Musique, danse et neurones miroirs: l'exemple du tango

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TANGO ROSARIO IV CONGRESO INTERNACIONAL DE TANGOTERAPIA

INTERNATIONAL ASSOCIATION OF TANGO THERAPY

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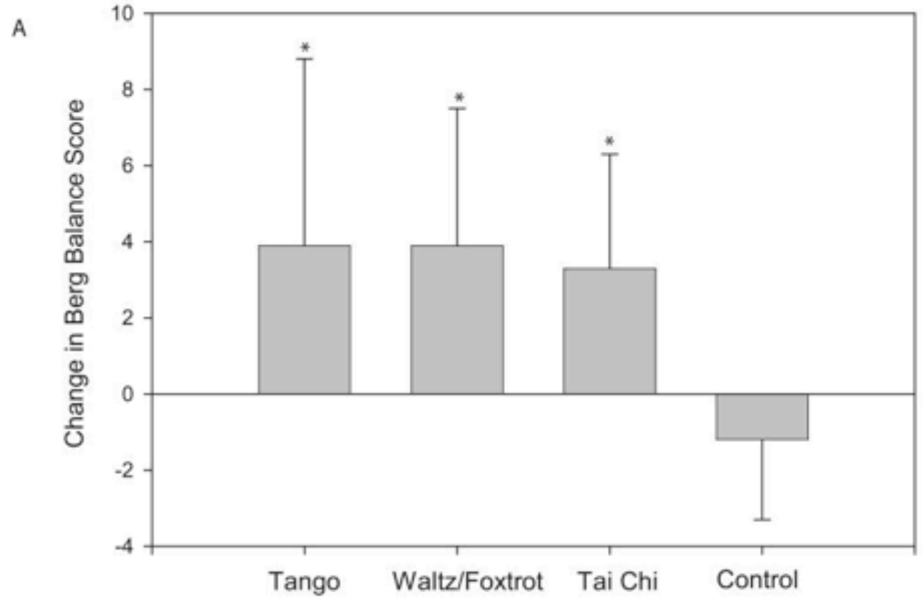
Tango Therapy UK

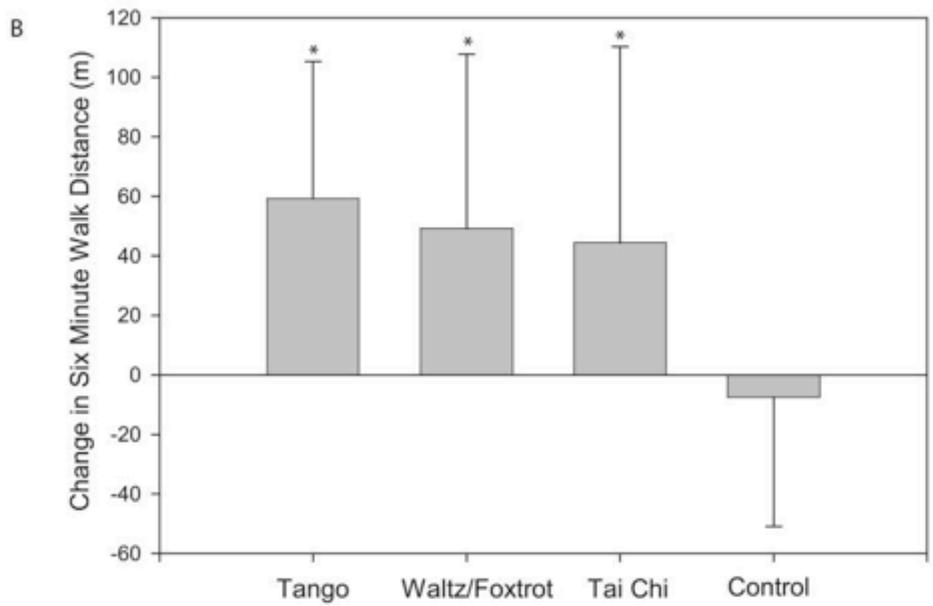
Dance of passion, enchantment and well being

Tango Therapy

Tango & Parkinson's : the studies

- *Effects of Tango on functional mobility in Parkinson's disease : A preliminary Study*. Hackney ME, Kantorovich S, Levin R, Earhart GM. J Neurol Phys Ther. 2007 Dec; 31(4) : 173-9
- *Short duration, intensive tango dancing for Parkinson disease : an uncontrolled study*. Hackney ME, Earhart GM. 2009
- *Effects of dance on gait and balance in Parkinson's disease: a comparison of partnered and nonpartnered dance movement*. Hackney ME, Earhart GM. Neurorehabil Neural Repair. 2010 May;24(4):384-92.
- *Effects of dance on movement control in Parkinson's disease: a comparison of Argentine tango and American ballroom.* Hackney ME, Earhart GM. J Rehabil Med. 2009 May;41(6):475-81.
- *Recommendations for Implementing Tango Classes for Persons with Parkinson Disease.* Hackney M, Earhart G. American Journal Dance Therapy (2010)
- *Randomized Controlled Trial of Community-Based Dancing Modify Disease Progression in Parkinson Disease*. Duncan RP, Earhart GM. Neurorehabil Neural Repair. 2011 Sep 29





Dance as therapy for individuals with Parkinson disease.
Earhart GM. Eur J Phys Rehabil Med. 2009 Jun; 45(2):231-8.

