure is a quarter note D3. The twenty-first measure is a quarter note C3. The twenty-second measure is a quarter note B2. The twenty-third measure is a quarter note A2. The twenty-fourth measure is a quarter note G2. The twenty-fifth measure is a quarter note F2. The twenty-sixth measure is a quarter note E2. The twenty-seventh measure is a quarter note D2. The twenty-eighth measure is a quarter note C2. The twenty-ninth measure is a quarter note B1. The thirtieth measure is a quarter note A1. The thirty-first measure is a quarter note G1. The thirty-second measure is a quarter note F1. The thirty-third measure is a quarter note E1. The thirty-fourth measure is a quarter note D1. The thirty-fifth measure is a quarter note C1. The thirty-sixth measure is a quarter note B0. The thirty-seventh measure is a quarter note A0. The thirty-eighth measure is a quarter note G0. The thirty-ninth measure is a quarter note F0. The fortieth measure is a quarter note E0. The forty-first measure is a quarter note D0. The forty-second measure is a quarter note C0. The forty-third measure is a quarter note B-1. The forty-fourth measure is a quarter note A-1. The forty-fifth measure is a quarter note G-1. The forty-sixth measure is a quarter note F-1. The forty-seventh measure is a quarter note E-1. The forty-eighth measure is a quarter note D-1. The forty-ninth measure is a quarter note C-1. The fiftieth measure is a quarter note B-2. The fifty-first measure is a quarter note A-2. The fifty-second measure is a quarter note G-2. The fifty-third measure is a quarter note F-2. The fifty-fourth measure is a quarter note E-2. The fifty-fifth measure is a quarter note D-2. The fifty-sixth measure is a quarter note C-2. The fifty-seventh measure is a quarter note B-2. The fifty-eighth measure is a quarter note A-2. The fifty-ninth measure is a quarter note G-2. The sixtieth measure is a quarter note F-2. The sixty-first measure is a quarter note E-2. The sixty-second measure is a quarter note D-2. The sixty-third measure is a quarter note C-2. The sixty-fourth measure is a quarter note B-2. The sixty-fifth measure is a quarter note A-2. The sixty-sixth measure is a quarter note G-2. The sixty-seventh measure is a quarter note F-2. The sixty-eighth measure is a quarter note E-2. The sixty-ninth measure is a quarter note D-2. The seventieth measure is a quarter note C-2. The seventy-first measure is a quarter note B-2. The seventy-second measure is a quarter note A-2. The seventy-third measure is a quarter note G-2. The seventy-fourth measure is a quarter note F-2. The seventy-fifth measure is a quarter note E-2. The seventy-sixth measure is a quarter note D-2. The seventy-seventh measure is a quarter note C-2. The seventy-eighth measure is a quarter note B-2. The seventy-ninth measure is a quarter note A-2. The eightieth measure is a quarter note G-2. The eighty-first measure is a quarter note F-2. The eighty-second measure is a quarter note E-2. The eighty-third measure is a quarter note D-2. The eighty-fourth measure is a quarter note C-2. The eighty-fifth measure is a quarter note B-2. The eighty-sixth measure is a quarter note A-2. The eighty-seventh measure is a quarter note G-2. The eighty-eighth measure is a quarter note F-2. The eighty-ninth measure is a quarter note E-2. The ninetieth measure is a quarter note D-2. The hundredth measure is a quarter note C-2.



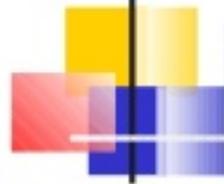


## Neuro-feedback



Bio feedback Theta Alpha :  
relaxation active

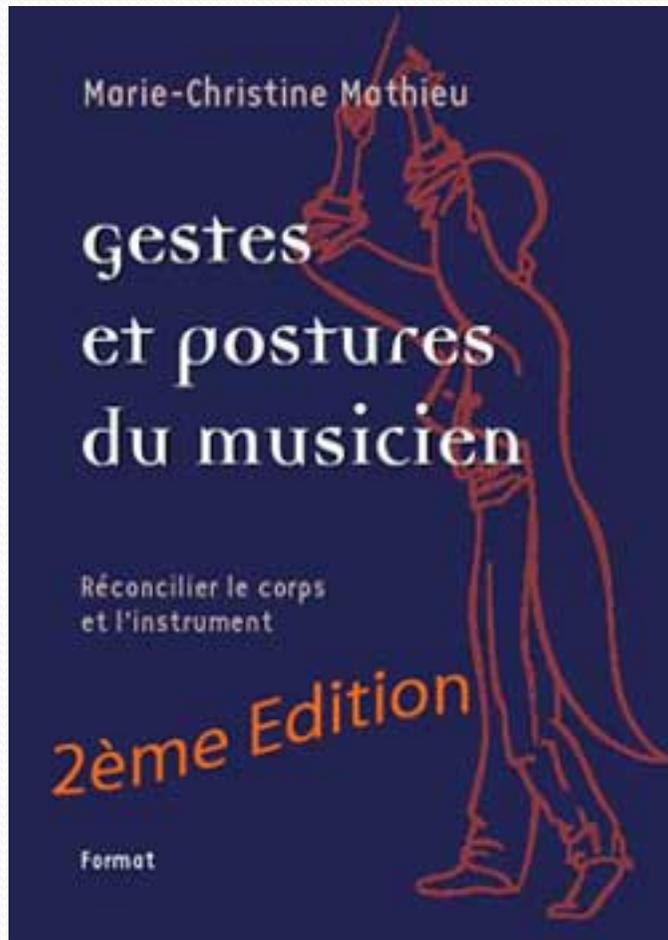
Bio feedback SMR (Alpha  
Beta) augmente l'attention  
(contrôle)



## Enhanced Musical Performance

---

- Alpha/theta training significantly improved musical performance by music students, as judged by independent raters (Egner & Gruzelier, 2003)

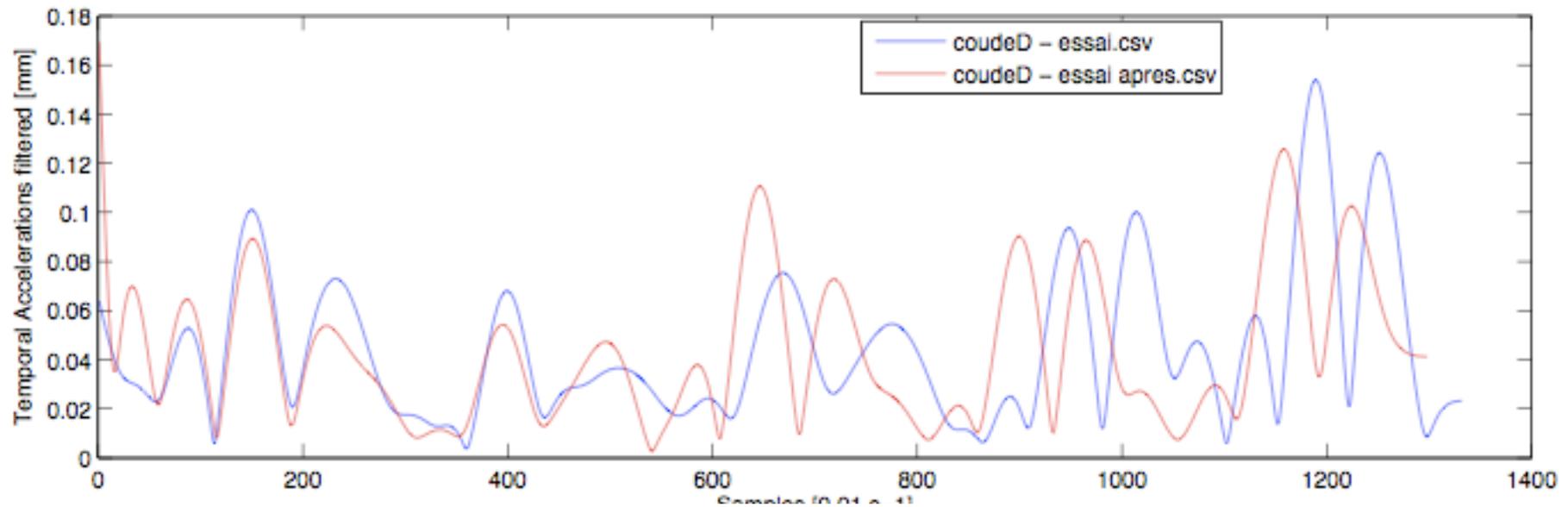


*Posture à éviter*

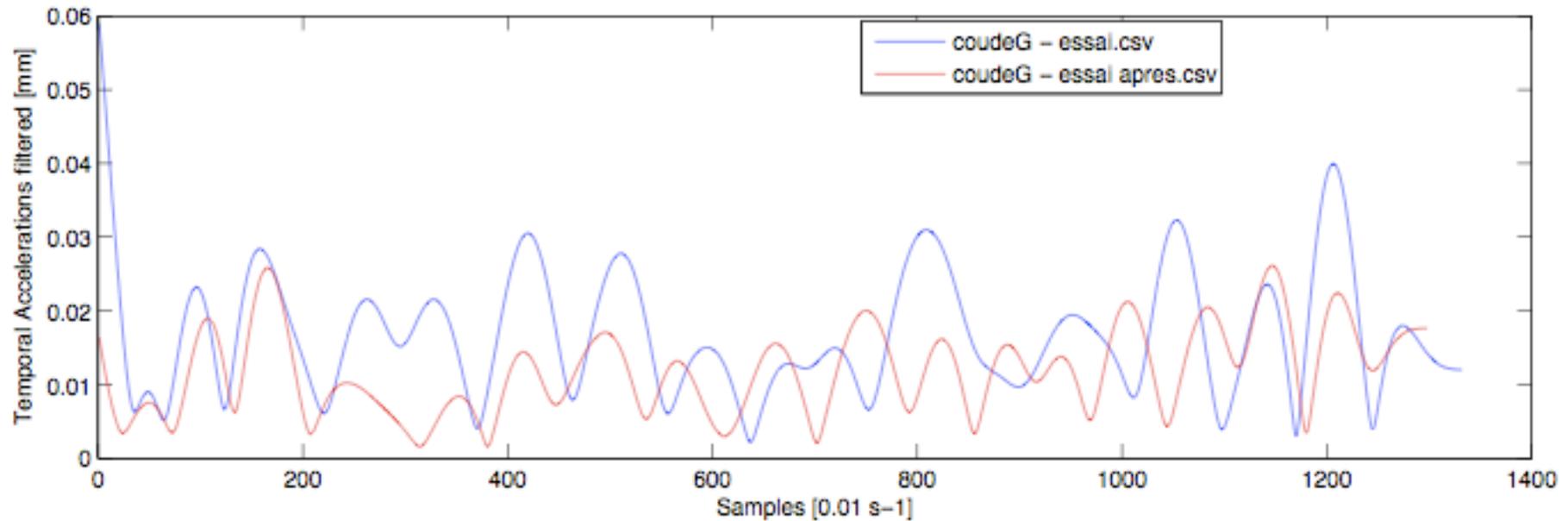


*Position favorisante*

**A slight change in posture is associated with dynamic changes (acceleration) in the right elbow (bow)**



**A slight change in posture position is also associated with dynamic changes (acceleration) in the left elbow**





**Inserm**

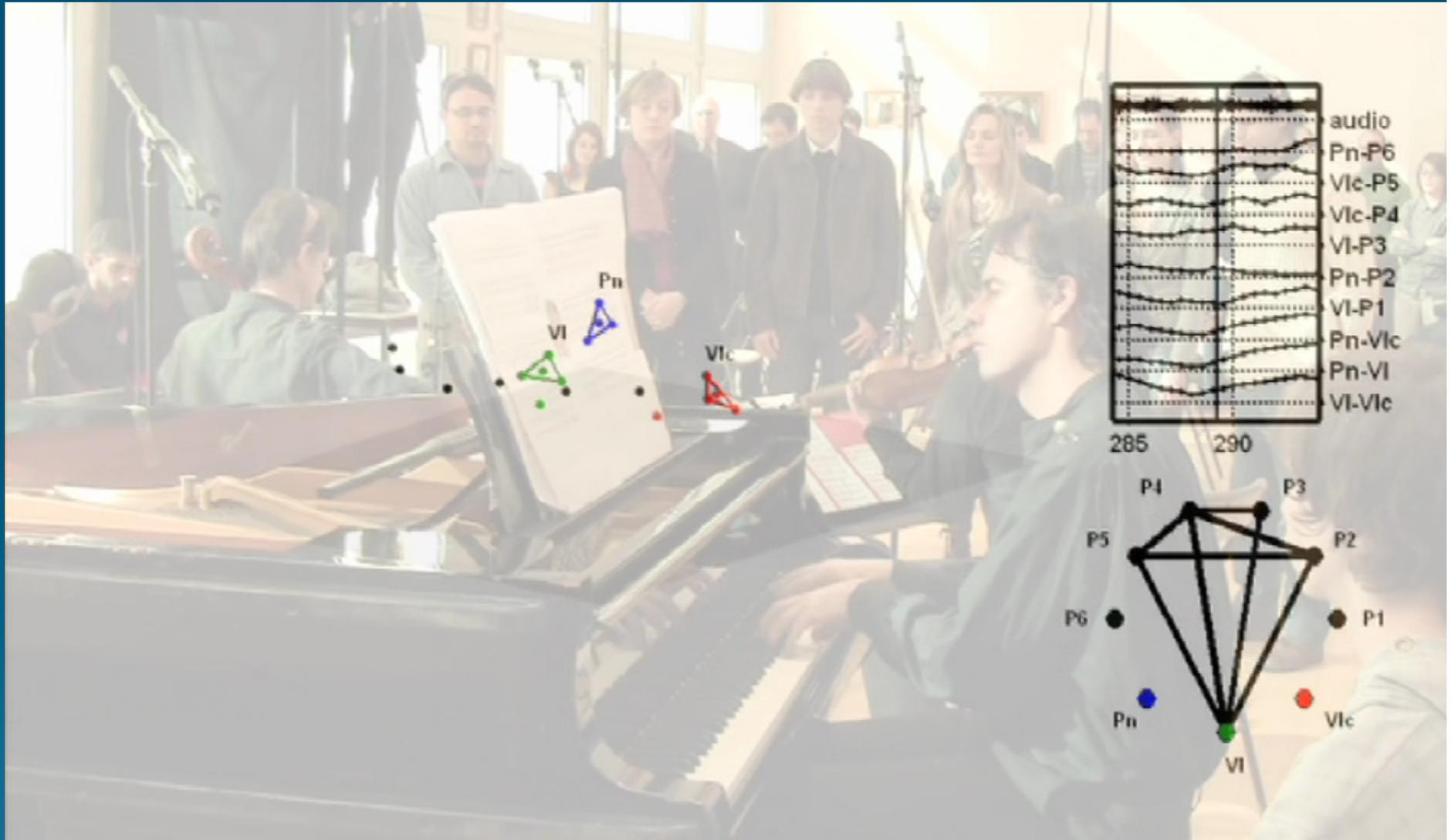
U887



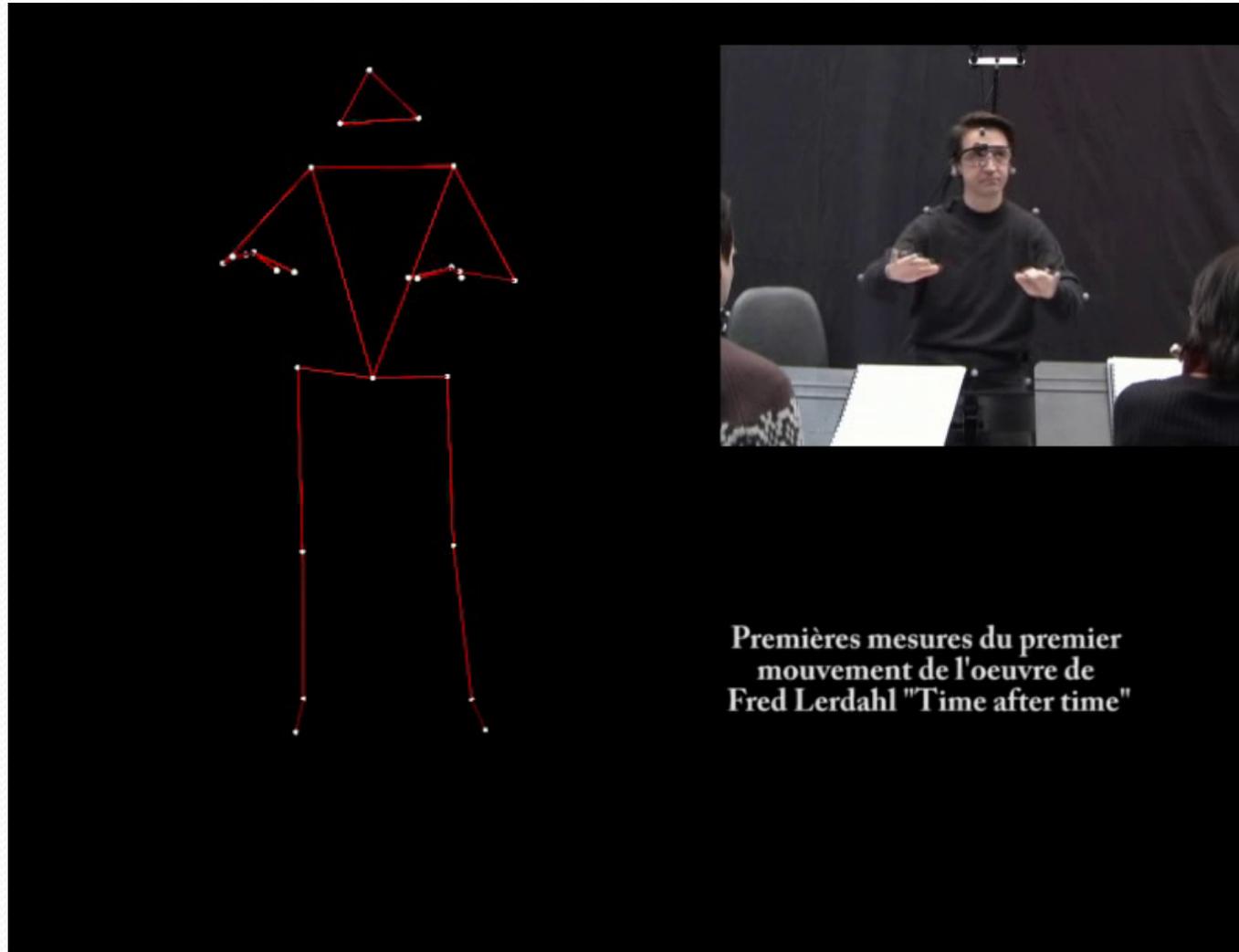


Les Incontournables  
> **Olivier Greif**, Compositeur



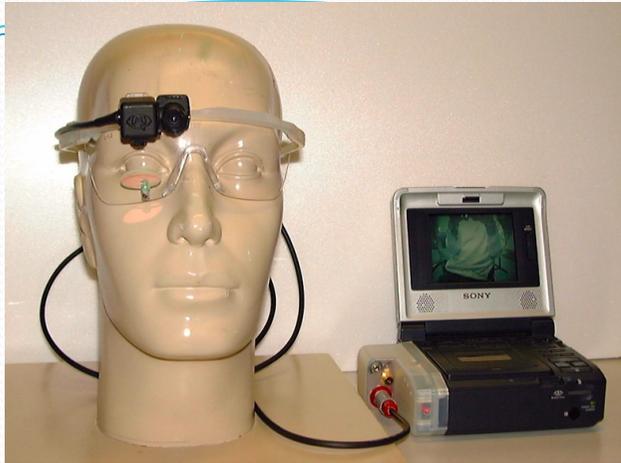


# Tracking eyes and body movements of a conductor in contemporary music



Premières mesures du premier mouvement de l'oeuvre de Fred Lerdahl "Time after time"

*Bigand, E., Lalitte, P., Lerdahl, F., Boucheix, J.-M., Gérard, Y & Pozzo, T. (2010). Looking into the eyes of the conductor. Musicae Scientiae.*



# Tsiganes, musique et empathie

Filippo Bonini Baraldi



« **Transylvanian swing** » rests on an elegant asynchronism between the viola and violin (swing *boiteux*) :  
*to be or not to be an aksak? (3/2)*

« **Smooth fingers** » (dulcea).  
*The smoothness of the violinist's hand is the soul of the gypsies.*

*P. Casals : « expressive fingering »*



et



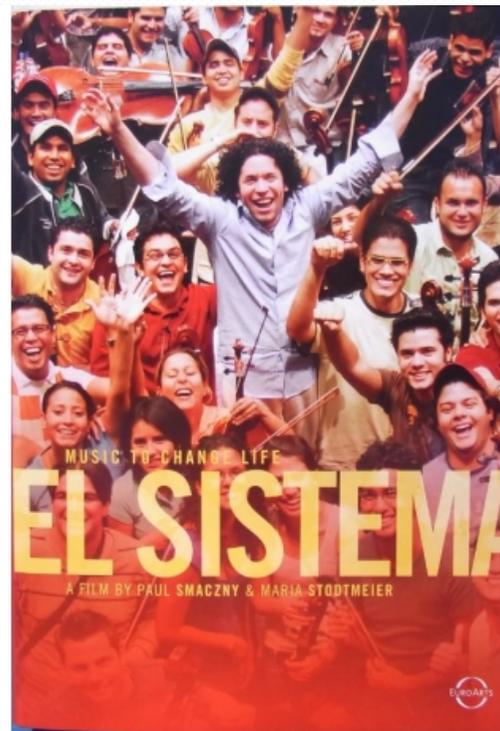
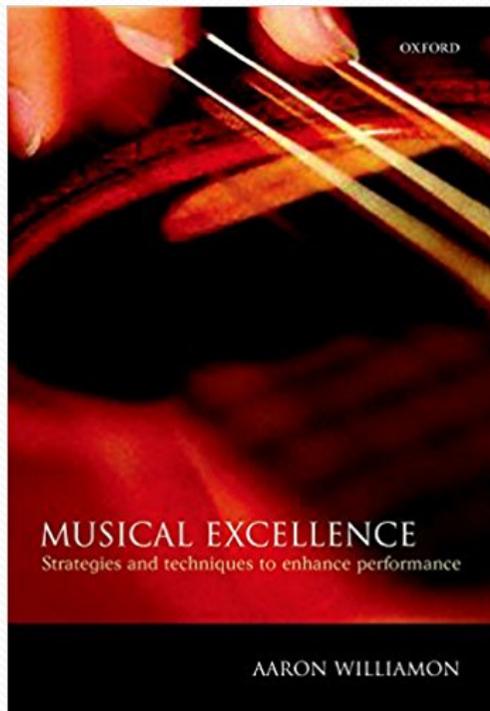
Unité Plasticité  
et Motricité

en collaboration avec le

LABORATOIRE  
D'ETHNOMUSICOLOGIE  
DU MUSÉE DE L'HOMME

présentent

# Musique et cerveau



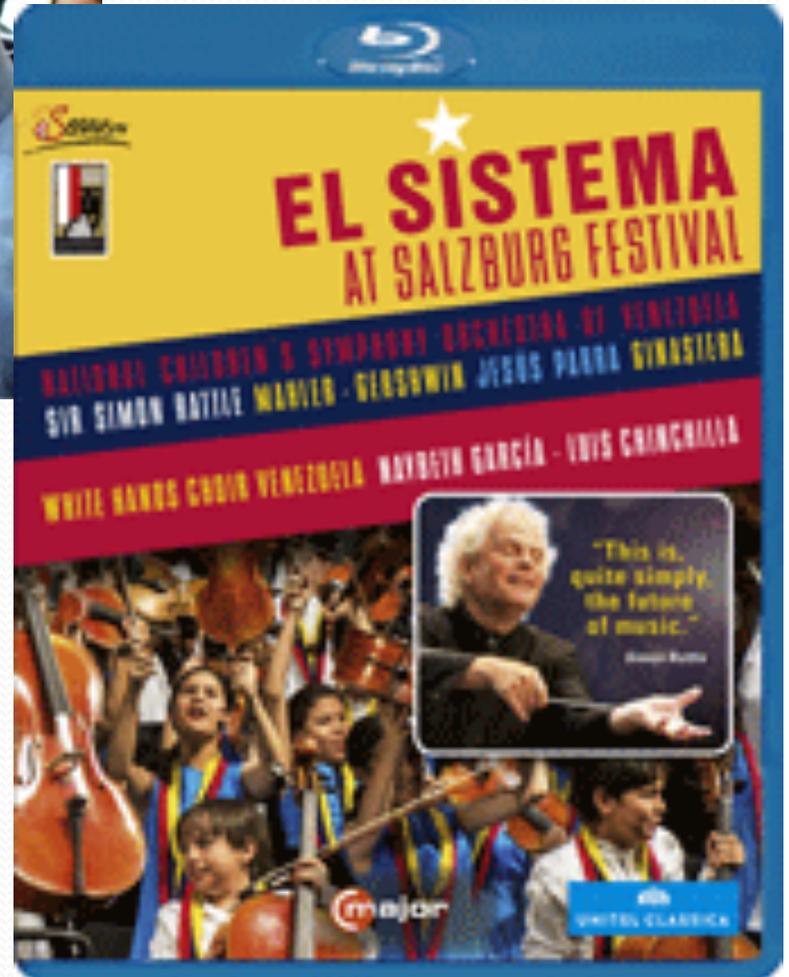
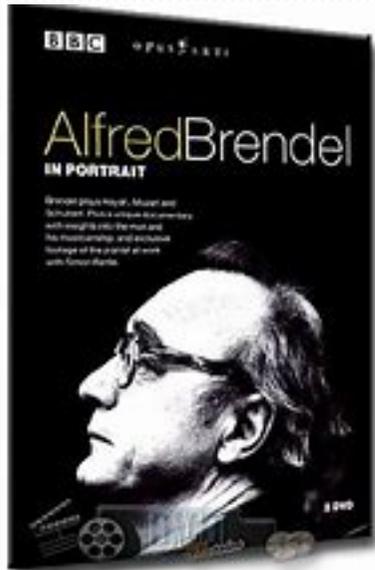
**« Aussitôt qu'un enfant commence à apprendre la musique, il devient un être en progrès »**