frontiers IN AGING NEUROSCIENCE
Community

ORIGINAL RESEARCH ARTICLE » This article is part of a Research Topic
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Superior sensory, motor, and cognitive performance in elderly individuals with multi-year dancing activities

Jan-Christoph Kattenstroth[1], Izabella Kolankowska[1], Tobias Kalisch[2] and Hubert R. Dinse[1]*

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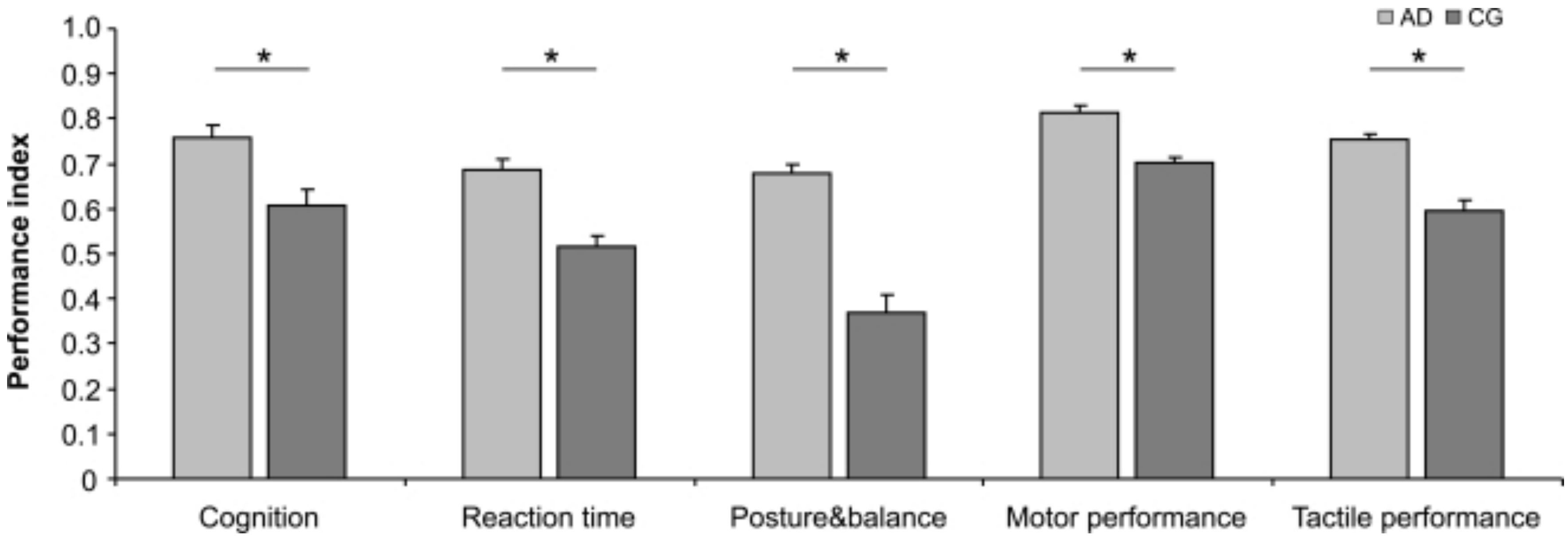
Here we demonstrate the impact of multi-year (average 16.5 years) amateur dancing (AD) in a group of elderly subjects (aged 65–84 years) as compared to education-, gender- and aged-matched controls (CG) having no record of dancing or sporting activities. Besides posture and balance parameters, we tested reaction times, motor behavior, tactile and cognitive performance. In each of the different domains investigated, the AD group had a superior performance as compared to the non-dancer CG group.



SAGE-Hindawi Access to Research
Journal of Aging Research
Volume 2011, Article ID 176709, 10 pages
doi:10.4061/2011/176709

Research Article

Balance, Sensorimotor, and Cognitive Performance Expert Senior Ballroom Dancers

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substantially better performance in the expert group than in the controls in terms of expertise-related domains like posture, balance, and reaction times. However, there was no generalization of positive effects to those domains that were found to be improved in amateur dancers, such as tactile and cognitive performance, suggesting that there might be an optimal range of intervention intensity to maintain health and independence throughout the human lifespan.