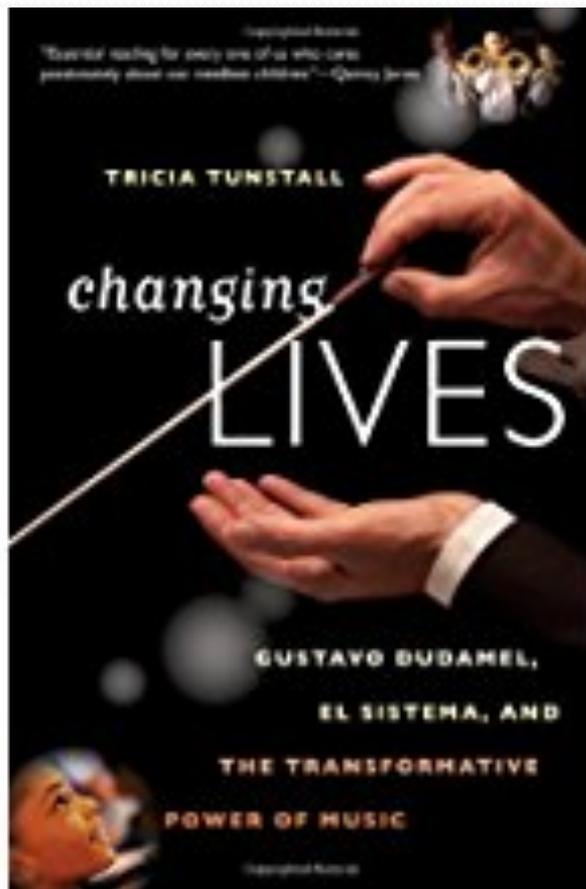
**. A. Abreu**











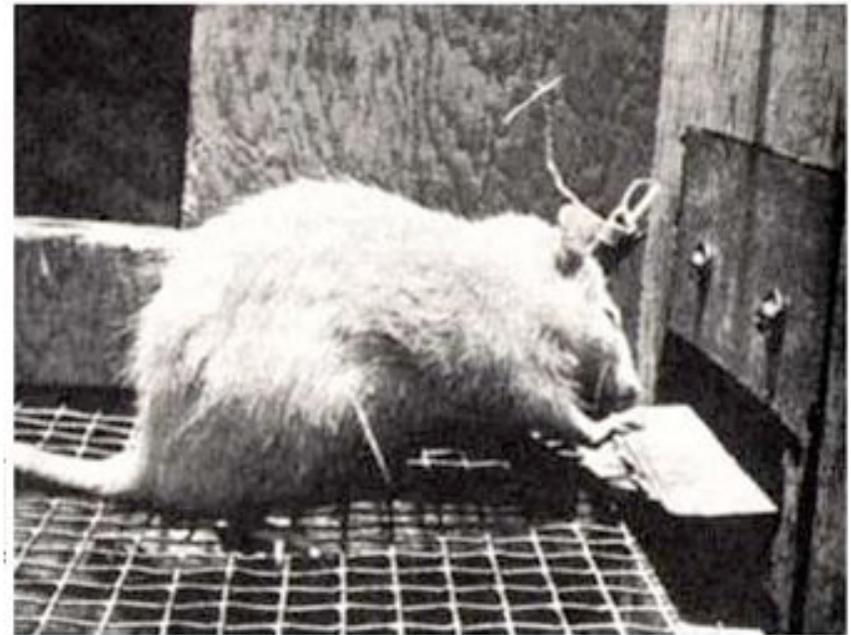
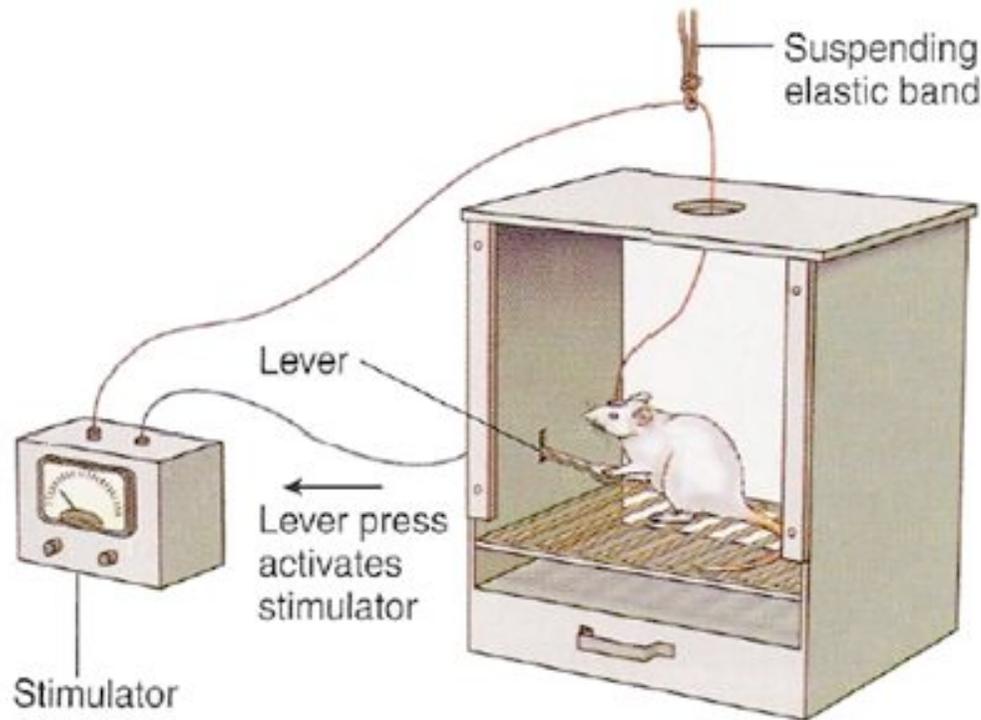
REVUE  
INTERNATIONALE  
D'ÉDUCATION  
SÈVRES  
n° 75, septembre 2017

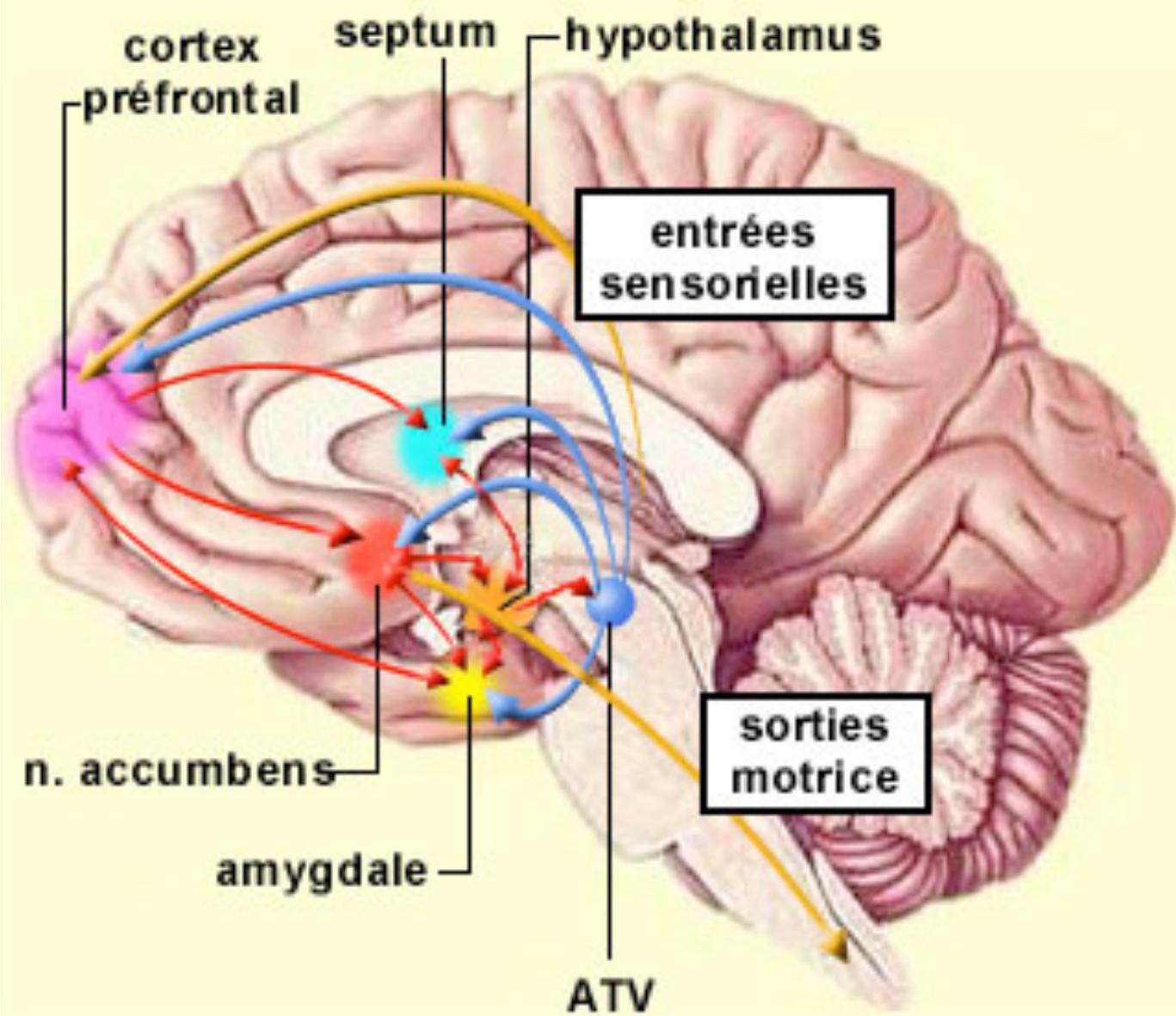


DOSSIER  
musique  
et éducation



# Olds et Milner, 1954 : Découverte des « centres du plaisir »





# Les substances toxicomanogènes stimulent les systèmes de récompense

Activation des systèmes de récompense

Cortex frontal

Striatum

Hippocampe

Septum

Thalamus

Nucleus accumbens

A 11/14

Hypothalamus

Hypophyse

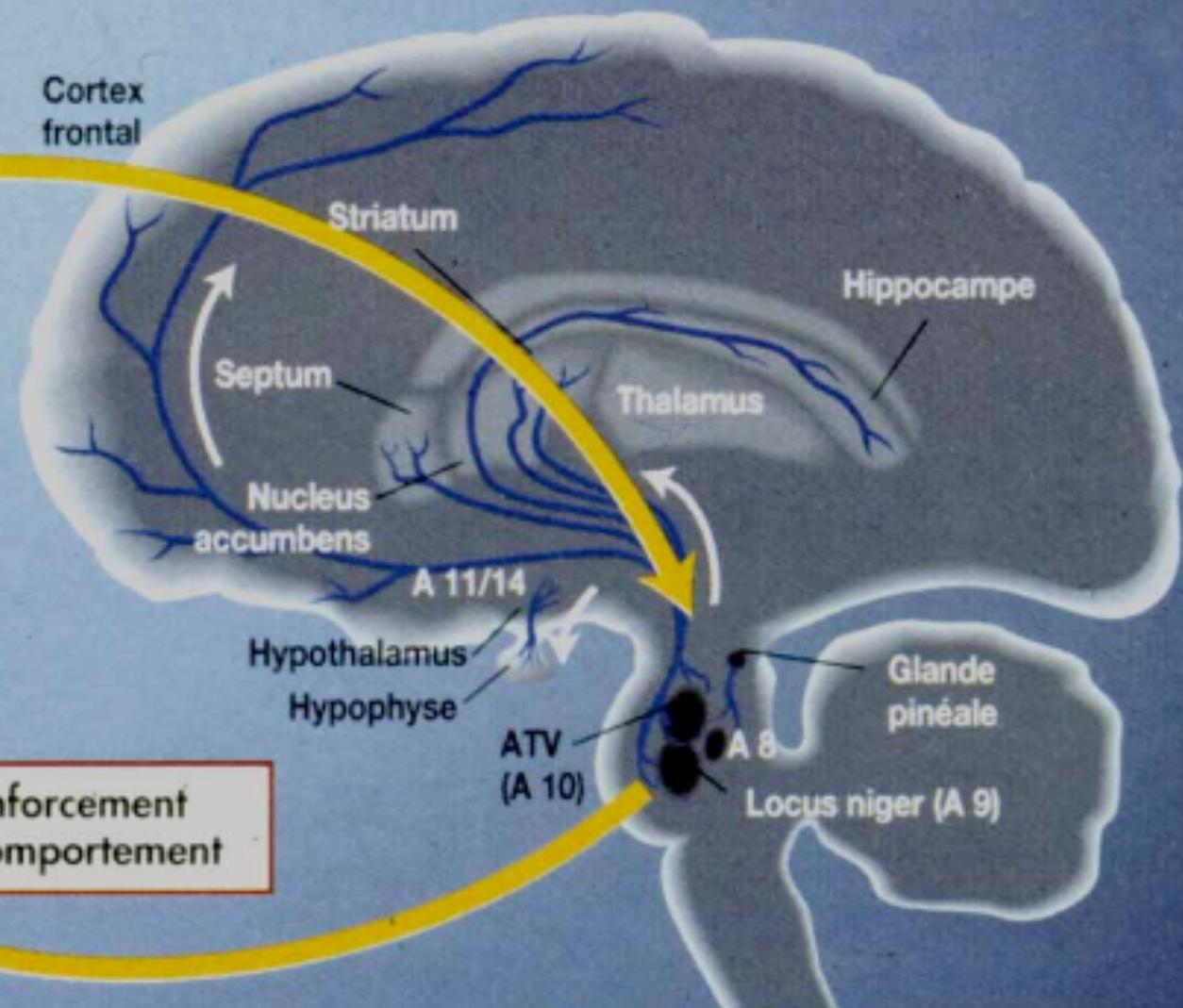
Glande pinéale

ATV (A 10)

Locus niger (A 9)

Renforcement du comportement

PRINCIPALES PROJECTIONS DOPAMINERGIQUES



# Les substances toxicomanogènes stimulent les systèmes de récompense

Activation des systèmes de récompense

Cortex frontal

Striatum

Hippocampe

Septum

Thalamus

Nucleus accumbens

A 11/14

Hypothalamus

Hypophyse

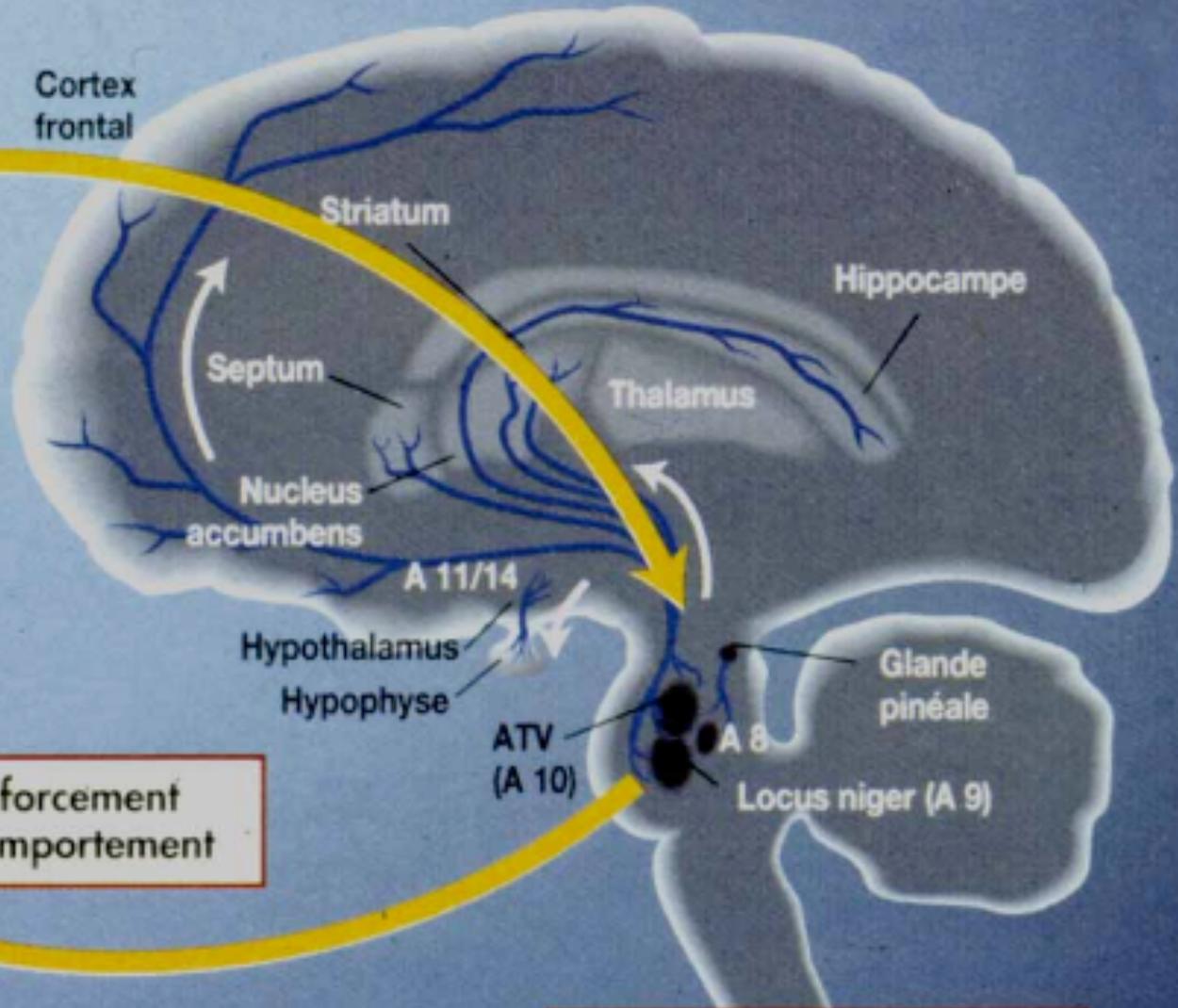
Glande pinéale

ATV (A 10)

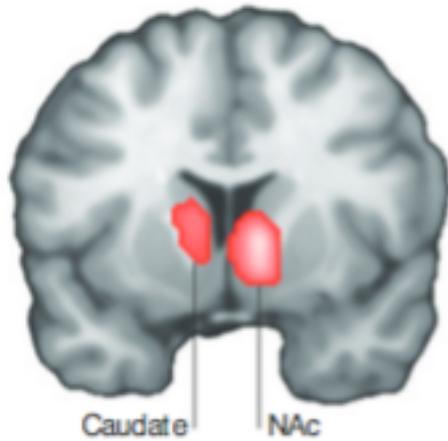
Locus niger (A 9)

Renforcement du comportement

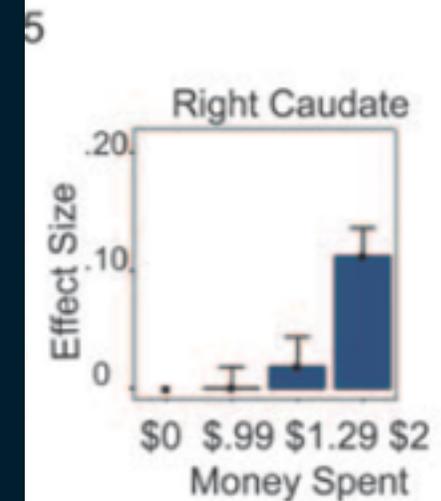
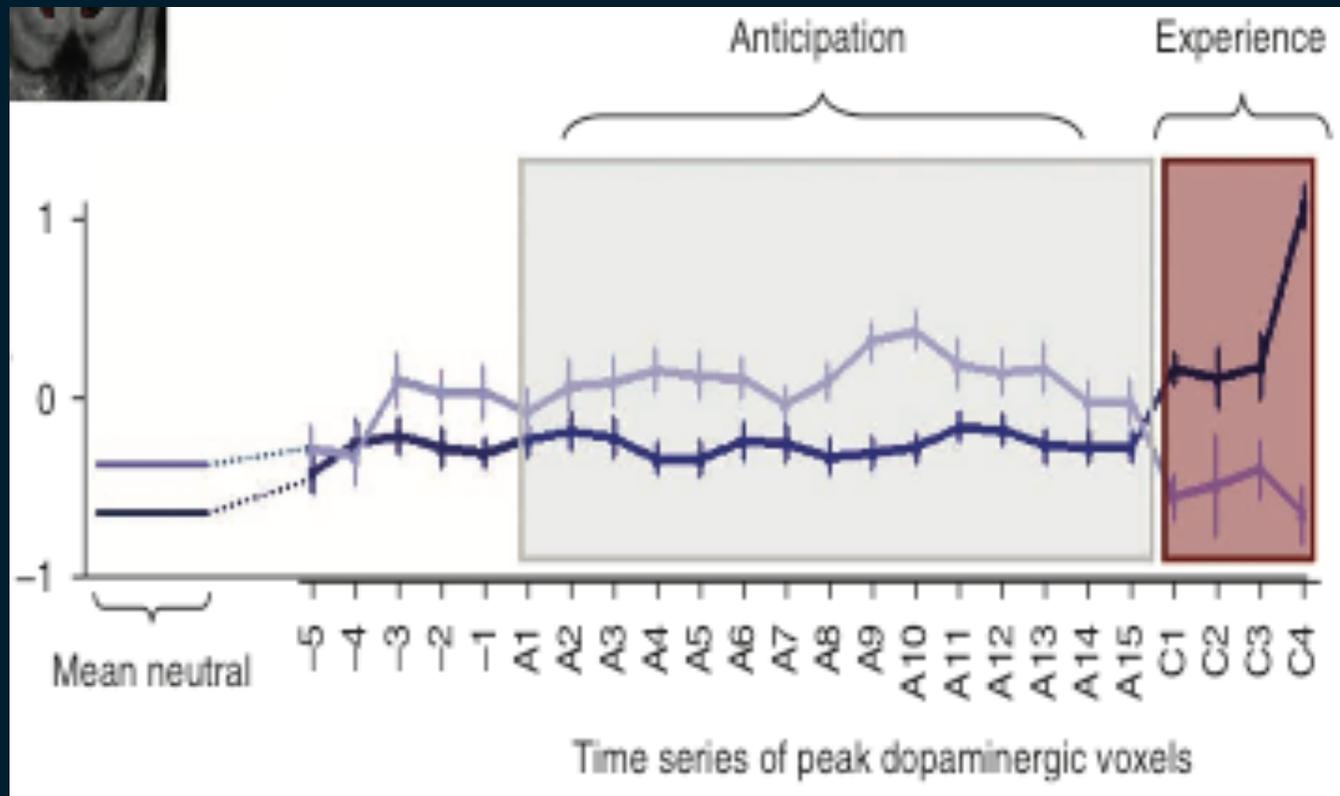
PRINCIPALES PROJECTIONS DOPAMINERGIQUES