Journal of Aging Research

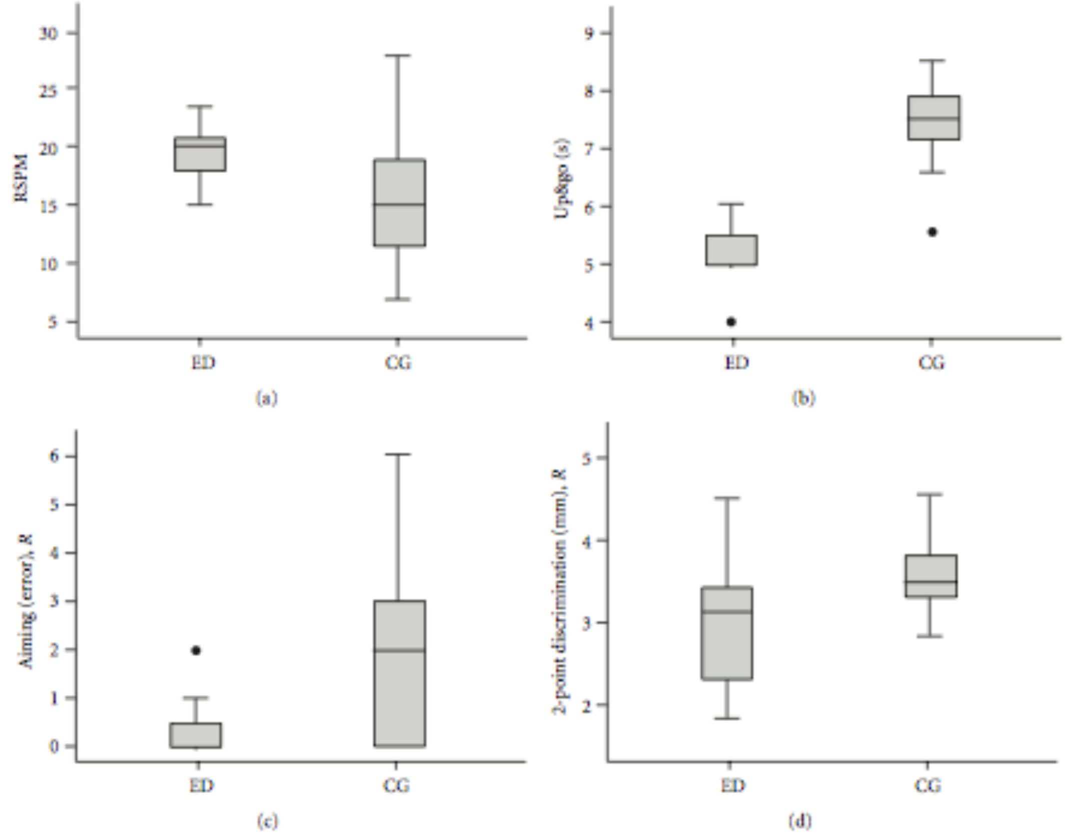


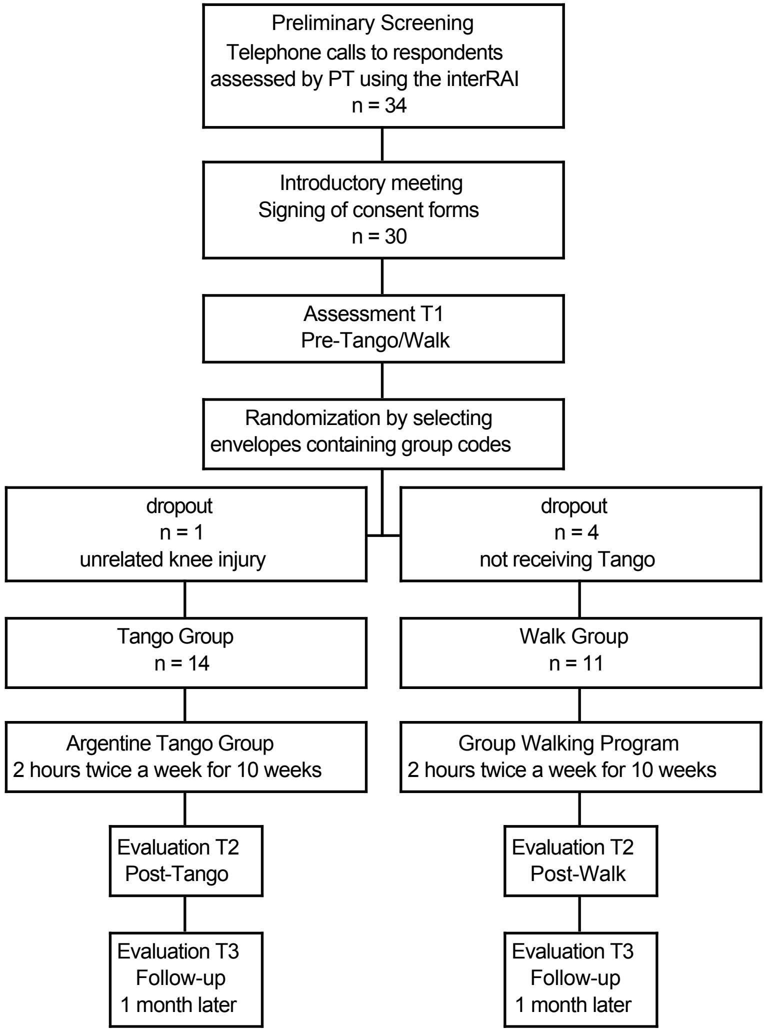
Figure 2: Performance of expert dancers (ED) and a matched control group (CG) for selected tests covering cognitive, posture and balance, motor, and tactile domains. Participants of the ED group showed (a) higher scores in the RSPM ($z = -2.776$, $P = 0.006$), (b) shorter *Up and go* times ($z = -3.819$, $P \leq 0.001$), (c) less errors in the *Aiming* test for the right hand ($z = -2.808$, $P = 0.005$), and (d) lower *2-Point-discrimination thresholds* for the right index finger ($z = -2.434$, $P = 0.015$). Horizontal lines within the boxes represent the medians. Boxes show the top and bottom quartiles, and whiskers represent the minima and maxima within 1.5 interquartile range (IQR). Outliers (>3.0 IQR) are labeled as solid dots.