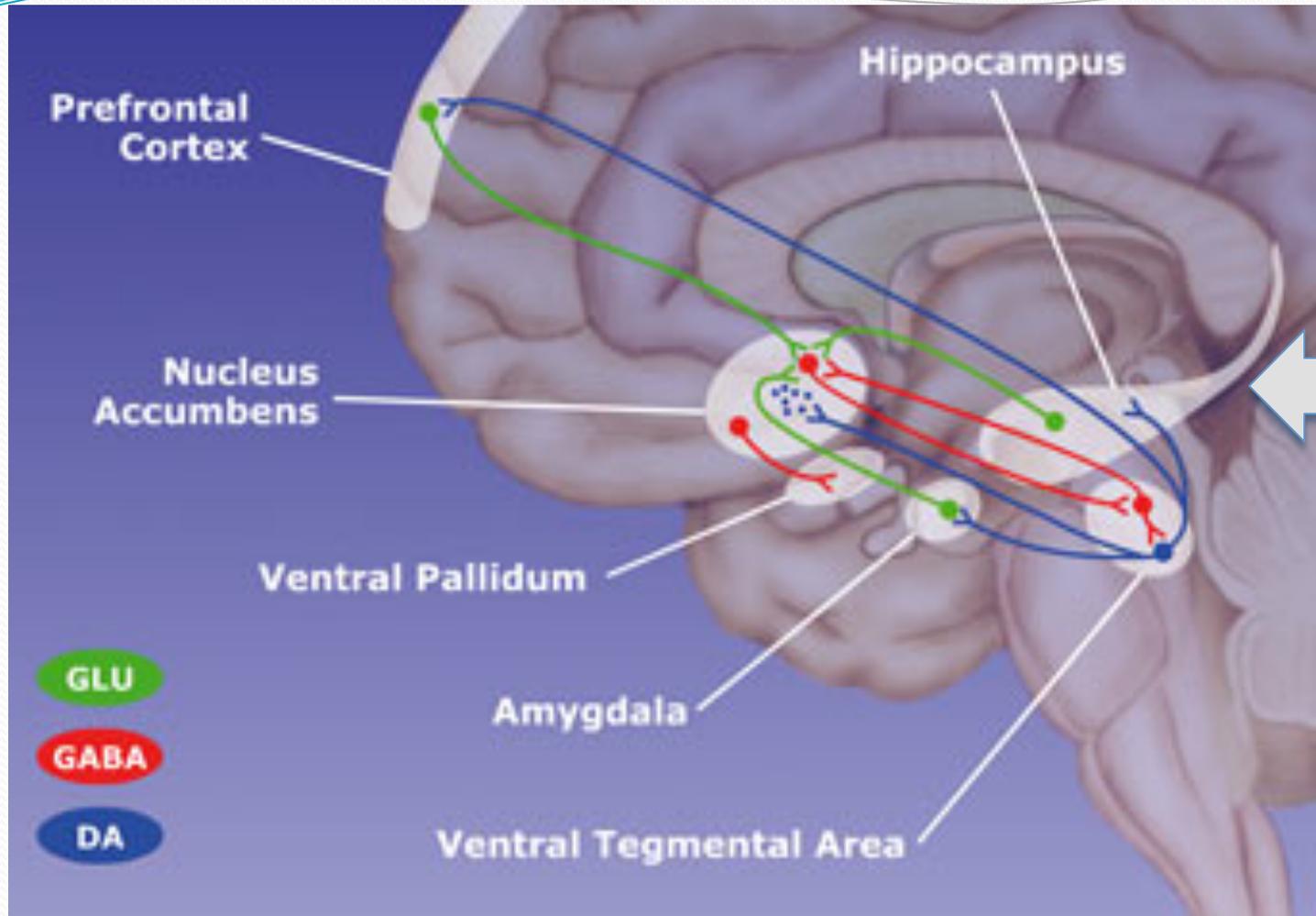
D  
y=6



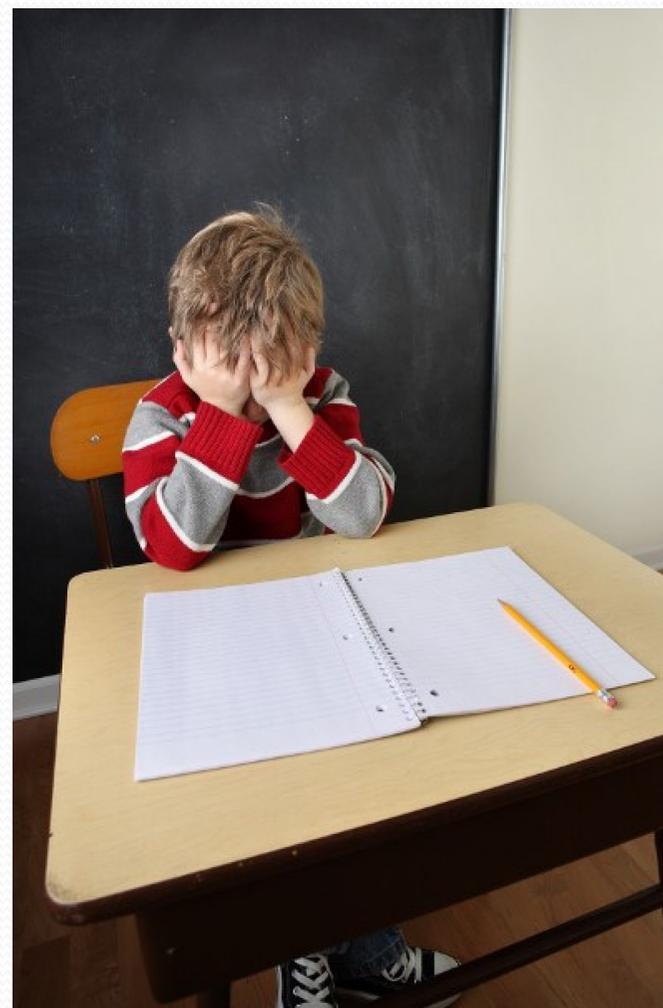
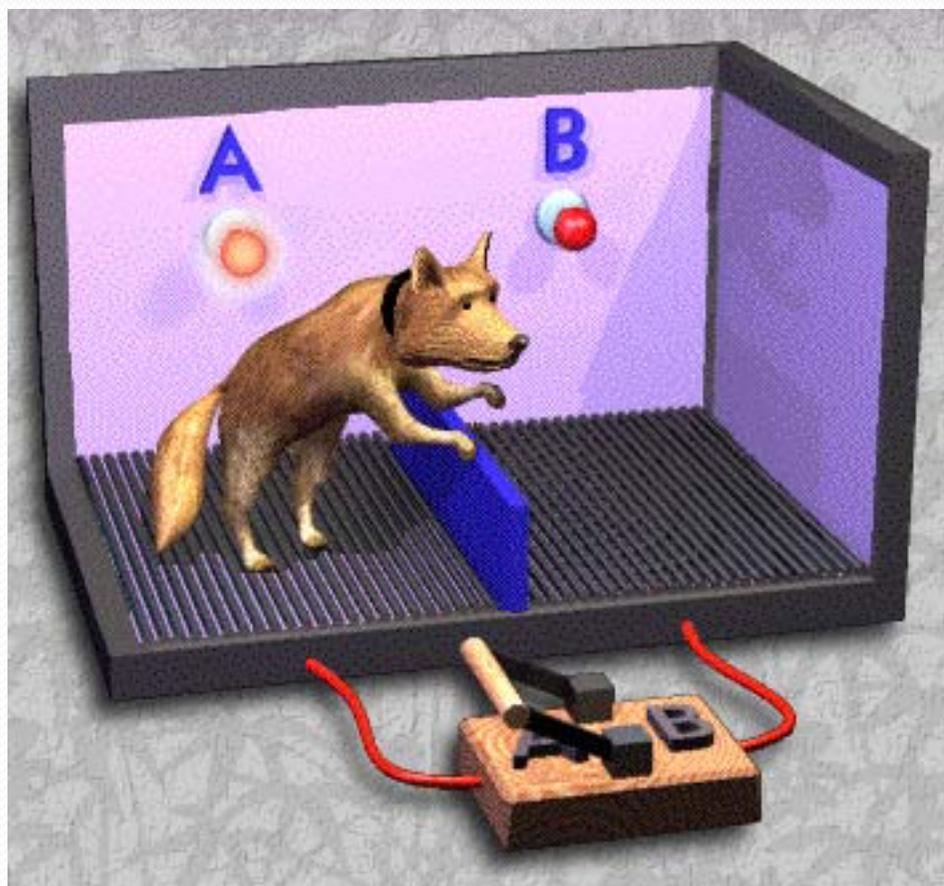
Le noyau Accumbens est sensible aux récompenses primaires (nourriture, boisson, sexe) et secondaires (argent pouvoir)



« No pain, no gain »



## Résignation apprise



**« Aussitôt qu'un enfant commence à apprendre  
la musique, il devient un être en progrès »**

**. A. Abreu**



**Expression entraine la  
technique**



**« Aussitôt qu'un enfant commence à apprendre  
la musique, il devient un être en progrès »**

**. A. Abreu**

**Besoin de renforcement positif**

**Besoin de feed back informatif**

**Embodiment**



*Christophe Béreau  
CRR Dijon*



*Thierry Pozzo  
INSERM Dijon*



**Inserm**

U887

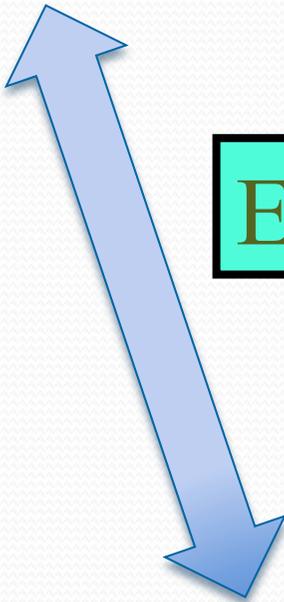


SON



MOUVEMENT

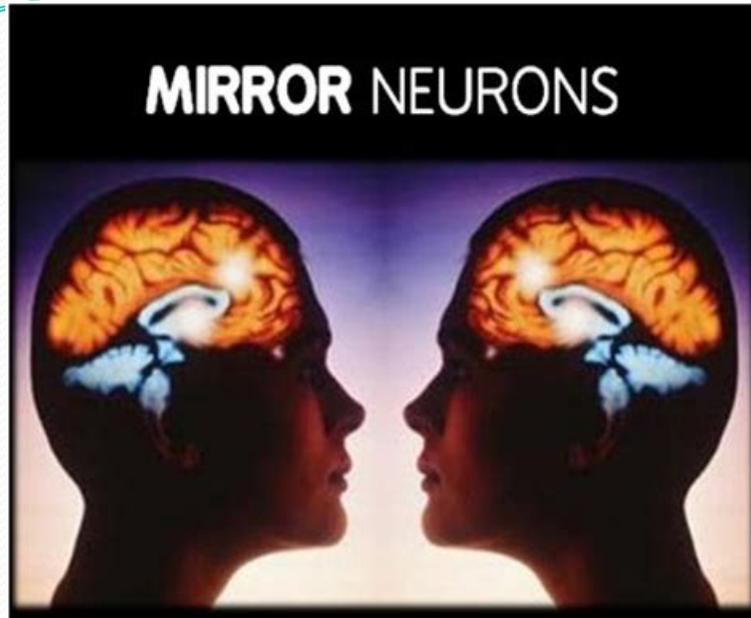
EXPRESSION

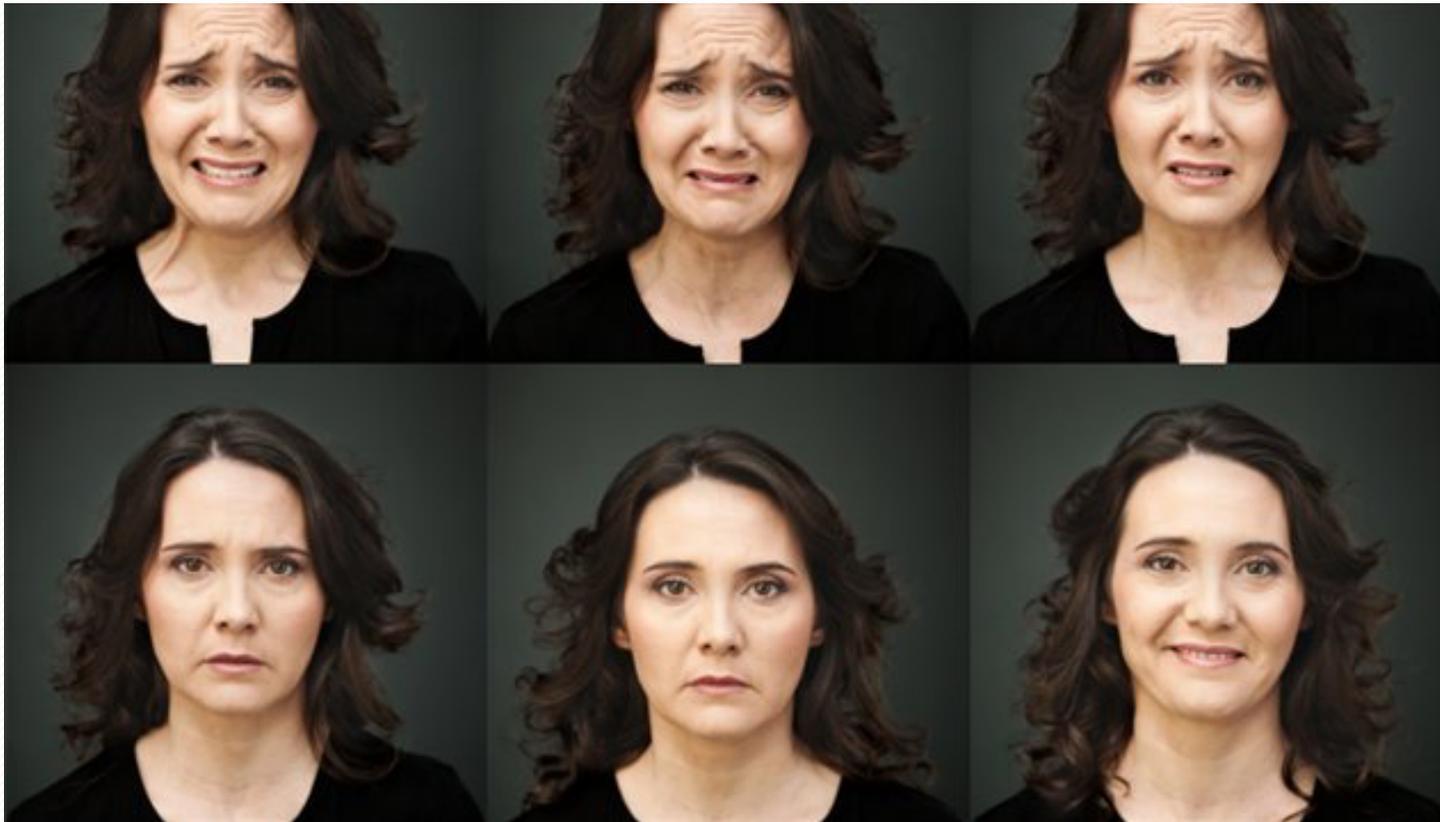


PARTITION



Musique et contagion émotionnelle  
« *musicology communicative* »



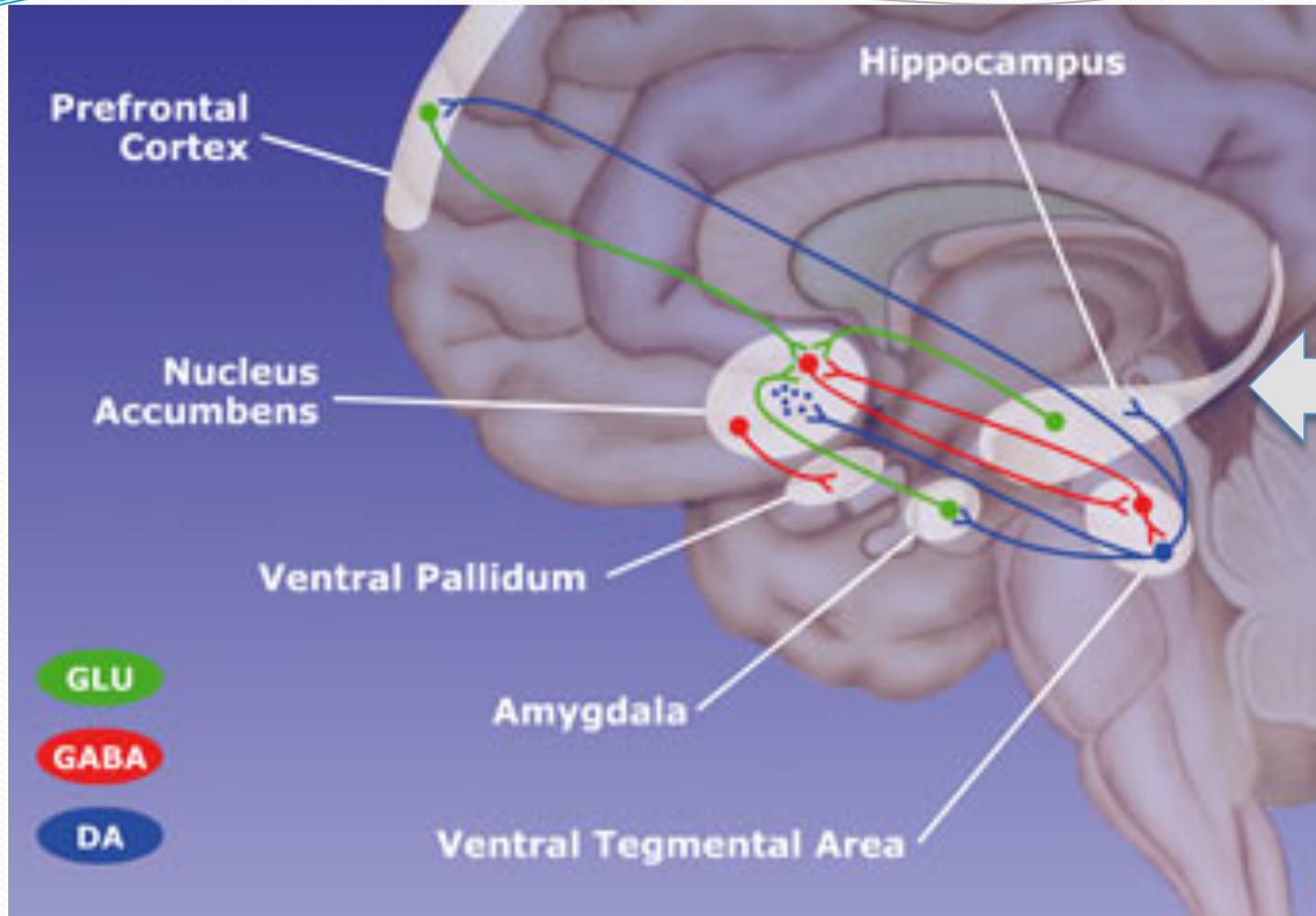


On écoute pas « la musique » : on écoute l'humain  
(humanité) qui est dans la musique

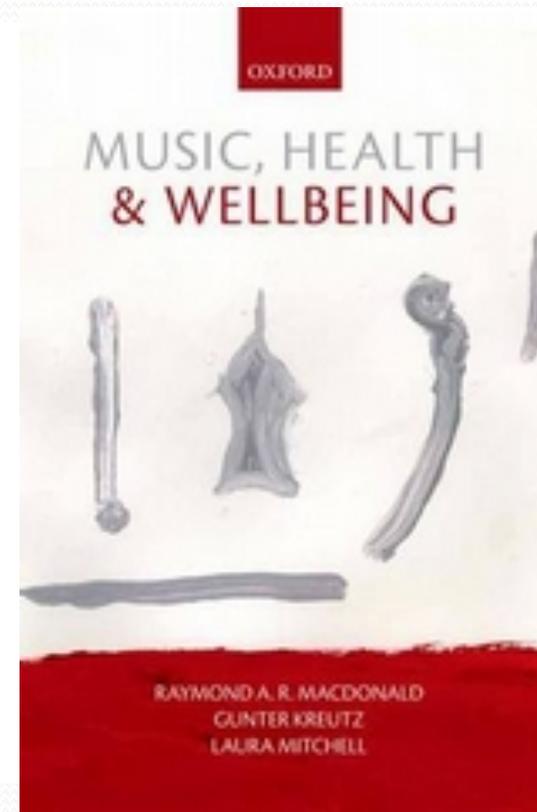
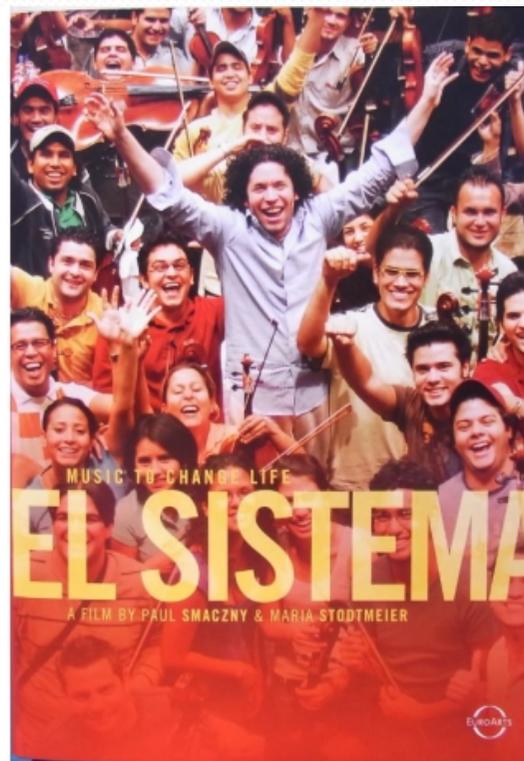
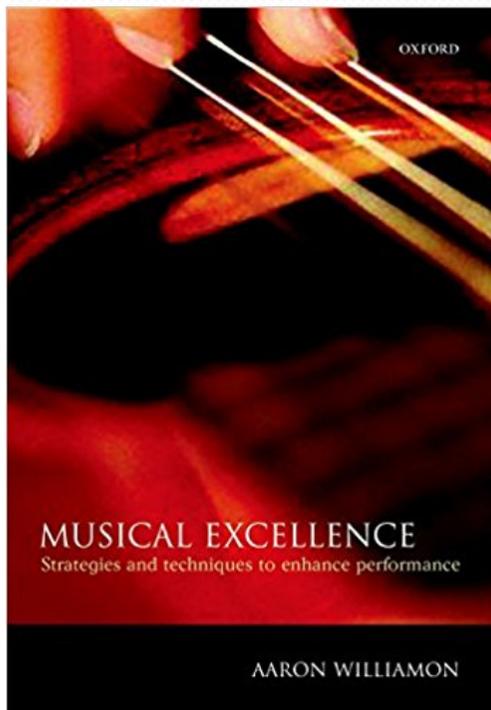


« Ces musiciens pour qui chaque note est une question de vie ou de mort »

« No pain, no gain »



# Musique et cerveau



**Bien être**

**MUSIQUE**

**Santé**

**Education**

## Clinically distinct: Parkinson's disease

THE NOBEL<sup>47</sup>  
CONFERENCE<sup>TM</sup>  
GUSTAVUS ADOLPHUS COLLEGE



À CREIL, EN NÉONATOLOGIE

# UNE MUSICIENNE AU CHEVET DES PRÉMATURÉS



LA MAISON  
des  
MATERNELLES

• GRANDS PRÉMAS : CHANTER POUR EUX • [S'INFORMER](#)

▶ 🔊 1:58 / 2:33





SEVENTH FRAMEWORK  
PROGRAMME

# EBRAMUS

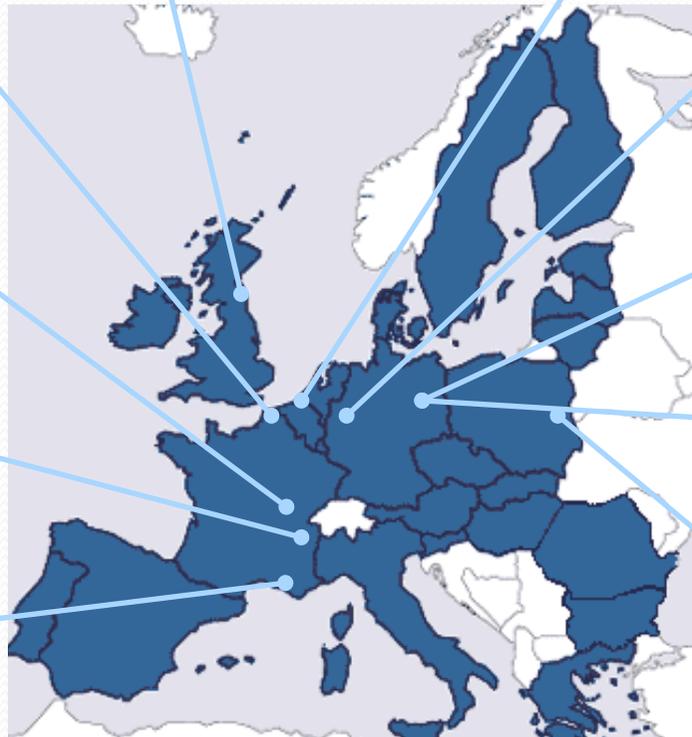


## Europe BRAIn and MUSic

New perspectives for stimulating cognitive and sensory processes



**LEAD-CNRS**





# La musique relaxe plus que le Valium

Le 09/04/2013 à 07:33:30

Vues : 501 fois **1 REA**



## Médecine : la musique bientôt sur ordonnance ?

**SANTÉ** - La musique adoucit les moeurs, mais pas seulement. En se basant sur l'analyse de quelque 400 articles scientifiques publiés, des psychologues canadiens de l'Université McGill, au Québec, ont montré que la musique pouvait stimuler le système immunitaire, réduire l'anxiété ou encore aider à réguler l'humeur.



**Bien être**

**MUSIQUE**

**Santé**

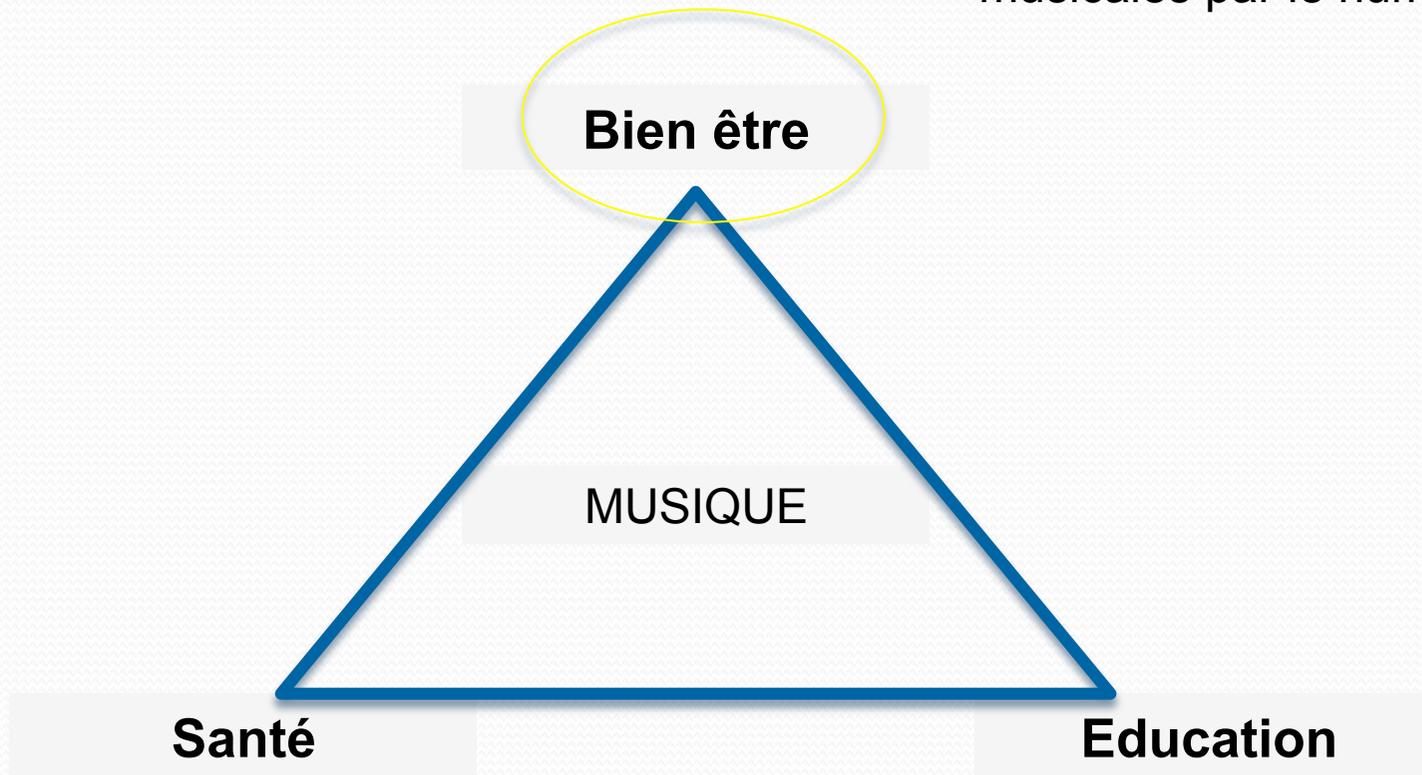
**Education**

Éducation des enfants par la musique

# MUSIC MATTERS!

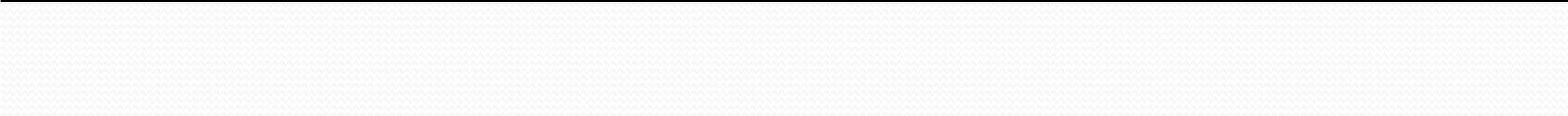


Démocratisation des pratiques  
musicales par le numérique



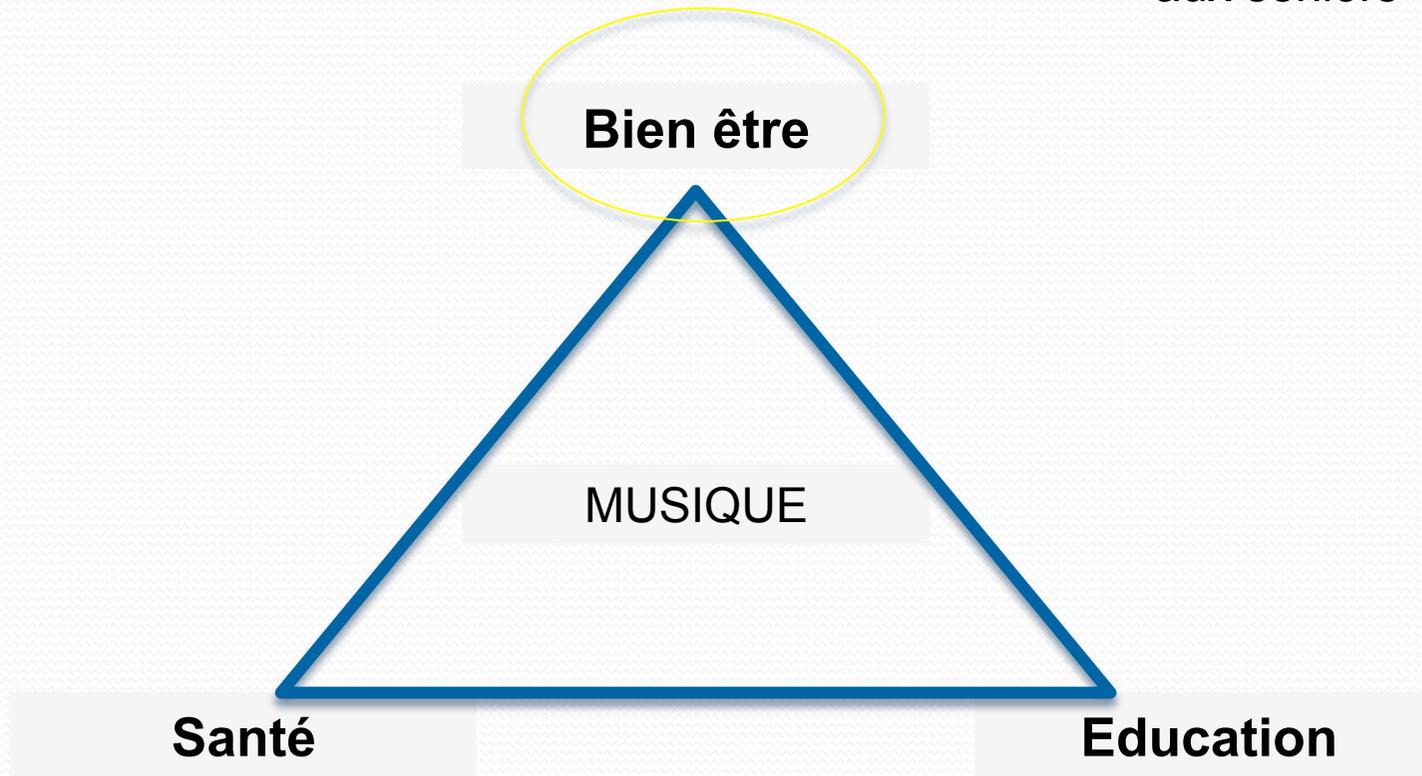


the jymmin' space



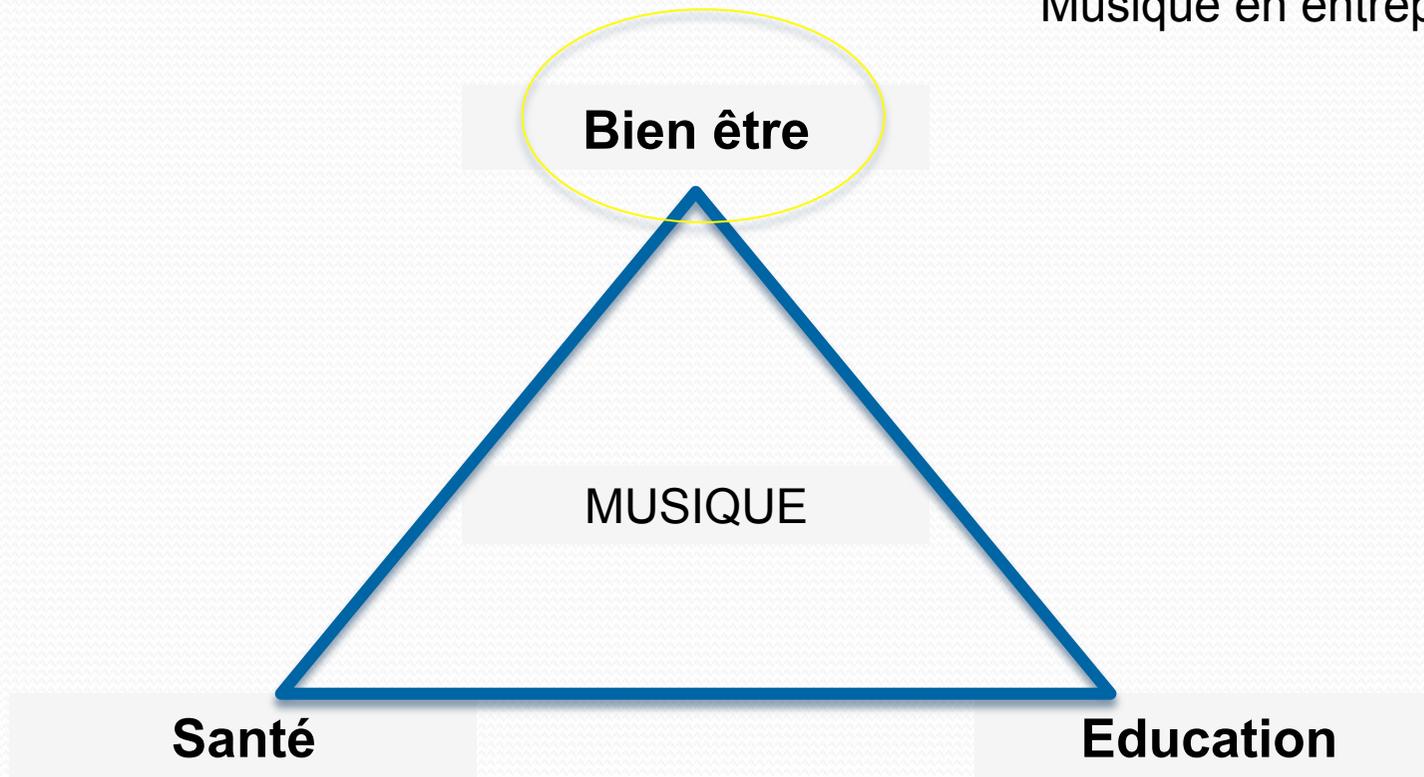


Pratique musicale adaptée  
aux séniors

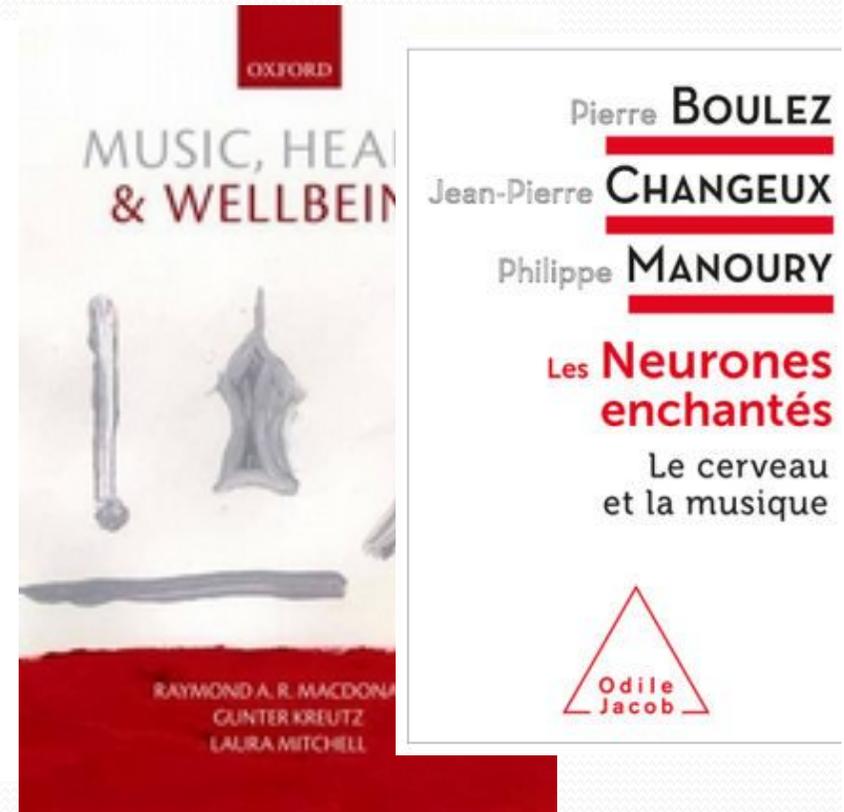
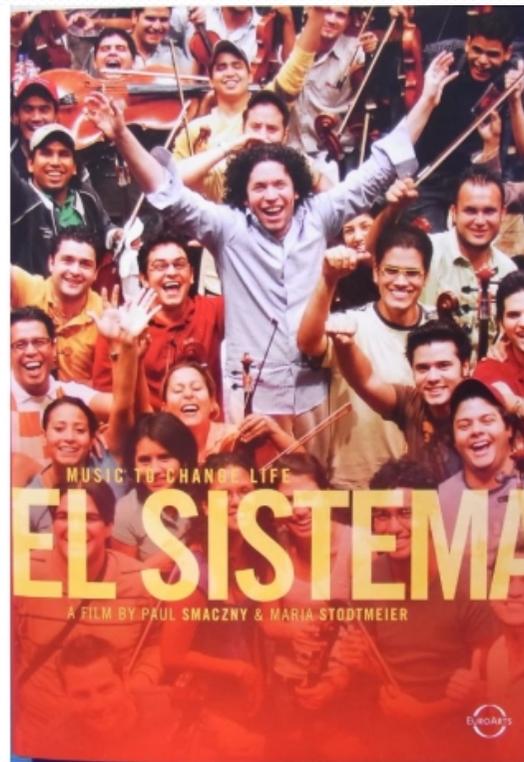
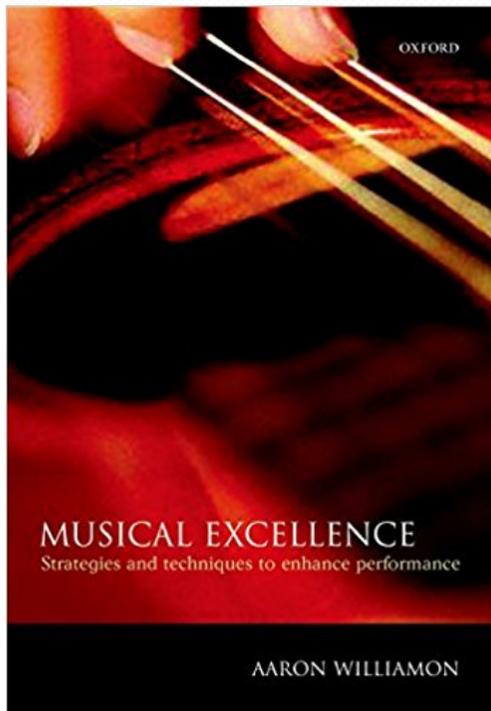


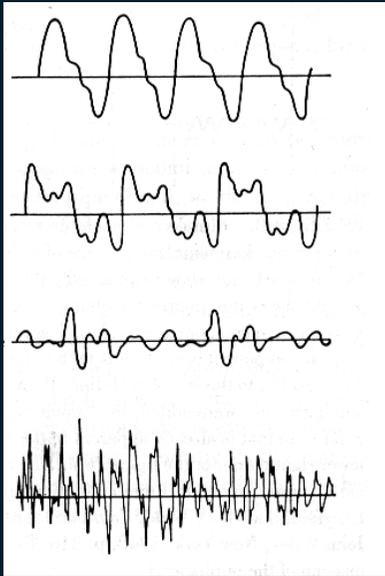


Musique en entreprise



# Musique ↔ Cerveau

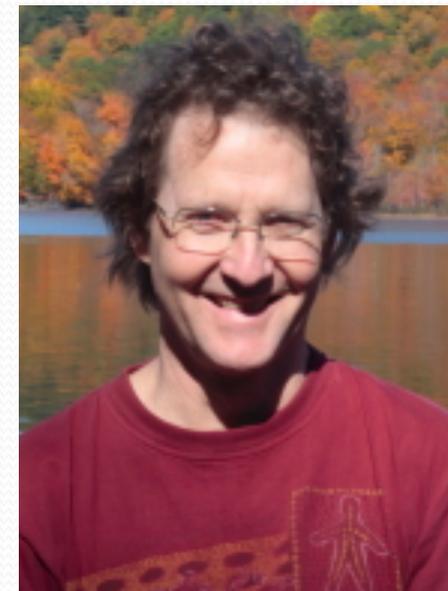
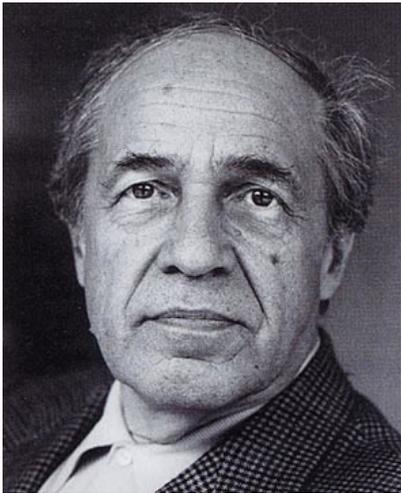