Figure 1: Single row of the nonverbal geriatric concentration test (AKT). Subjects had to mark 20 symbols equivalent to the one at the top in five rows of 55 similar looking patterns within a maximum time limit of 30 s. After an initial training session, three consecutive sessions were run. Needed times for each session were averaged for evaluating individual performance.

Journal of Aging and Physical Activity, 2008, 16, 435-453

Effect of a Community-Based Argentine Tango Dance Program on Functional Balance and Confidence in Older Adults

Patricia McKinley, Allison Jacobson, Alain Leroux, Victoria Bednarczyk, Michel Rossignol, and Joyce Fung



Doing the tango improves the aging brain

The sultry moves of Argentine tango dancing can help the aging brain. McGill researchers have discovered that the fancy footwork required to perform the tango bolsters brainpower and improves balance.

With Canada's growing aging population, this news is music to health professionals' ears. About one-third of the elderly population in Canada experiences a fall each year and 40 percent of hospital admissions of this age group are due to fall-related injuries. Statistics show that 71 percent of seniors over the age of 65 live alone, and many spend more than seven hours a day without any social contact. This isolation, coupled with the normal aging process, can lead to cognitive decline.

This is where tango steps in. "Our findings suggest that tango may be better than walking for improving the execution of complex tasks and the ability to move within a restricted area without losing one's footing," says McGill University School of Physical and Occupational Therapy professor Patricia McKinley.

For the study, funded by the Drummond Foundation, researchers recruited 30 seniors from Cummings Jewish Senior centre, aged 62 to 90. All were healthy individuals who had experienced a fall within the last year and had developed a fear of falling. Half the group was assigned to take tango lessons and the other half to a walking group. Each group met for two hours twice a week for ten weeks at the Constance Lethbridge Rehabilitation Centre. The tango group showed more improvement in balance, posture and motor coordination, as well as cognitive gains, than the walking group. They also performed significantly better than the walking group at performing a complex cognitive task while walking, standing on one foot, or turning in confined spaces.

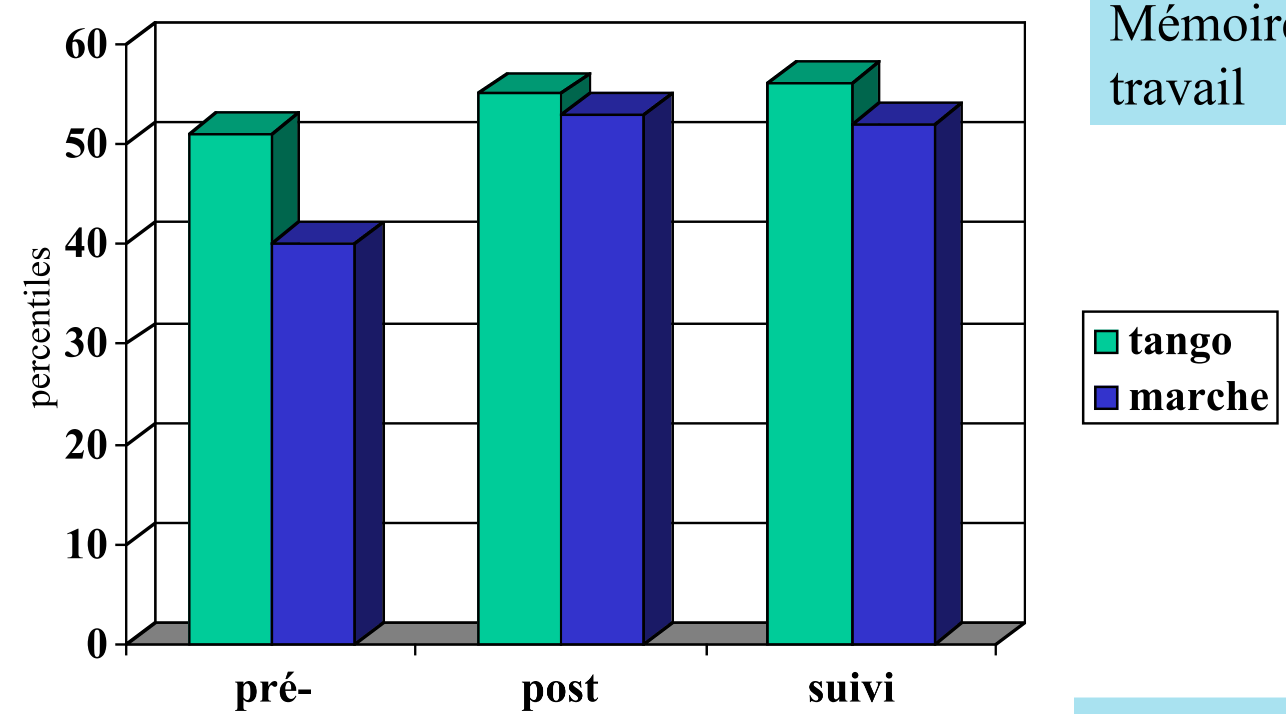
Memory testing, however, was inconclusive, perhaps because the sample size was not large enough, says McKinley.

"Tango dancing is an ideal leisure activity for this population," says McKinley. "It satisfies three basic requirements for exercise adherence: it's fun, it's a group activity, and it has a tangible goal that can be perceived not only by the dancer, but by his or her family and friends."