Intelligence du son

Intelligence sensible

Intelligence des structures



# Etapes de traitement de l'information musicale

## THINKING IN SOUND

THE COGNITIVE PSYCHOLOGY OF HUMAN AUDITION

EDITED BY  
STEPHEN McADAMS AND EMMANUEL BIGAND



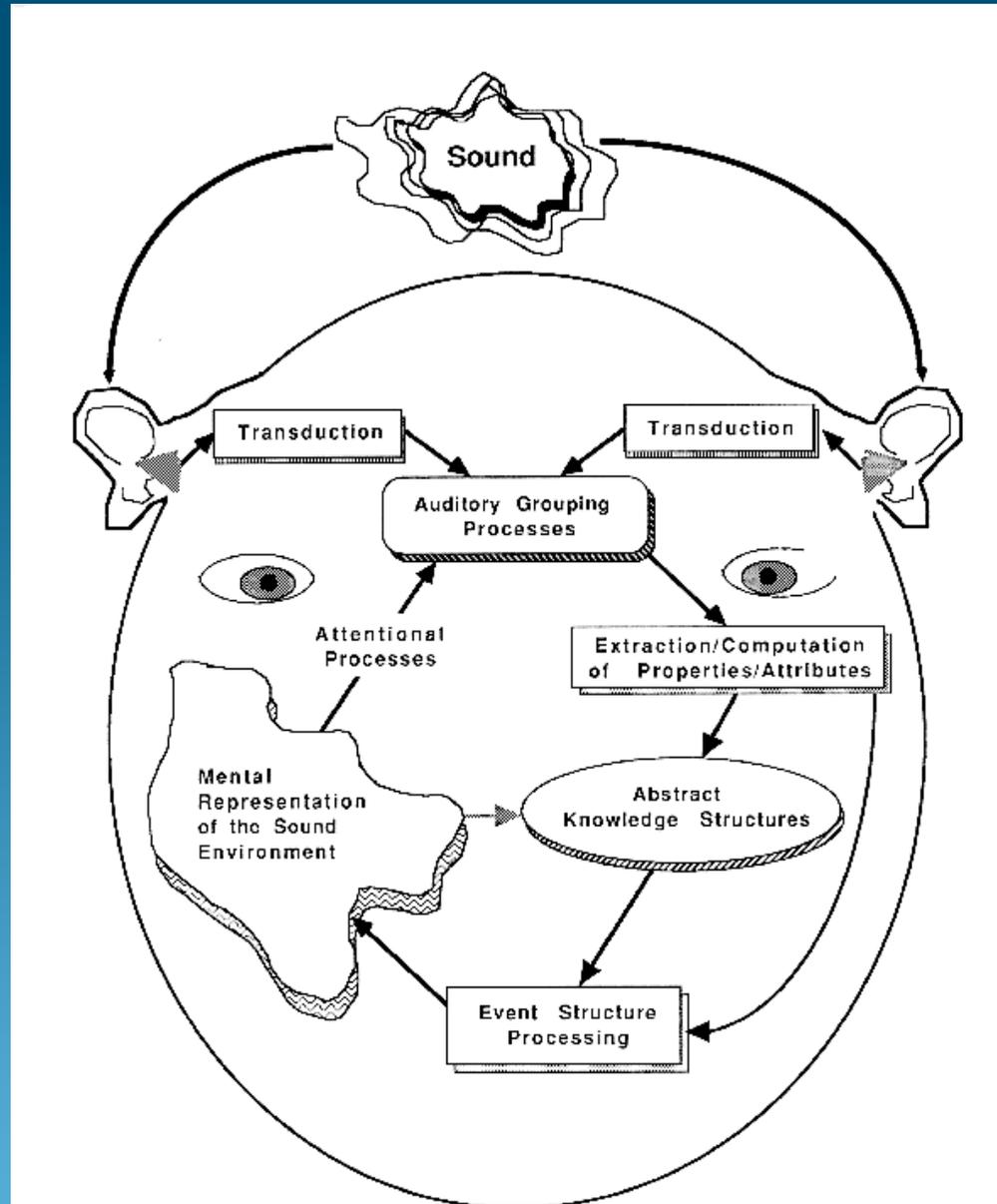
Material protégé par le droit d'auteur  
Stephen McAdams et Emmanuel Bigand

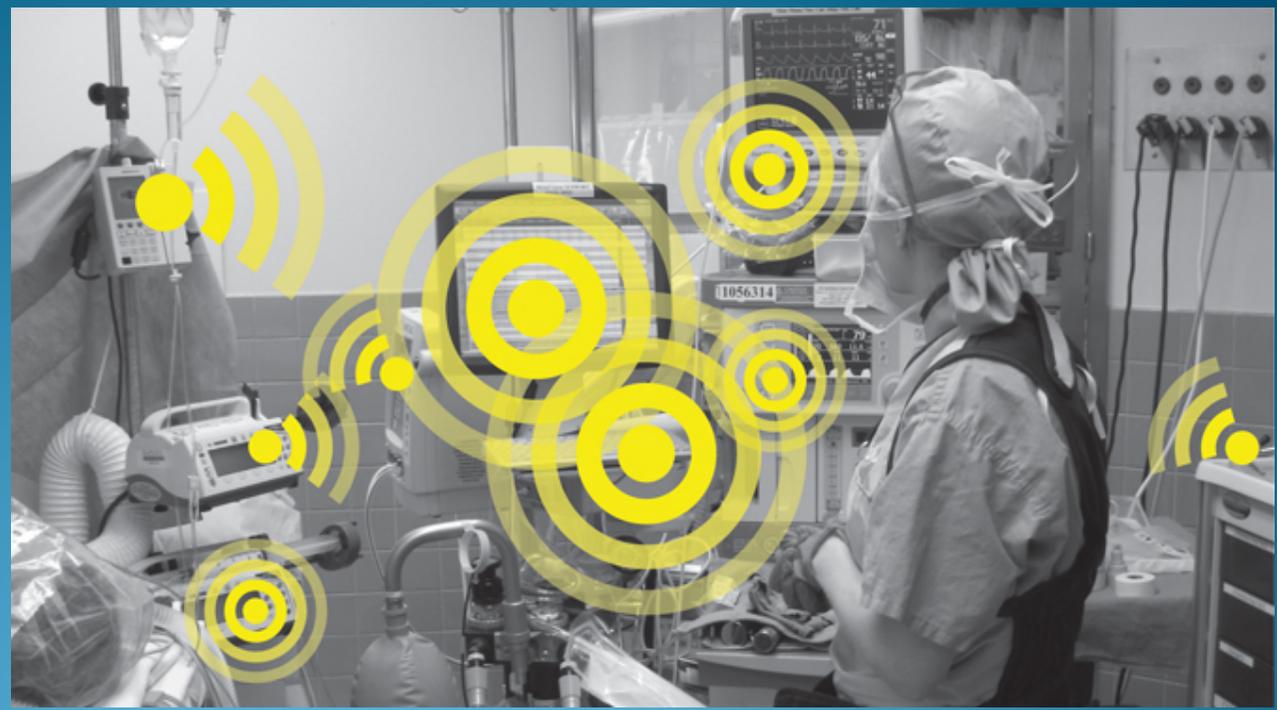
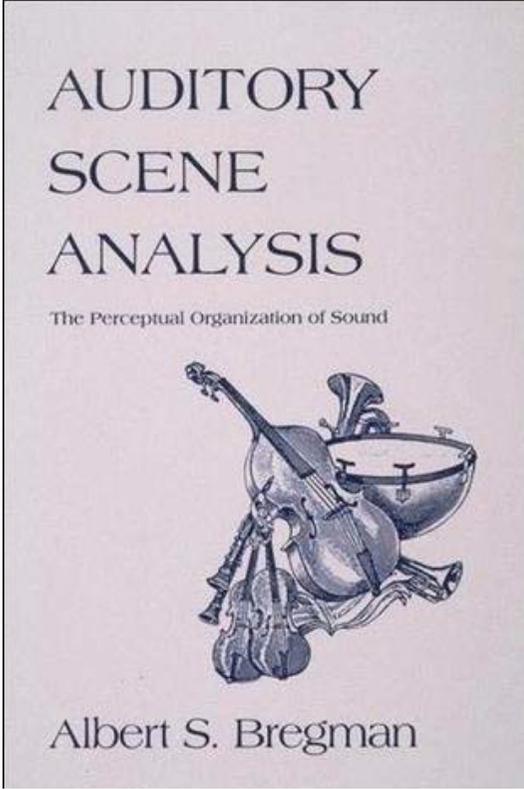
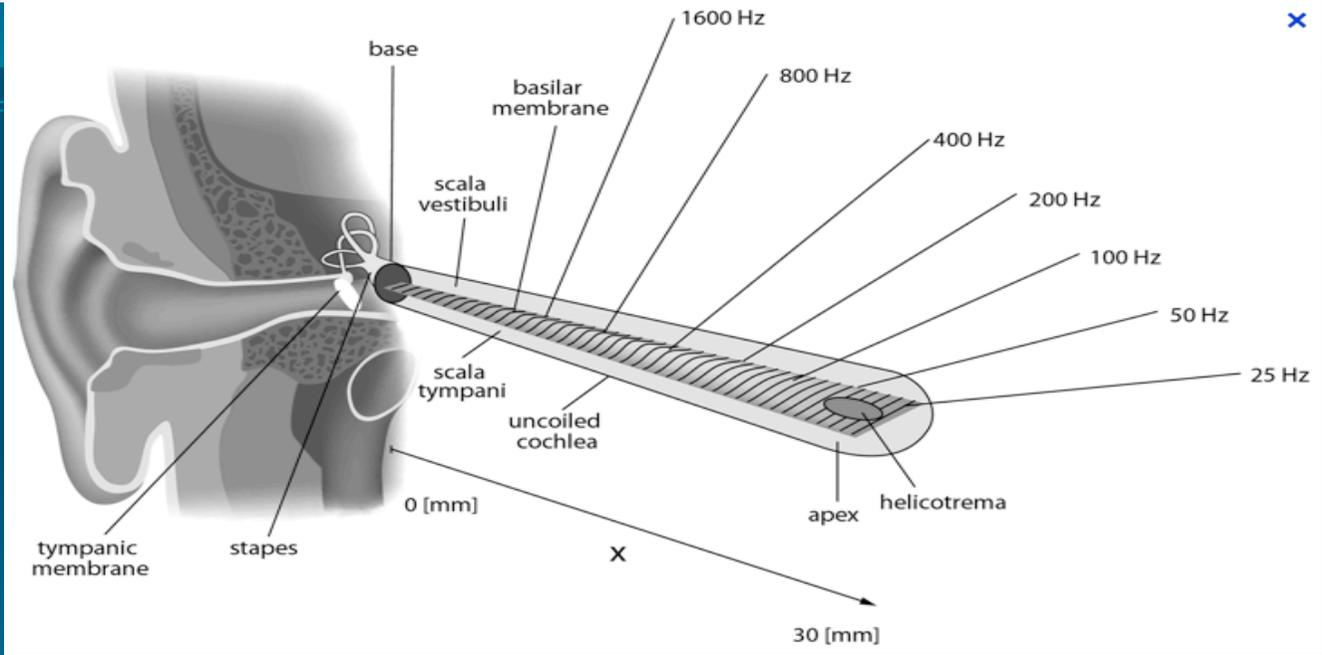
PENSER LES SONS

Psychologie  
cognitive  
de l'audition



Psychologie et sciences de la pensée





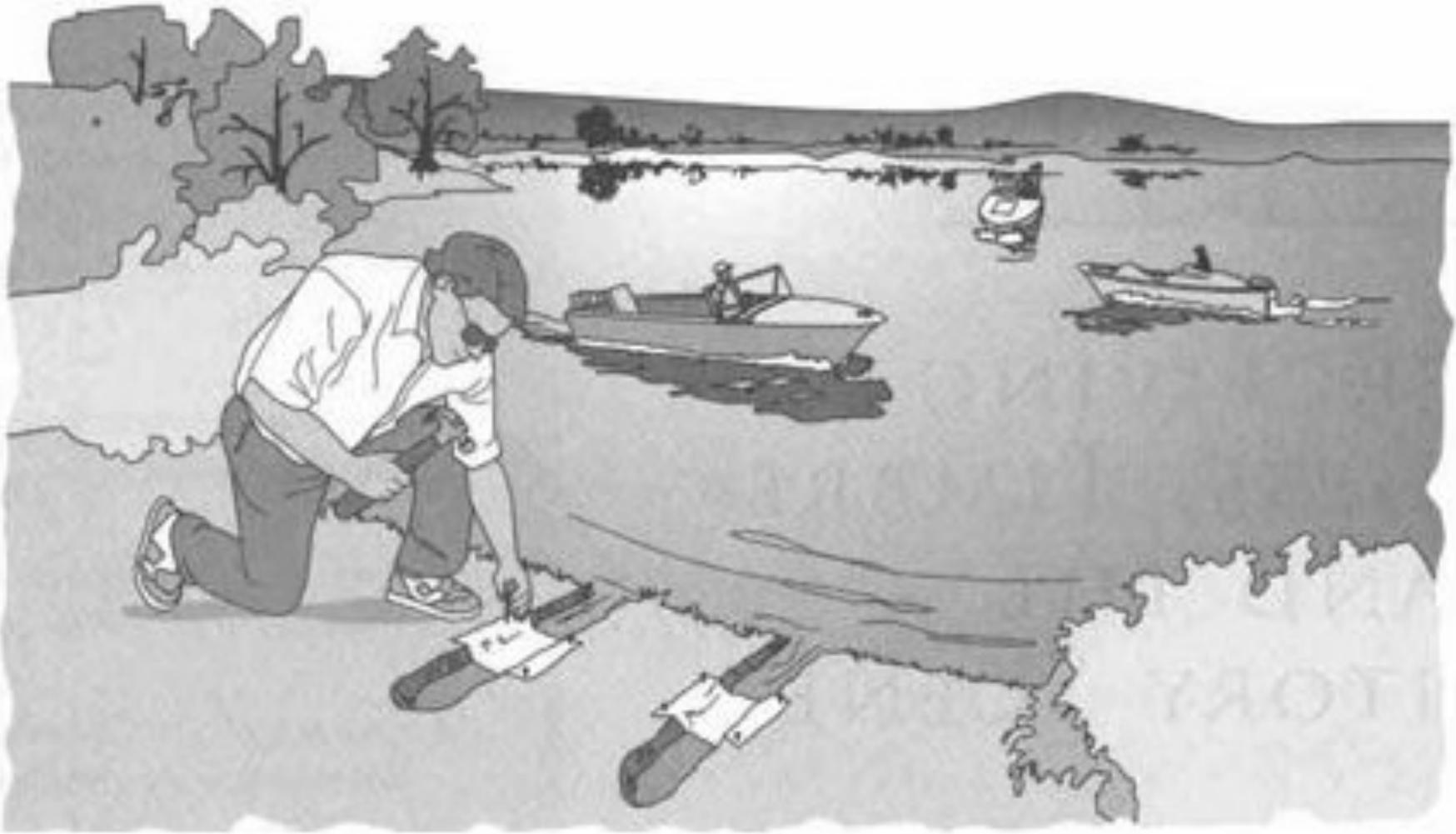


**Une clarinette et une  
cloche**

**ou**

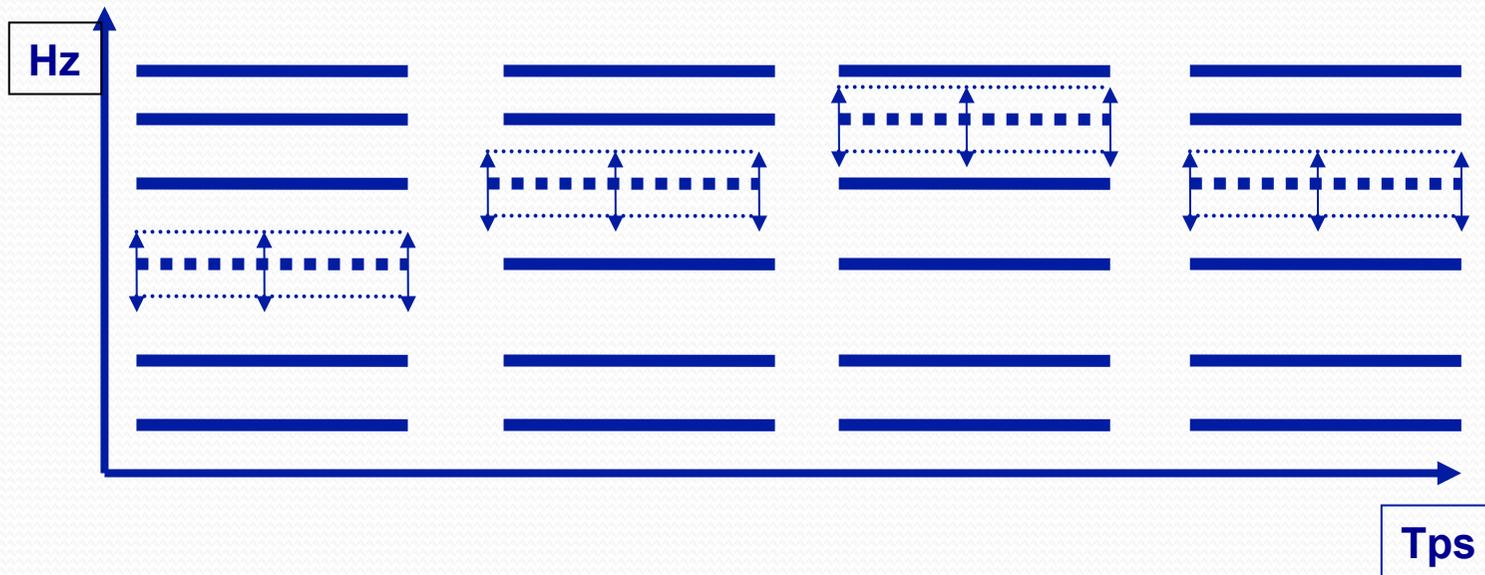


**Une clarino-cloche et une  
cloche-inette ?**



# Groupement simultané (fusion)

## 2. Changements cohérents de fréquence



*Auditory demo.*

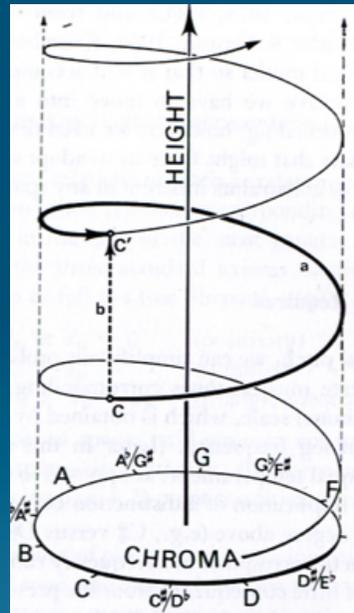
*Musical demo*





1960-1983

# Traitement de la hauteur et illusions auditives



The Tritone Paradox of D# to A

Some other ways that Deutsch's scale illusion is perceived.

The pattern that produces the octave illusion, and a way that it is often perceived.



Rozen Risset

Gold Medal  
CNRS



Polyphonie vocale de Sardaigne

En collaboration avec Bernard Lottat-Jacob

Polyphonie vocale de Sardaigne

Adresse: <http://www.ethnomus.org/ecoute/quintina/seq1.html> aller à

Polyphonie vocale de Sardaigne

Hz  
1500  
1280  
1065  
841  
617  
300

EXTRAIT DU SPECTRE secondes 8 à 13

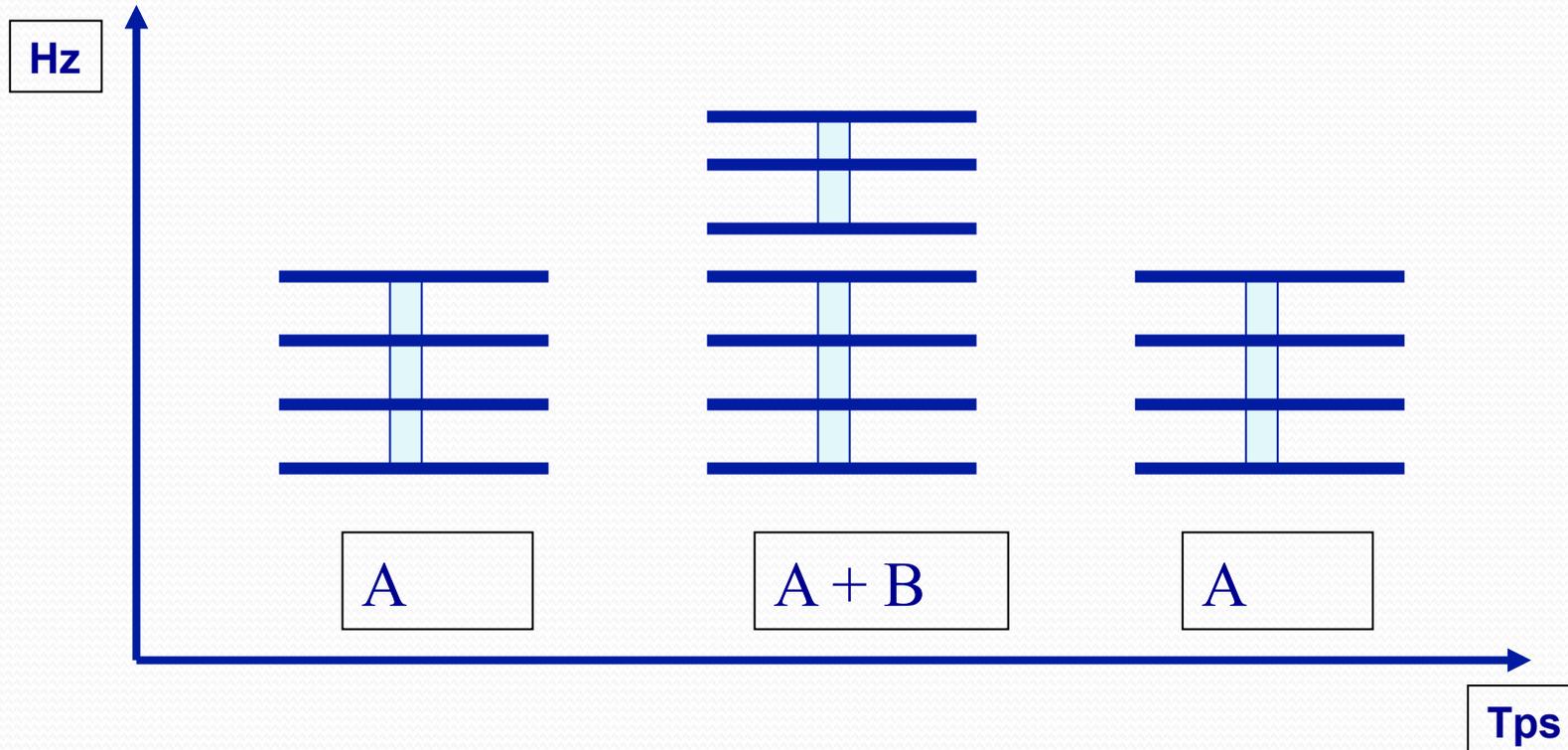
Zone Internet



# L'analyse des scènes auditives explique les règles du contrepoint classique

Groupement simultané (fusion)

Groupement séquentiel (ségrégation des flux)