Source: McGill University

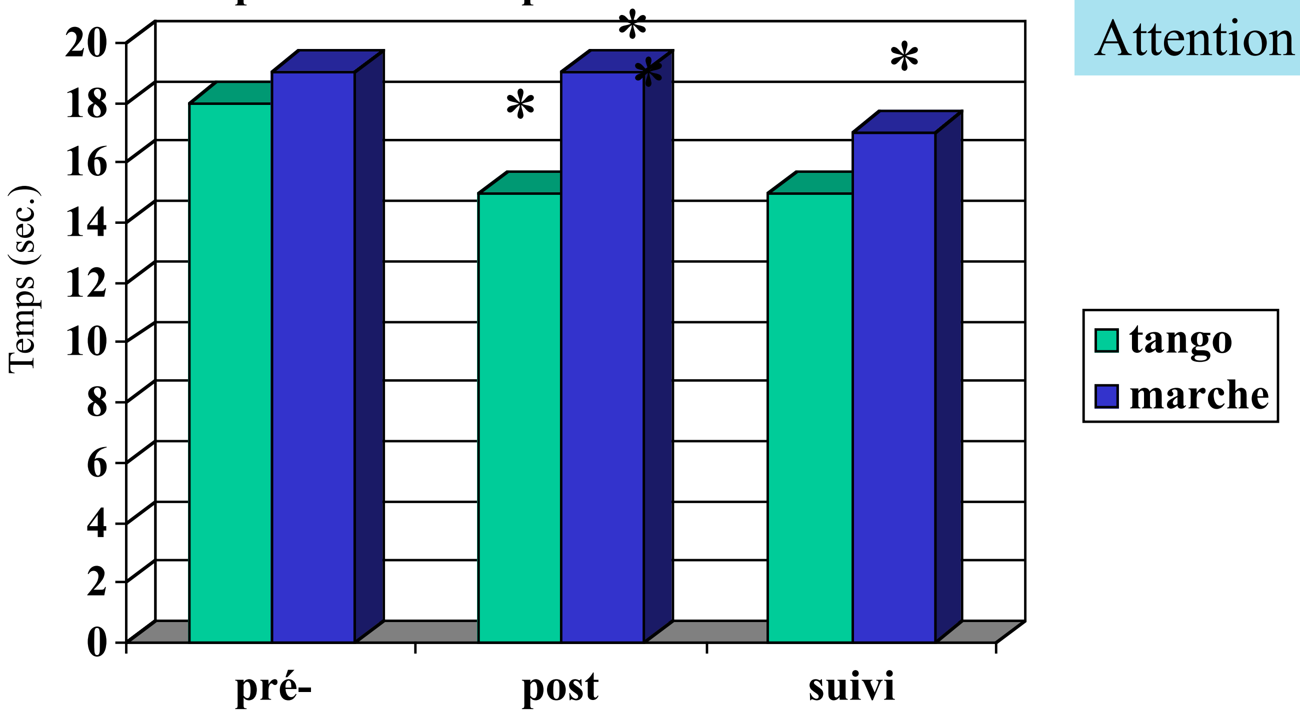
Jacobson AC, McKinley PA, Leroux A, Rainville C. Program No. 757.7 2005 Abstract Viewer/Itinerary Planner. Washington, DC: Society for Neuroscience; 2005. Argentine tango dancing as an effective means for improving cognition and complex task performance in at-risk elderly: a feasibility study.

Mémoire de travail



Amélioration significative de la mémoire de travail dans les deux groupes

Attention divisée



Amélioration significative et persistante de l'attention divisée dans le groupe "tango"

Comment le tango peut-il améliorer le fonctionnement cérébral?

- Plusieurs explications avancées :
  - Général: le tango, comme l'aérobic, élève le rythme cardiaque d'environ 70% après une session de danse
  - Sensori-moteur:
- Entraîne la marche dans directions multiples (avant arrière côté)
- Favorise initiative du mouvement, entraîne l'impulsion et le transfert d'énergie
- Stimule l'équilibre : travail de la posture dynamique et de l'équilibre seul et en couple

Mais commun à beaucoup d'autres activités.

  - Cognitive/affective
- Entraîne à exécuter des situations double-tâche : marcher tout en évitant des obstacles, anticiper la figure suivante, prendre en considération la position et lesmouvements du partenaire
- Largement basé sur la pratique de mouvements rythmés; nécessité de transcodage de l'information entre différentes modalités
- Favorise les relations socio-affectives entre partenaires et entre les couples

Mais commun à beaucoup d'autres danses.

THE NEUROSCIENCE OF *Dance*

Recent brain-imaging studies reveal some of the complex neural choreography behind our ability to dance

By Steven Brown and Lawrence M. Parsons

KEY CONCEPTS

- Dance is a fundamental form of human expression that likely evolved together with music as a way of generating rhythm.
- It requires specialized mental skills. One brain area houses a representation of the body's orientation, helping to direct our movements through space; another serves as a synchronizer of sorts, enabling us to pace our actions to music.
- Unconscious entrainment—the process that causes us to absentmindedly tap our feet to a beat—reflects our instinct for dance. It occurs when certain subcortical brain regions converse, bypassing higher auditory areas.

—*The Editors*

So natural is our capacity for rhythm that most of us take it for granted: when we hear music, we tap our feet to the beat or rock and sway, often unaware that we are even moving. But this instinct is, for all intents and purposes, an evolutionary novelty among humans. Nothing comparable occurs in other mammals nor probably elsewhere in the animal kingdom. Our talent for unconscious entrainment lies at the core of dance, a confluence of movement, rhythm and gestural representation. By far the most synchronized group practice, dance demands a type of interpersonal coordination in space and time that is almost nonexistent in other social contexts.

Even though dance is a fundamental form of human expression, neuroscientists have given it relatively little consideration. Recently, however, researchers have conducted the first brain-imaging studies of both amateur and professional dancers. These investigations address such questions as, How do dancers navigate though space? How do they pace their steps? How do people learn complex series of patterned movements? The results offer an intriguing glimpse into the complicated mental coordination required to execute even the most basic dance steps.

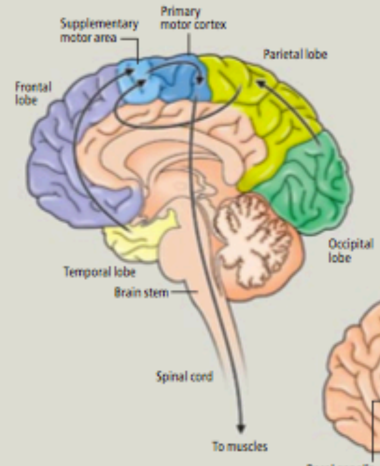
I Got Rhythm

Neuroscientists have long studied isolated movements such as ankle rotations or finger tapping. From this work we know the basics of how the brain orchestrates simple actions. To hop on one foot—never mind patting your head at the same time—requires calculations relating to spatial awareness, balance, intention and timing, among other things, in the brain's sensorimotor system. In a simplified version of the story, a region called the posterior parietal cortex (toward the back of the brain) translates visual information into motor commands, sending signals forward to motion-planning areas in the premotor cortex and supplementary motor area. These

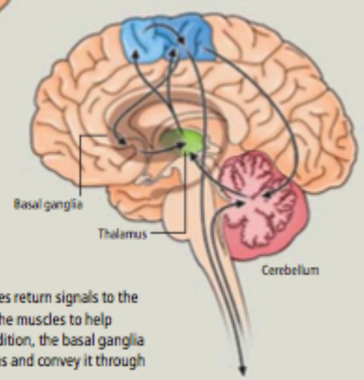
[THE BASICS]

THE BRAIN'S MOVING PARTS

To identify the brain areas that control dance, researchers first need a sense of how the brain allows us to carry out voluntary movements in general. A highly simplified version is presented here.



Motion planning (*left*) occurs in the frontal lobe, where the premotor cortex on the outer surface (*not visible*) and the supplementary motor area evaluate signals (*arrows*) from elsewhere in the brain, indicating such information as position in space and memories of past actions. These two areas then communicate with the primary motor cortex, which determines which muscles need to contract and by how much and sends instructions down through the spinal cord to the muscles.



Fine-tuning (*right*) occurs, in part, as the muscles return signals to the brain. The cerebellum uses the feedback from the muscles to help maintain balance and refine movements. In addition, the basal ganglia collect sensory information from cortical regions and convey it through the thalamus to motor areas of the cortex.

TANTALIZING TANGO FINDING

In a study published in December 2007, Gammon M. Earhart and Madeleine E. Hackney of the Washington University School of Medicine in St. Louis found that tango dancing improved mobility in patients with Parkinson's disease. The condition stems from a loss of neurons in the basal ganglia, a problem that interrupts messages meant for the motor cortex. As a result, patients experience tremors, rigidity and difficulty initiating movements they have planned.

The researchers found that after 20 tango classes, study subjects "froze" less often. Compared with subjects who attended an exercise class instead, the tango dancers also had better balance and higher scores on the Get Up and Go test, which identifies those at risk for falling.

As anticipated, this comparison eliminated many of the basic motor areas of the brain. What remained, though, was a part of the parietal lobe, which contributes to spatial perception and orientation in both humans and other mammals. In dance, spatial cognition is primarily kinesthetic: you sense the positioning of your torso and limbs at all times, even with your eyes shut, thanks to the muscles' sensory organs. These organs index the rotation of each joint and the tension in each muscle and relay that information to the brain, which generates an articulated body representation in response. Specifically, we saw activation in the precuneus, a parietal lobe region very close to where the kinesthetic representation of the legs resides. We believe that the precuneus contains a kinesthetic map that permits an awareness of body positioning in space while people navigate through their surroundings. Whether you are waltzing or simply walking a straight line, the precuneus helps to plot your path and does so from a body-centered or "egocentric" perspective.

Next we compared our dance scans to those taken while our subjects performed tango steps in the absence of music. By eliminating brain regions that the two tasks activated in common, we hoped to reveal areas critical for the synchronization of movement to music. Again this subtraction removed virtually all the brain's motor areas. The principal difference occurred in a part of the cerebellum that receives input from the spinal cord. Although both conditions engaged this area—the anterior vermis—dance steps synchronized to music generated significantly more blood flow there than self-paced dancing did.