## Musique spectrale

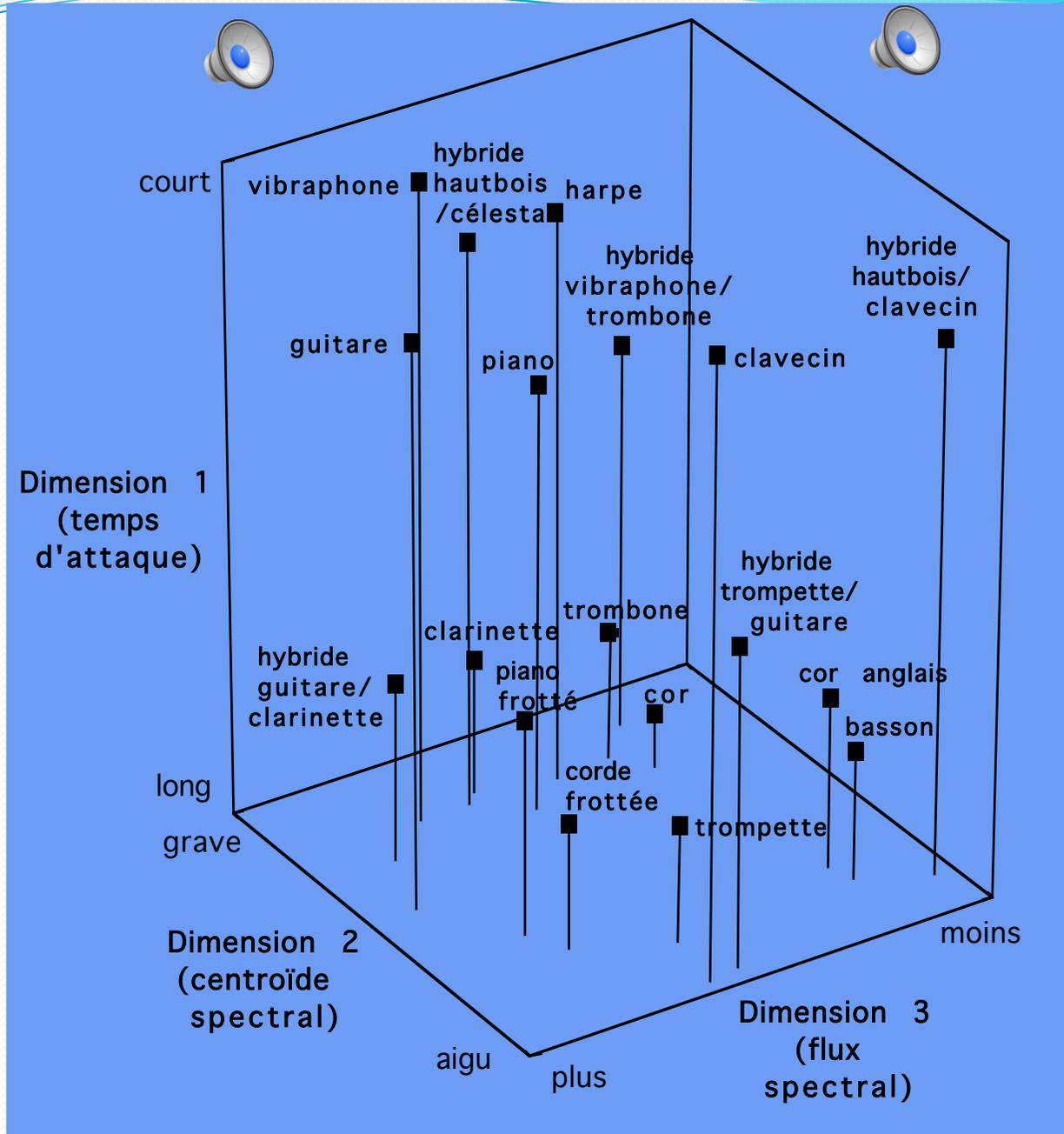


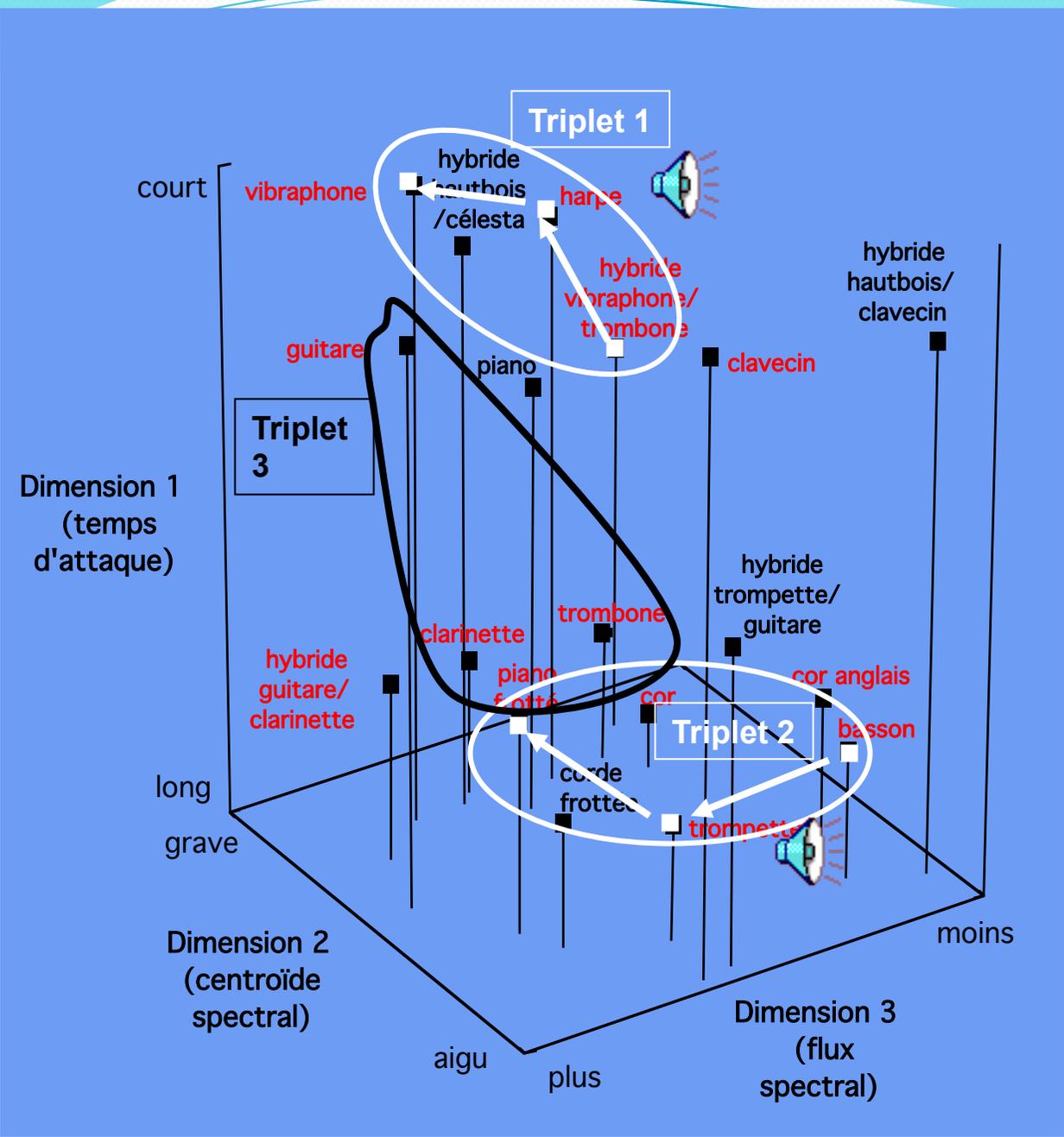
Kaija  
Saariaho

Gerard  
Grisey

Tristan  
Murail

# Espace de timbres musicaux

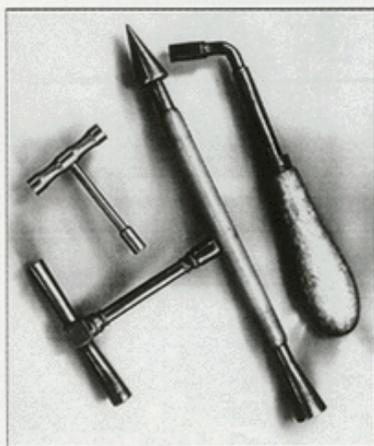




# Musique - intonation - tempérament :

Pierre-Yves ASSELIN

## MUSIQUE ET TEMPERAMENT

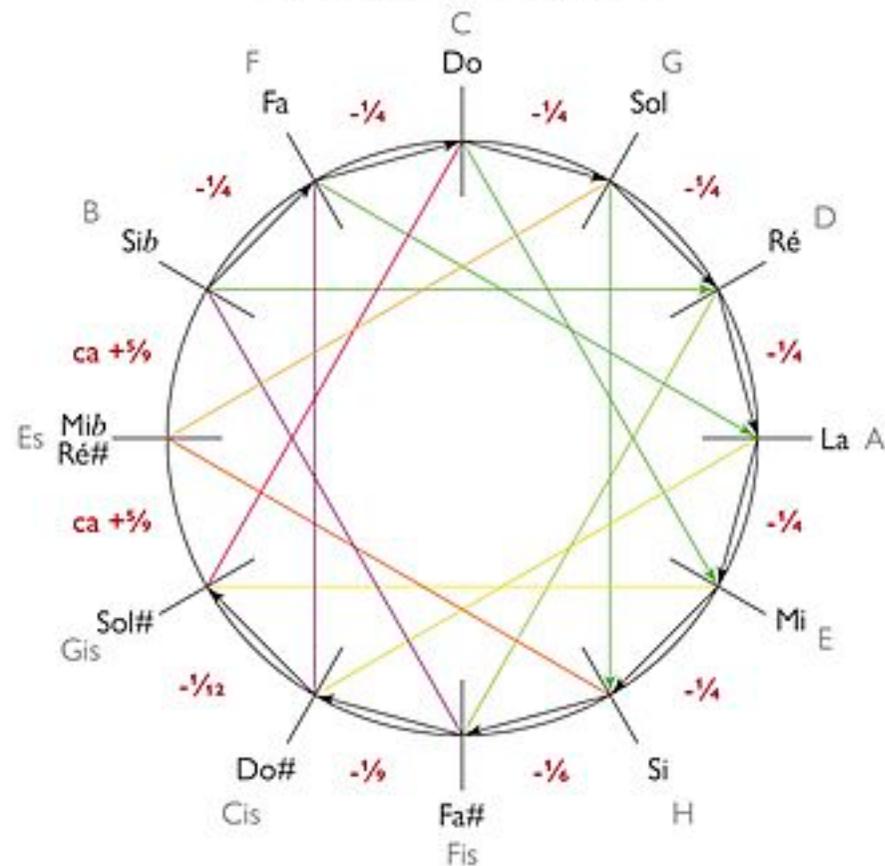


Préface de Marie-Claire ALAIN



Editions JOBERT

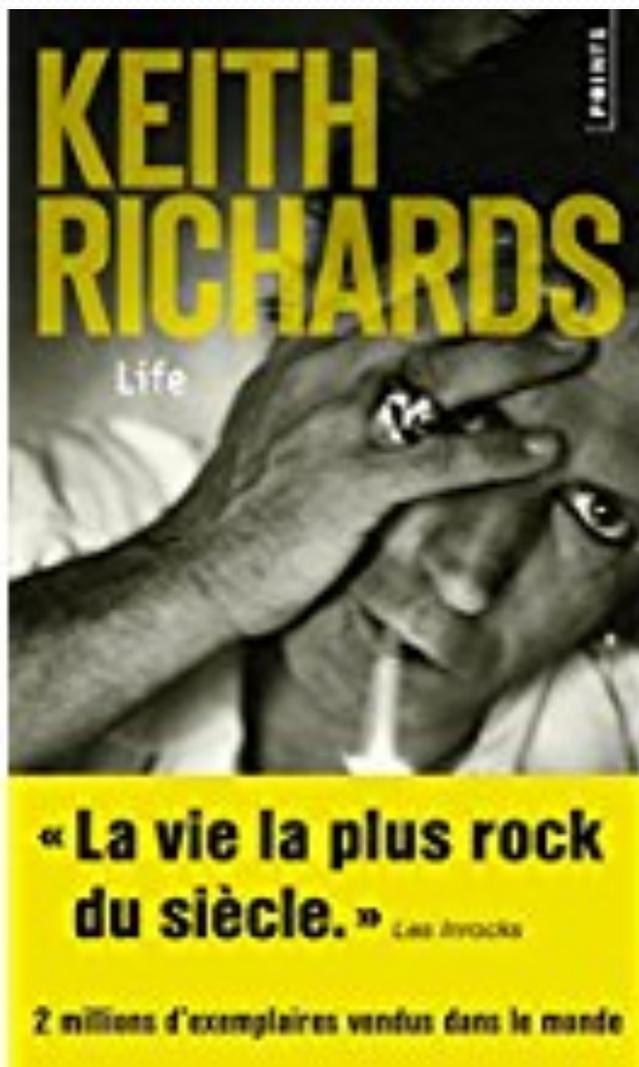
Tempérament d'après le chapitre vingt-quatrième du  
NOUVEAU SYSTÈME DE MUSIQUE THÉORIQUE  
de Jean-Philippe Rameau (1726)



Interprétation de Benjamin Righetti (2016)



Tempérament égal  
écrase les couleurs des  
tonalités



Can't you hear me knocking....  
Open chord





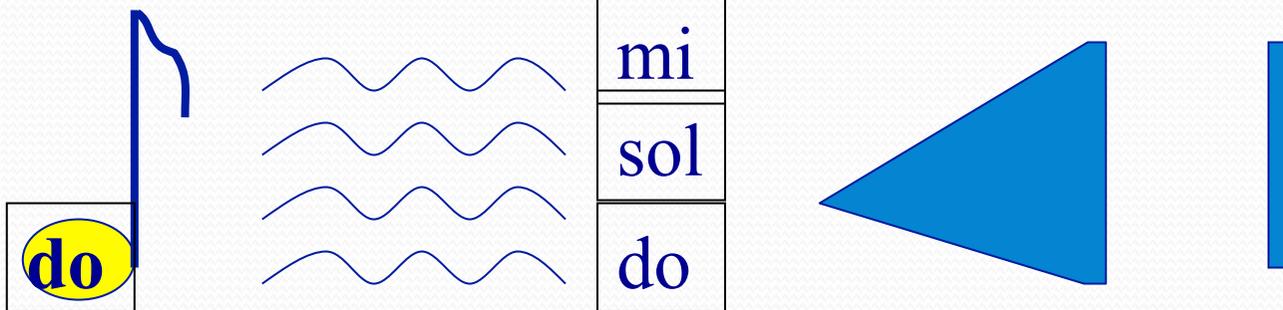
Georg Friedrich Haas

Fondée sur l'intégration du spectre harmonique ainsi que sur la dialectique entre les parties individuelles et le son global qui en résulte, la musique de Georg Friedrich Haas explore les limites des possibilités acoustiques et harmoniques de la gamme tempérée,

# 1. L'apprentissage implicite de la musique tonale

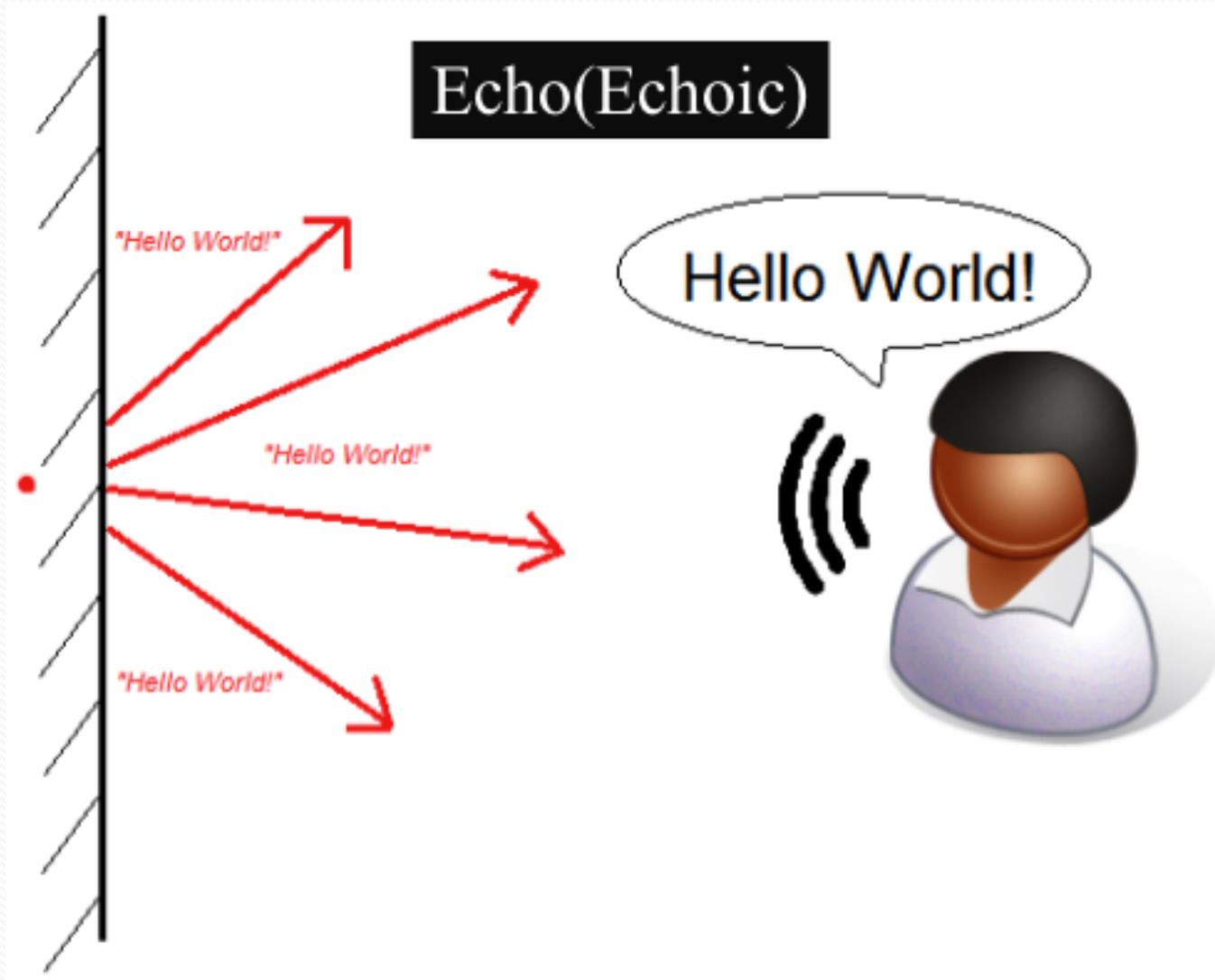
Regolarità statistica = Regolarità sensoriale ?

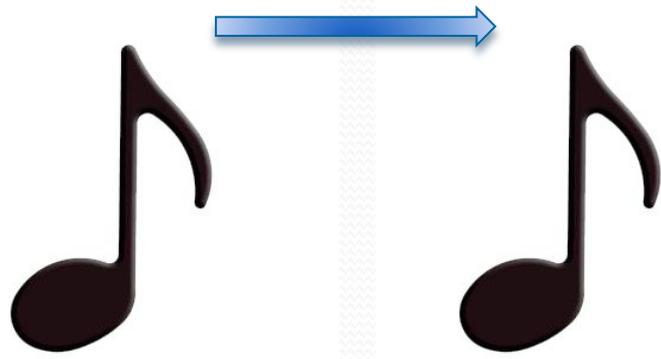
Parncutt, Huron, Leman, : Modele de memoria sensoriale



La probalita de transito tra gli noti e accordi e legato a la loro contextualita tonale nel la memoria sensorial

# La mémoire échoïque





TU SAIS MAMON, JE VA TE DIRE  
QUELQUE-CHOSE. TU SAIS... EH BEN  
L'AUTRE JOUR... TU SAIS... HEU...  
JE VA TE DIRE... L'AUTRE JOUR...  
ALORS JE VA TE RACONTER... BEN TU VOIS,  
L'AUTRE JOUR... HUMMM... QU'EST-  
CE QUE JE DISAIS?... AH OUI!...  
L'AUTRE JOUR, TU VOIS... JE T'A PAS  
RACONTÉ... HEU... PARCE QUE VOILÀ...  
TU SAIS QUOI... BEN VOILÀ... ALORS BON...  
TU IMAGINES UN PEU?... NON MAIS  
JE VA TE DIRE, ATTENDS UNE MINUTE...  
QUE JE ME RAPPELLE... L'AUTRE JOUR,  
DANS LA COUR DE RÉCRÉ... HEU... TU VOIS...  
DANS LA COUR DE RÉCRÉ...



# Retrieval from the Echo

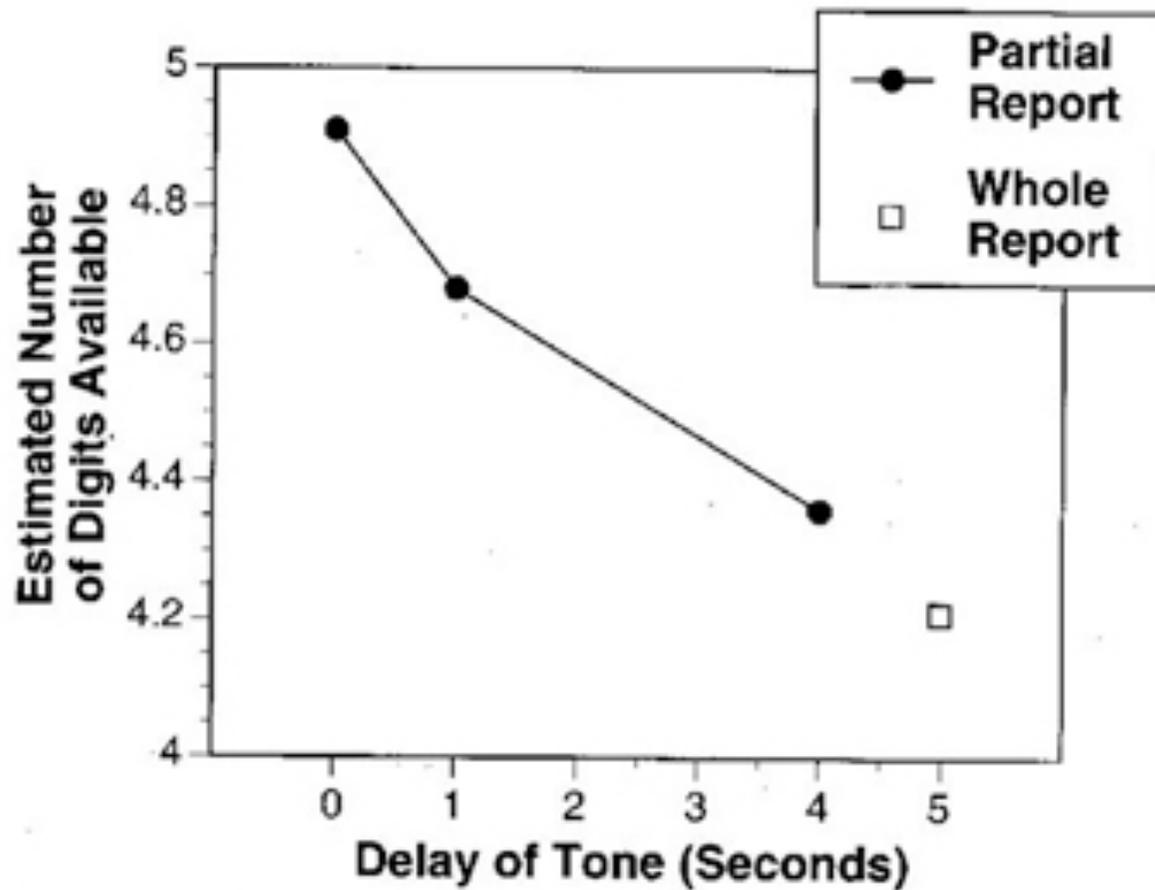
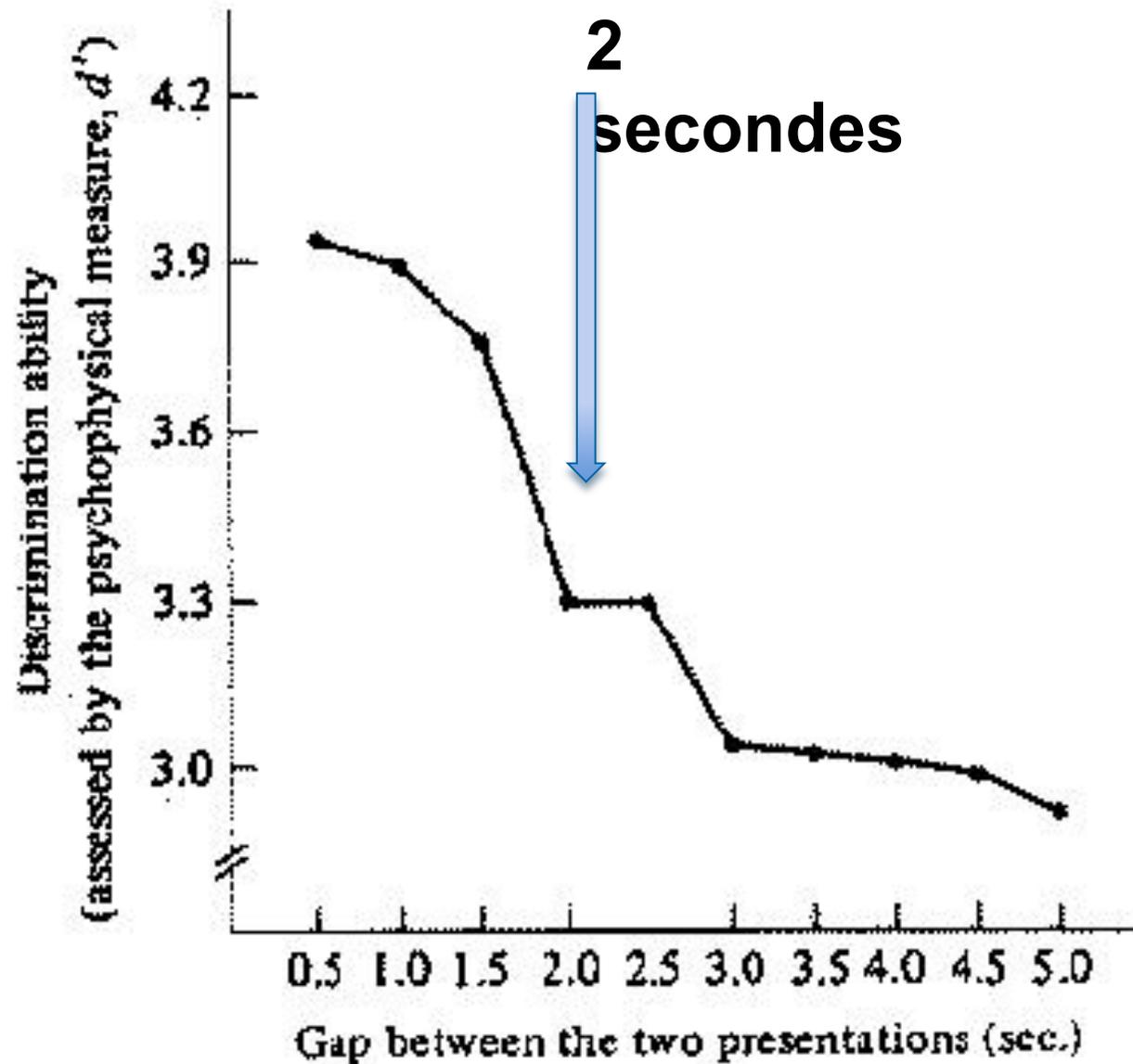


Figure 3.4 Estimated number of digits available when using the partial report technique as a function of the interval between hearing the digits and the presentation of the visual signal. Source: Darwin, Turvey, & Crowder (1972).