Albeit preliminary, our result lends credence

TAMI TOLPA; PETER MURRAY/Avenue Photos (dancers)

Cerebral Cortex August 2006;16:1157-1167
doi:10.1093/cercor/bhj057
Advance Access publication October 12, 2005

The Neural Basis of Human Dance

Steven Brown[1,2], Michael J. Martinez[1] and Lawrence M. Parsons[1,3]

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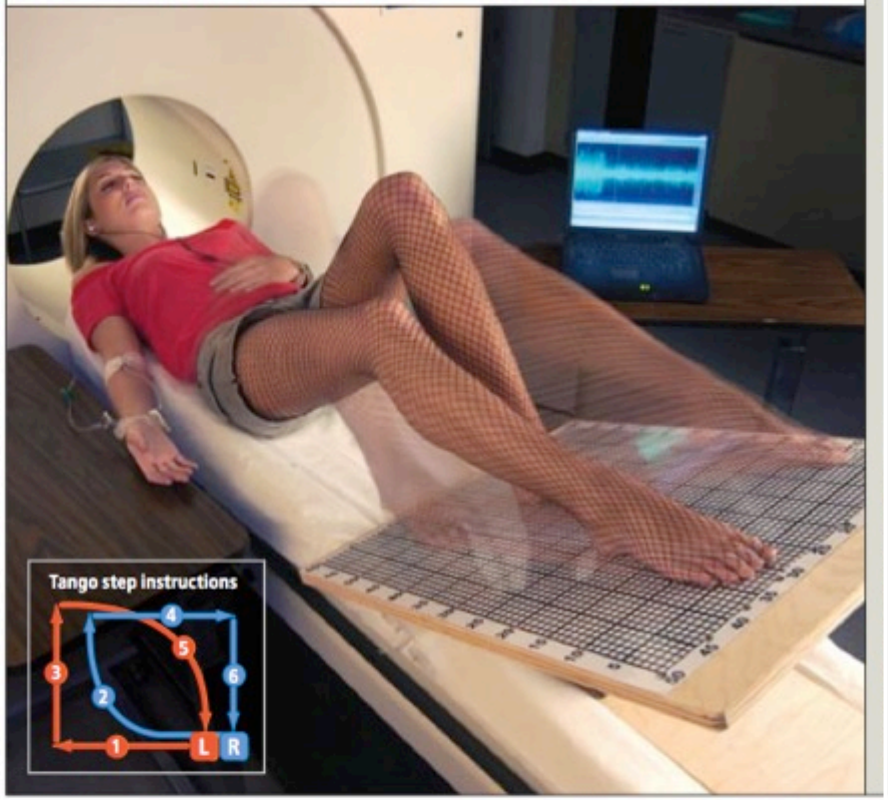
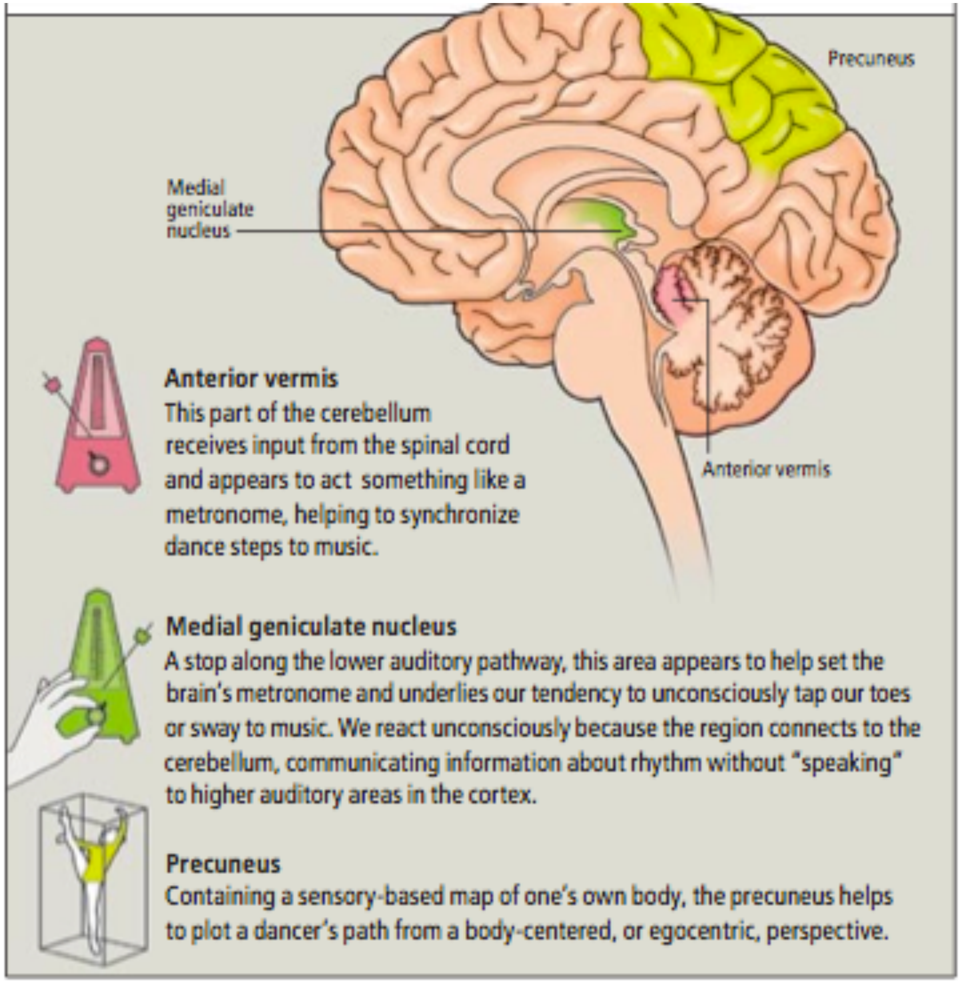
[2]Present address: Department of Psychology, Simon Fraser University, Burnaby, BC, Canada
[3]Present address: Department of Psychology, University of Sheffield, Sheffield, UK