**Même ou  
différent ?**

## The Ability to Discriminate between Two Sounds (Based on Crowder, 1982a).

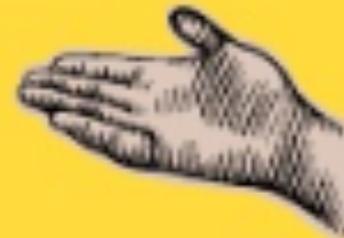


A musical score for piano in 4/4 time, consisting of two measures. The score is written on four staves: two for the treble clef and two for the bass clef, grouped by a large blue brace on the left. The key signature is one sharp (F#), and the time signature is 4/4. The first measure contains four quarter notes: G4 (treble), E4 (treble), G3 (bass), and E3 (bass). The second measure contains four quarter notes: A#4 (treble), E4 (treble), A#3 (bass), and E3 (bass). The notes A#4 and A#3 are highlighted in pink.

Iconic  
0.5 sec. long

Echoic  
3-4 sec. long

Haptic  
< 1 sec. long

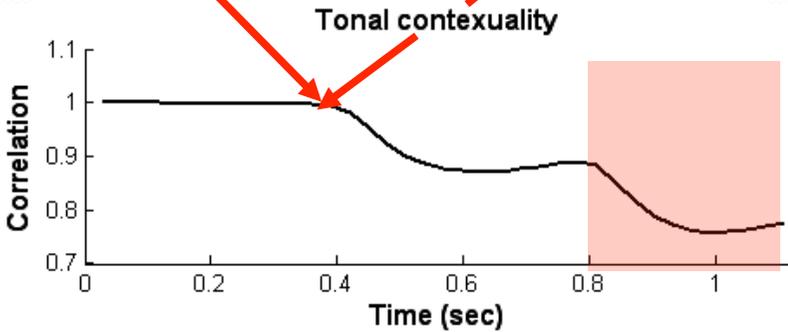
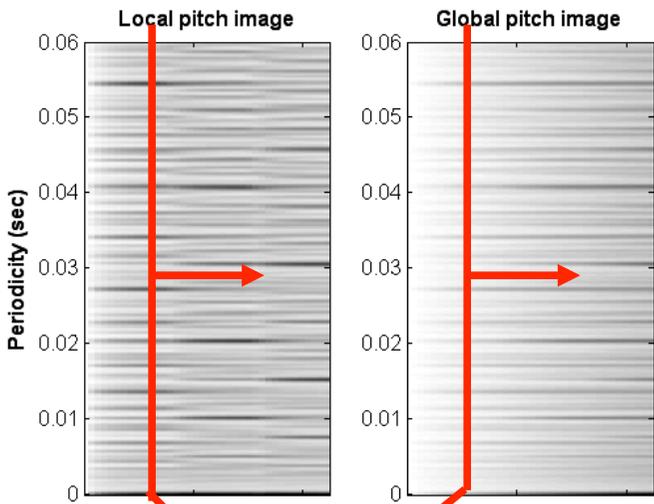
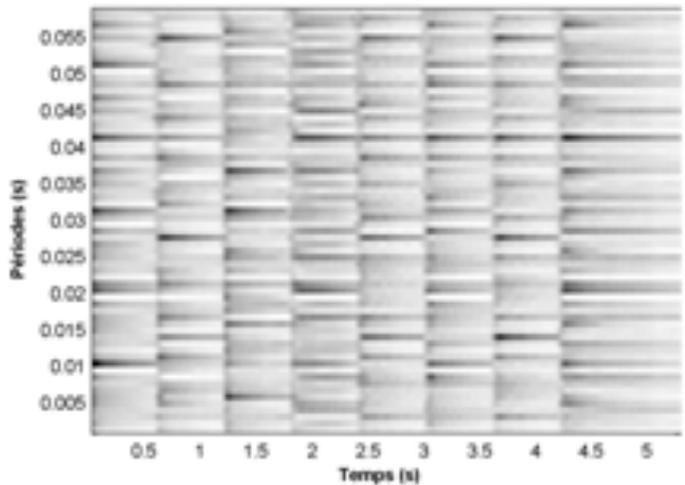




Mémoire à court terme

Percept immédiat

Contexte global



**Contextualité tonale :**  
différence entre ces deux images à chaque instant





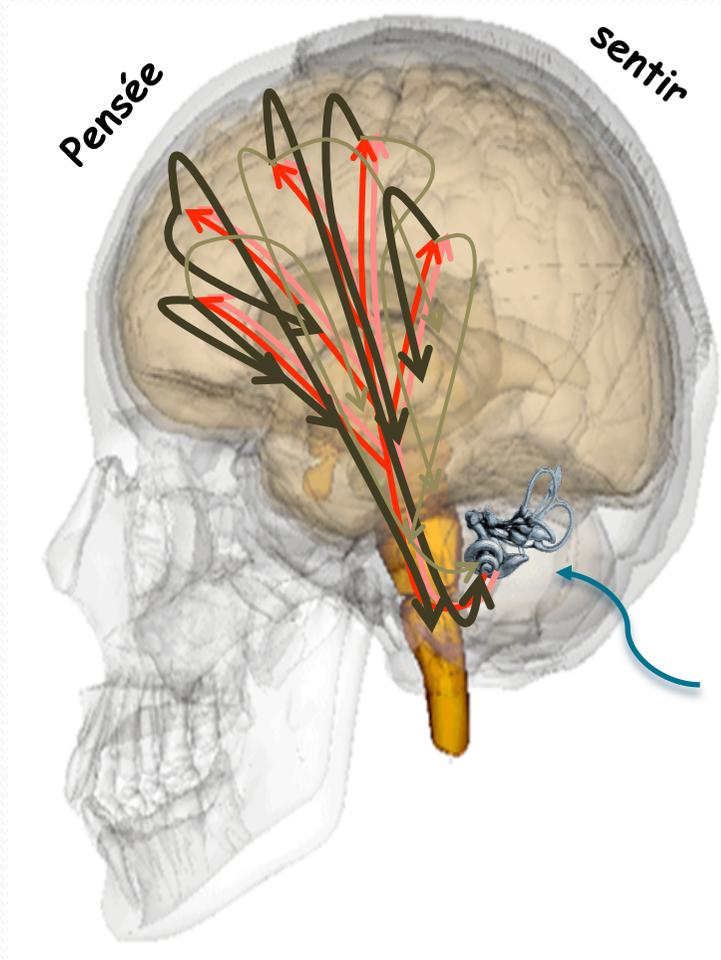
David Huron (Ohio)  
Marc Leman (Ghent)  
Richard Parncutt (Gratz)

# SUITE II.

## Prélude.



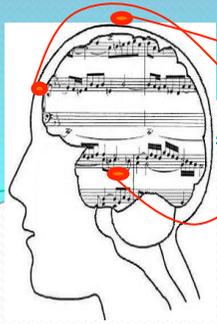
agir



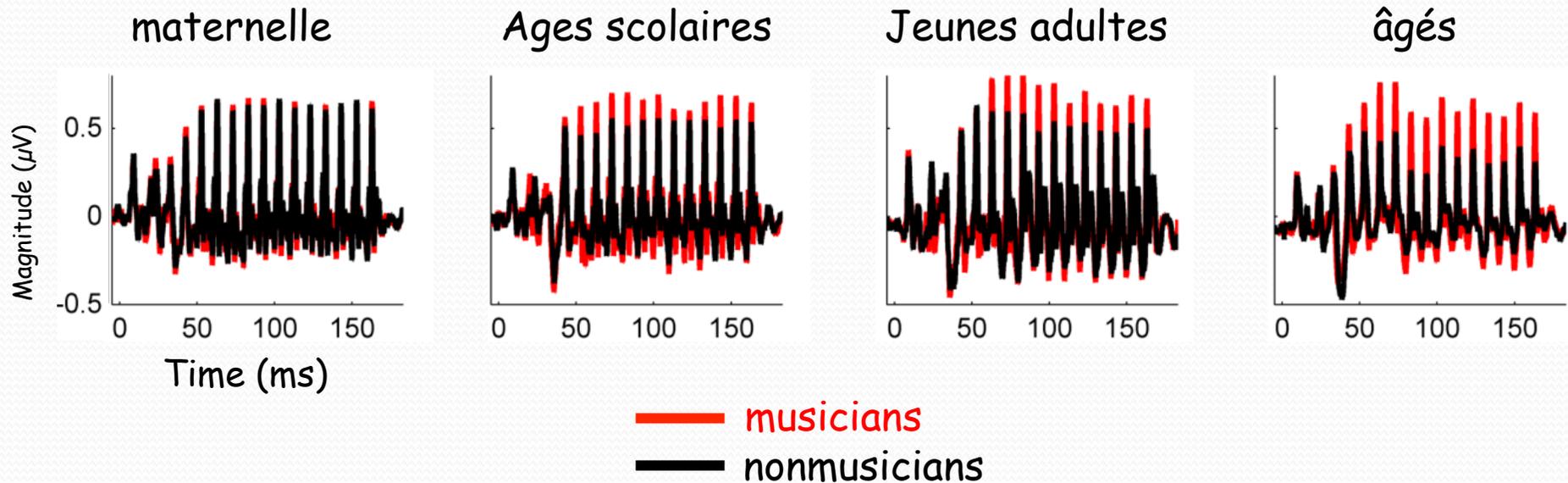
MUSIQUE



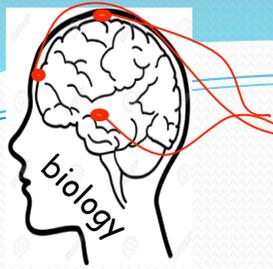
COGNITIVE, SENSORIMOTEUR, RECOM



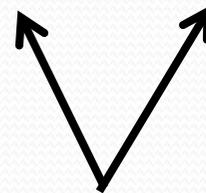
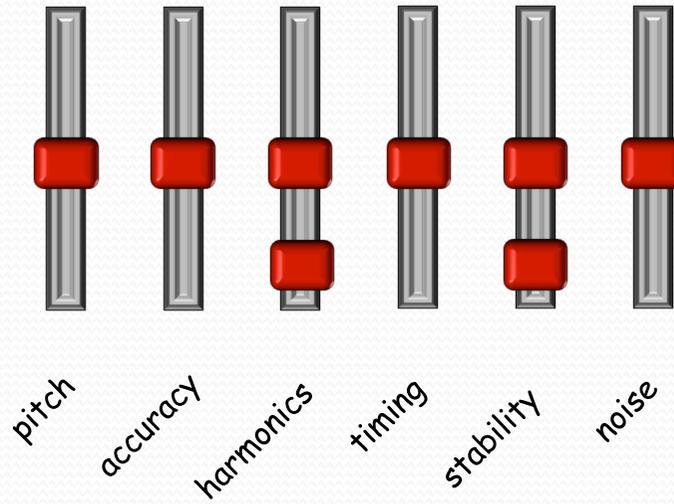
# Faire de la musique améliore le traitement du sons



Reviewed in:  
Kraus and White-Schwoch, *The Neuroscientist*, 2017

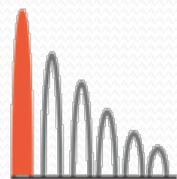


# Compenser la Déprivation linguistique

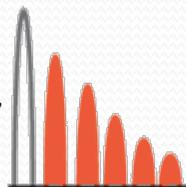


# FFR

Fréquence  
fondamentale



Harmoniques



Temps



tps dans le bruit



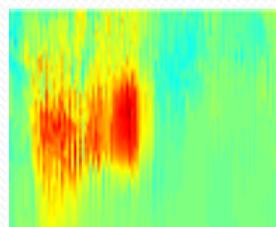
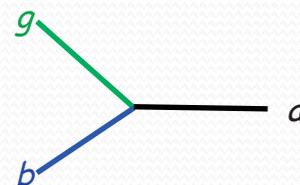
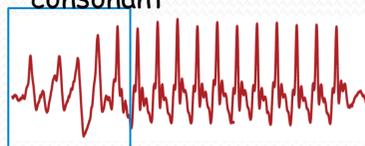
Précision  
Correlation stimulus  
réponse

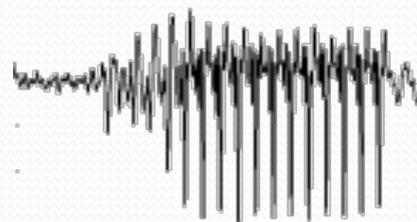
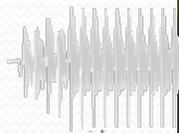


Stabilité



consonant





Onde sonore

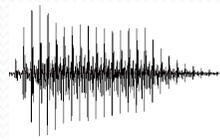
Onde cérébrale



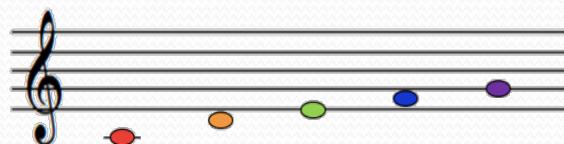
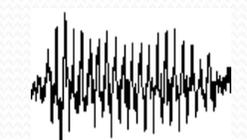
da  
haut



da  
?

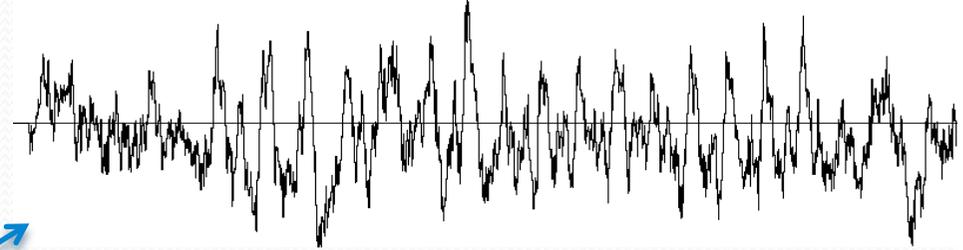


hautbo  
is

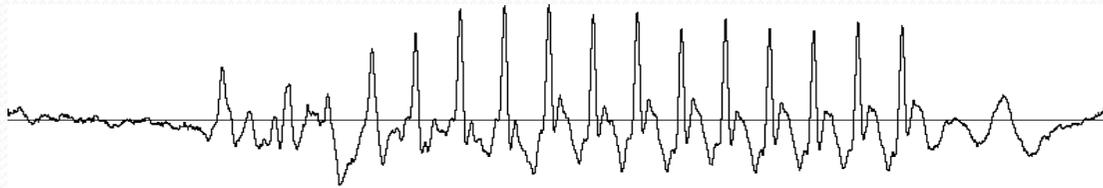


# La musique conserve votre cerveau jeune

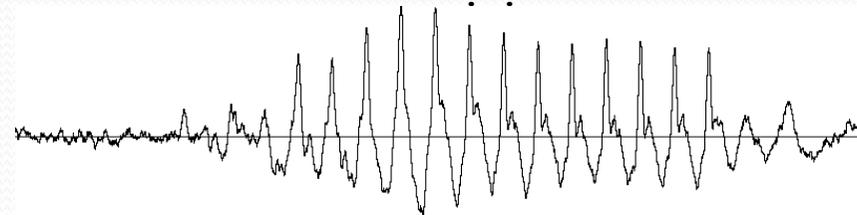
Agés



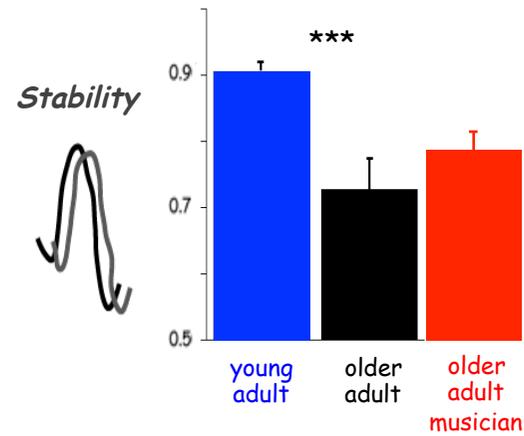
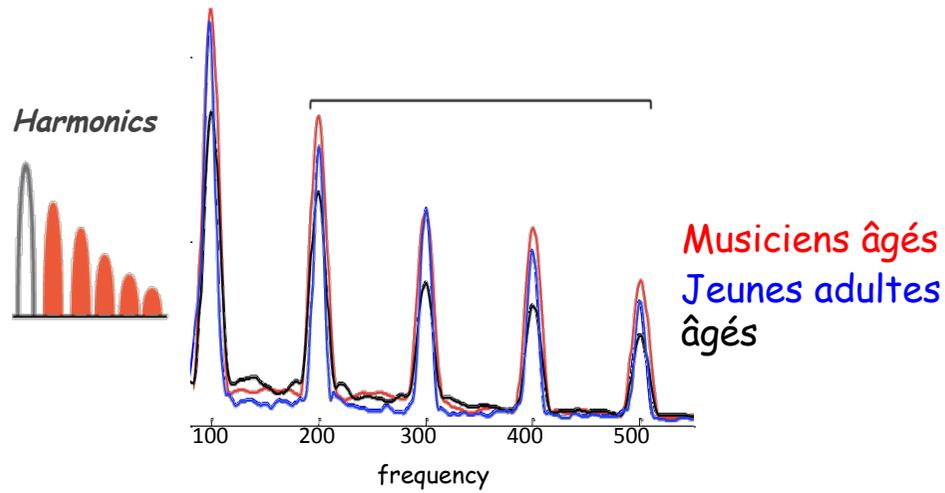
Jeune



Musiciens âgés

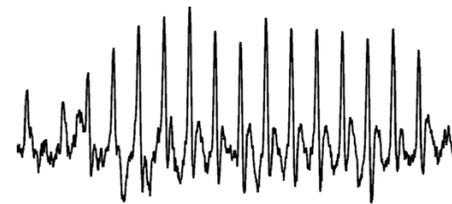


# Vieillesse biologique

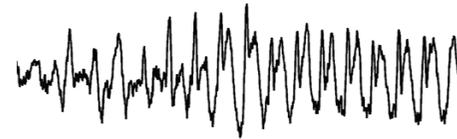




Silence



Bruit



musicians

nonmusicians

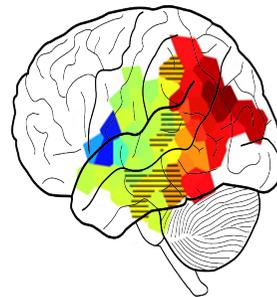
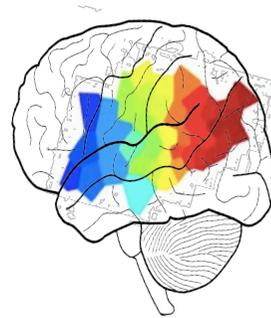


Explosion



Sports

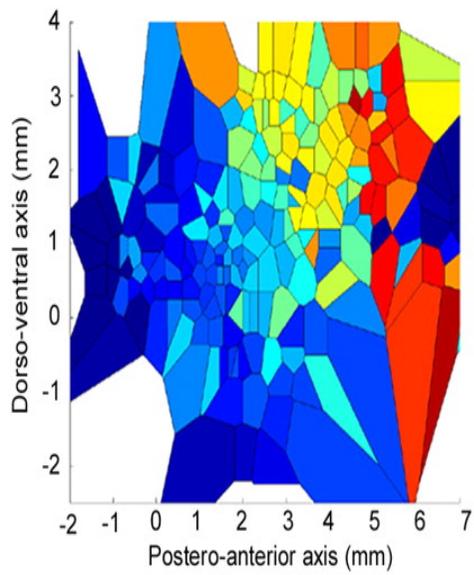
# Un niveau modéré de bruit dérègle le cerveau



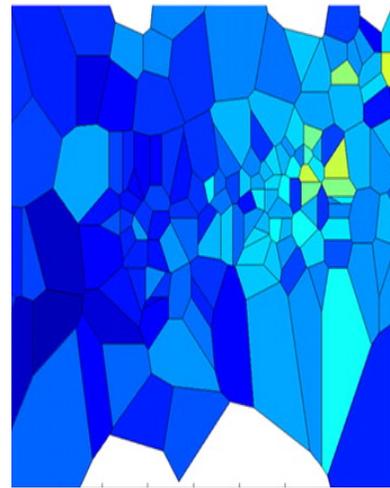
Chang & Merzenich (2003) *Science*  
Zhou et al. (2011) *J Neurosci*  
Pienkowski, Munguia & Eggermont (2013) *Hear Res*  
Hesse et al., (2016) *Front Neurol*



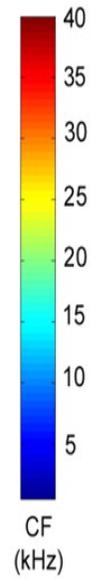
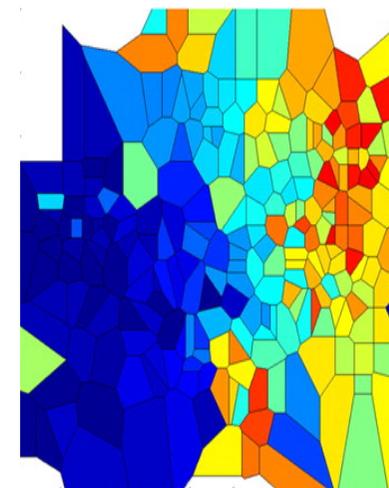
Cortex auditif contrôle



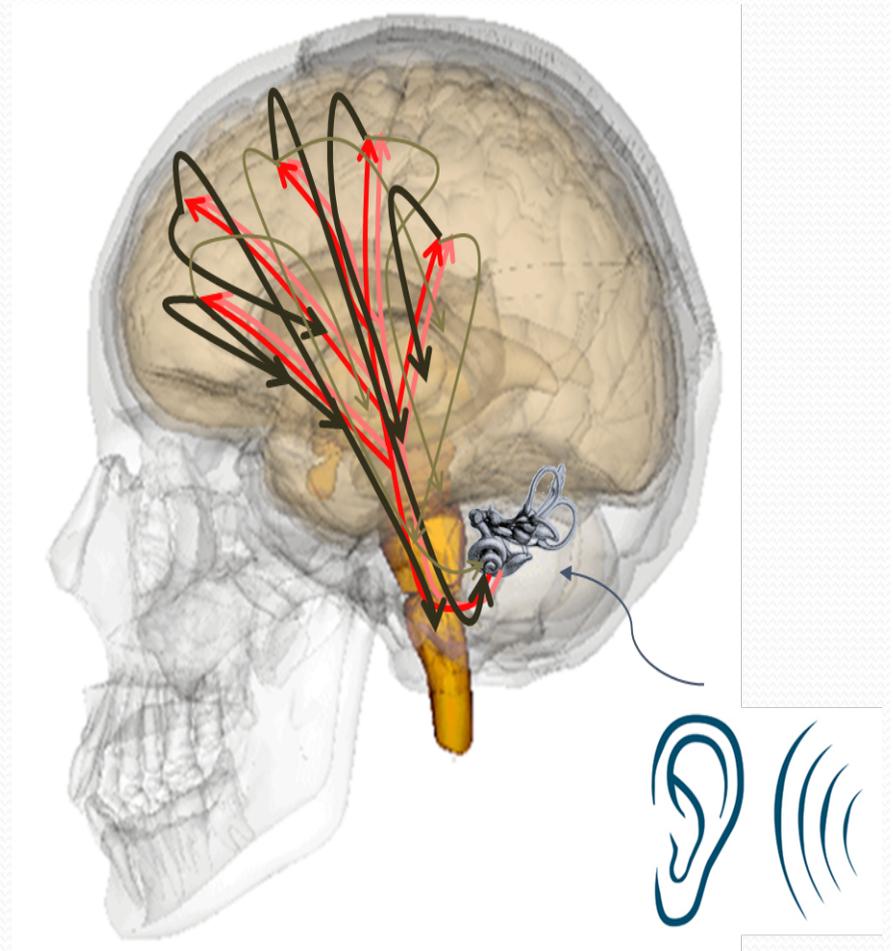
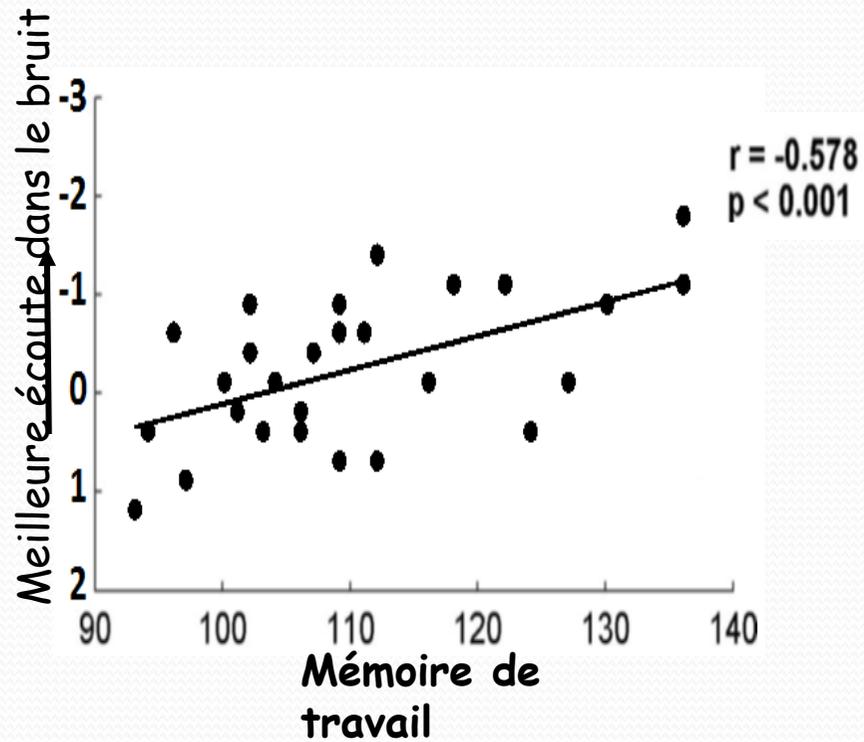
Exposé au bruit



Exposé au bruit  
Enrichissement auditif



# Entendre dans le bruit requiert la cognition



FFR - un instantané sur la santé cognitive

## Rythme du langage



# Musique contemporaine & cerveau

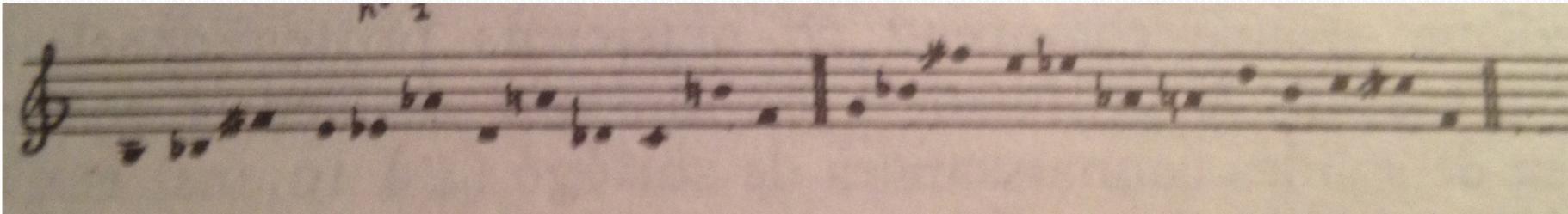


**La série instaure une  
cohérence qui crée une  
unité perceptive pour  
l'auditeur**



**Série 1**

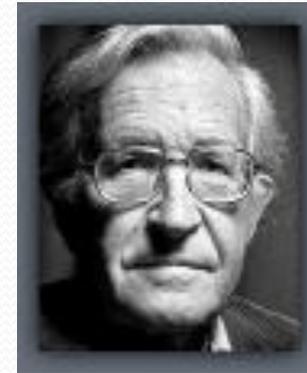
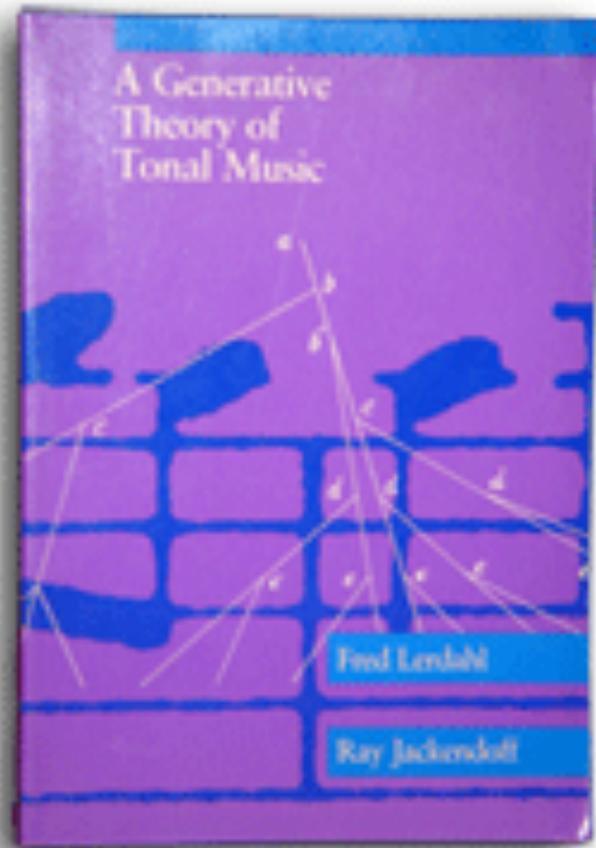
**Série 2**

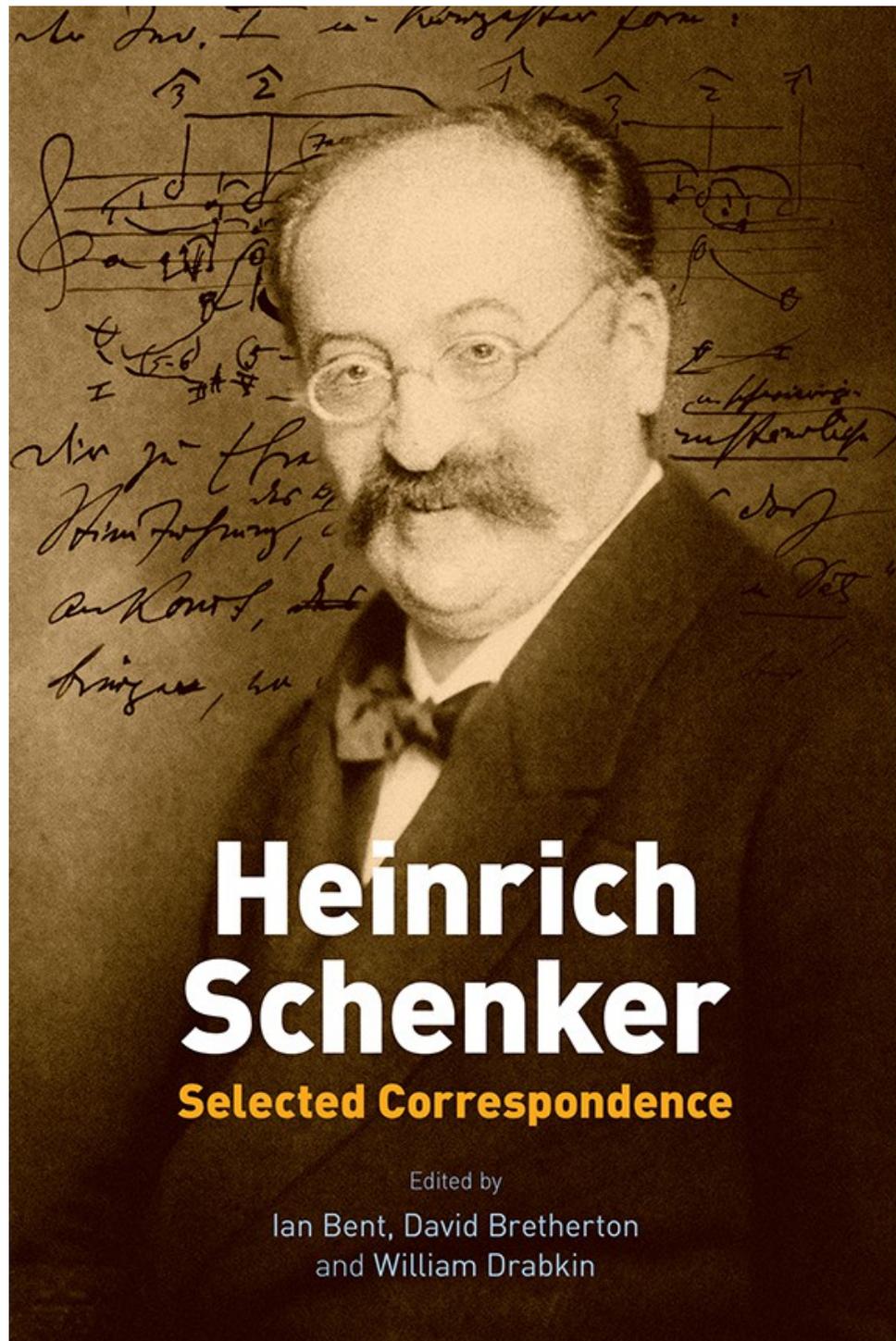


**Il existe des contraintes cognitives sur les langages musicaux**

**Un cerveau humain n'est pas supposé pouvoir assimiler des langages musicaux qui ne répondent pas à ces contraintes**

Il existe des contraintes cognitives générales qui pèsent sur les systèmes linguistiques et musicaux





# Heinrich Schenker

Selected Correspondence

Edited by  
Ian Bent, David Bretherton  
and William Drabkin

**Bien avant Noam Chomsky, le musicologue H. Schenker décrit le langage musical comme une « grammaire générative »**

MUSIC,  
LANGUAGE,  
and the BRAIN

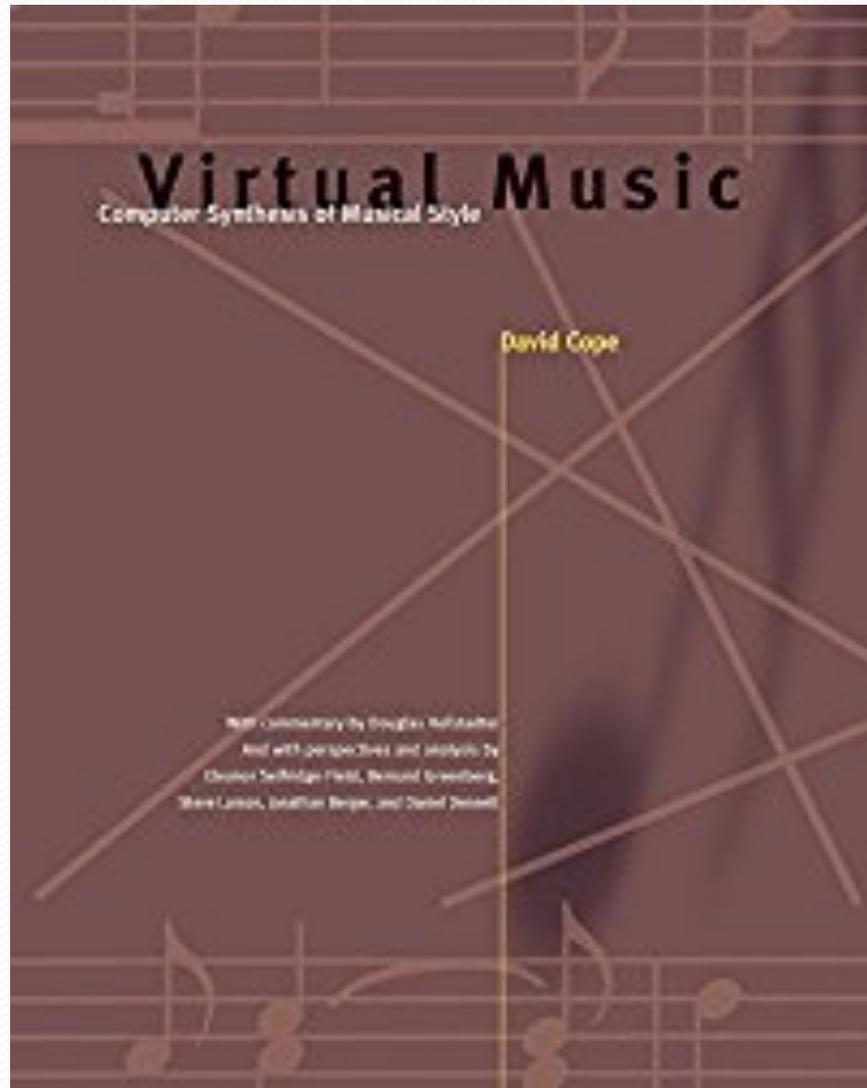


ANIRUDDH D. PATEL



**Les neurosciences  
confirment le lien  
entre musique et  
langage**

## Grammaire générative des styles musicaux :



## Les « universaux » musicaux



The border between music and noise is always culturally defined—which implies that, even within a single society, this border does not always pass through the same place; in short, there is rarely a consensus....

By all accounts there is no single and intercultural universal concept defining what music might be

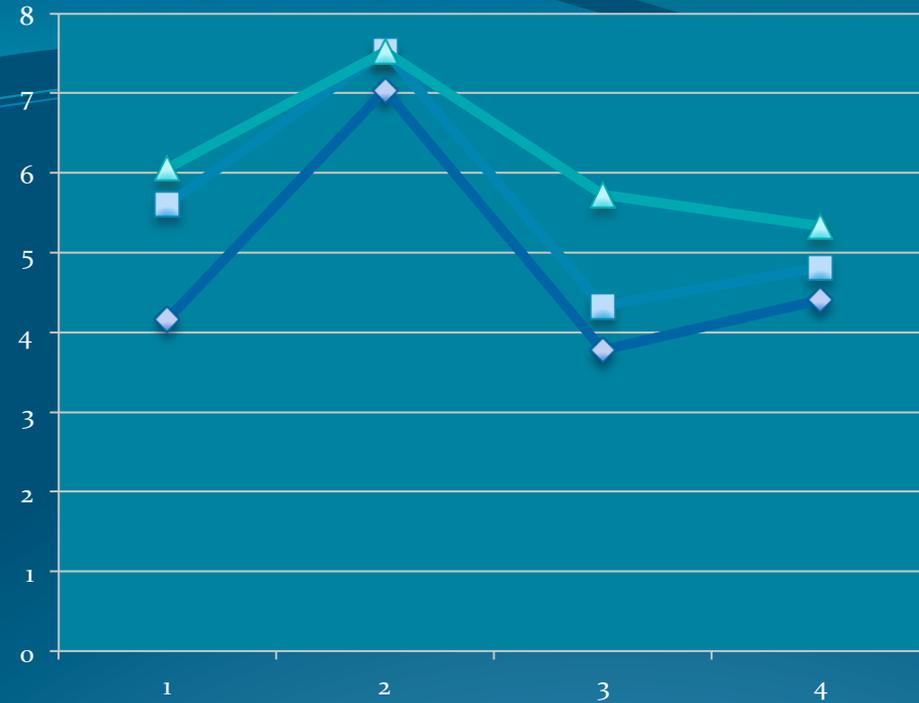
— *Jean-Jacques Nattiez* —

AZ QUOTES



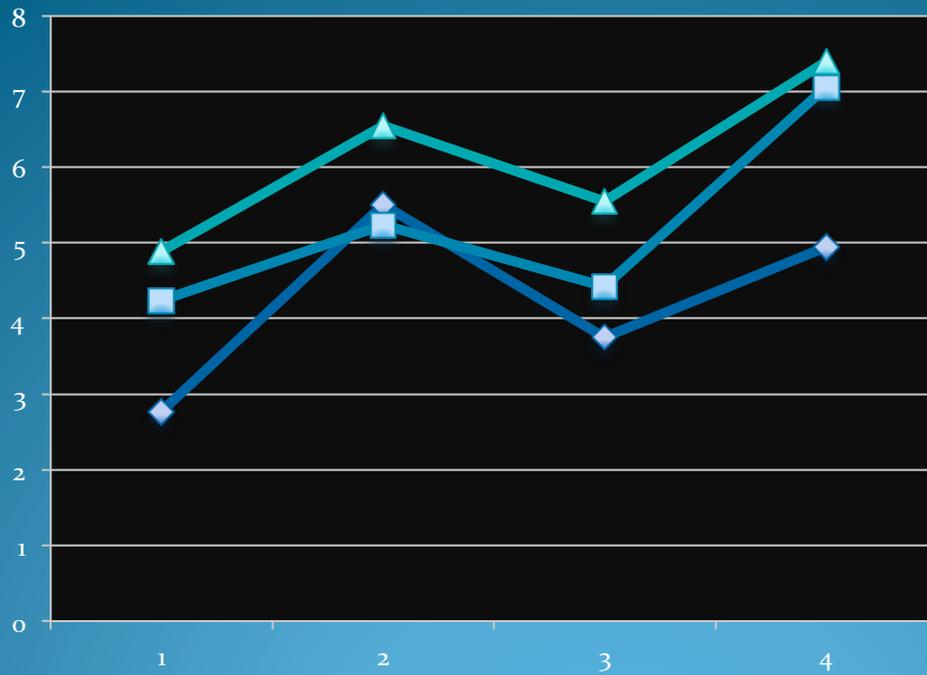


Hit -  
FA



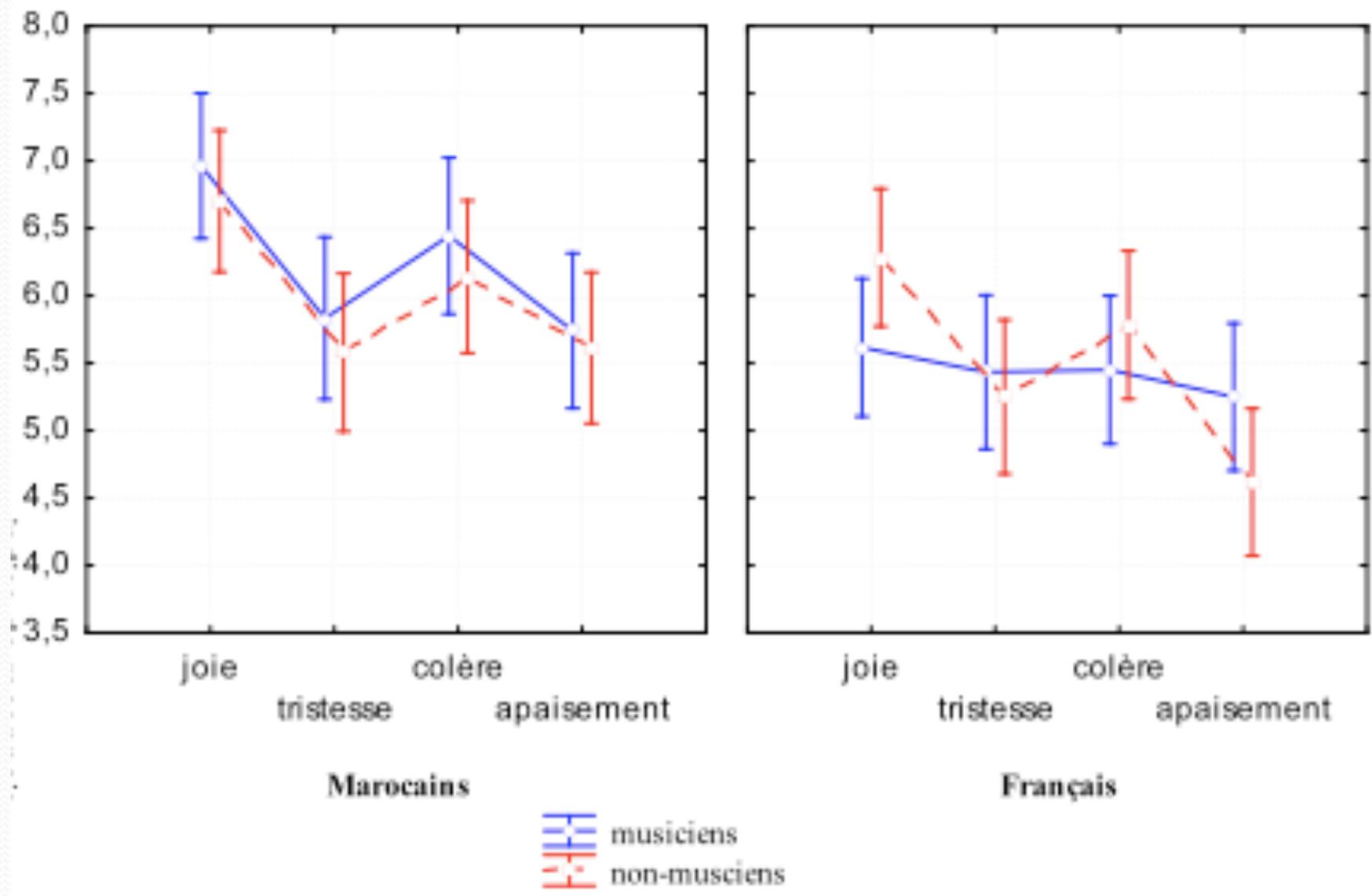
◆ Séries1  
■ Séries2  
▲ Séries3

Hit -  
FA



◆ Séries1  
■ Séries2  
▲ Séries3

- **Catégorisation émotionnelle : appartenance culturelle x expertise musicale**



JJ Nattiez

**Peut-on *traduire* la musique?**



# Musique ↔ Cerveau