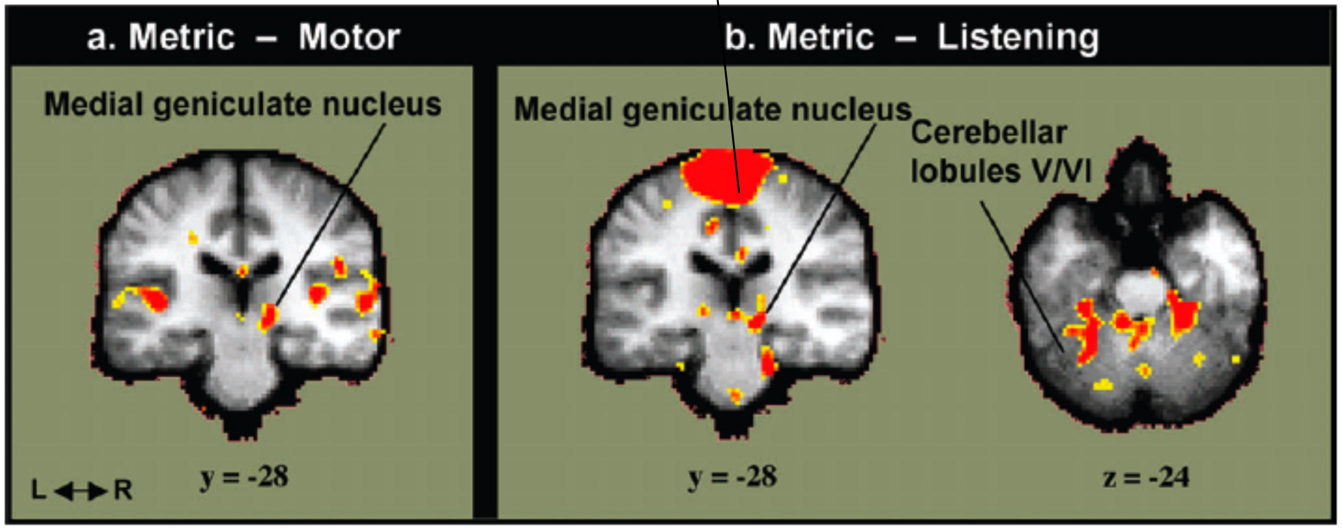
- Étude PET
- 10 sujets âge moy. : 33a
- 2.5a en moy d'expérience du **tango argentin**
- Deux comparaisons :
    - -metric/non metric
    - - self paced/entrained
- Trois conditions contrôle
    - Listening (musique grecque)
    - Contractions (avec musique)
    - repos

To identify brain areas important to dance, the authors had amateur tango dancers lie flat inside a PET scanner. The device held their heads stationary, but they were able to listen to tango music through headphones and move their legs along an inclined surface (*photograph*).



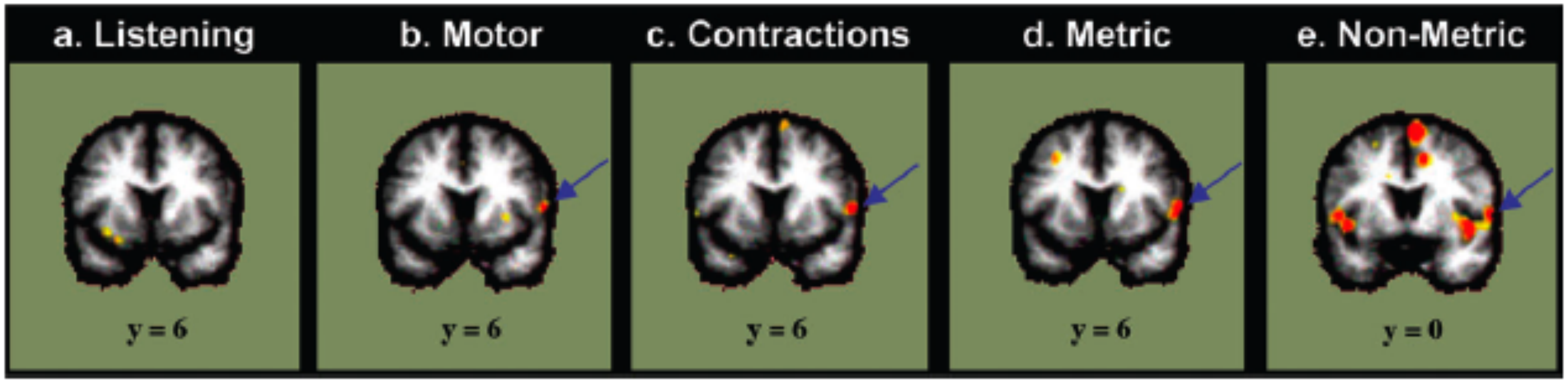


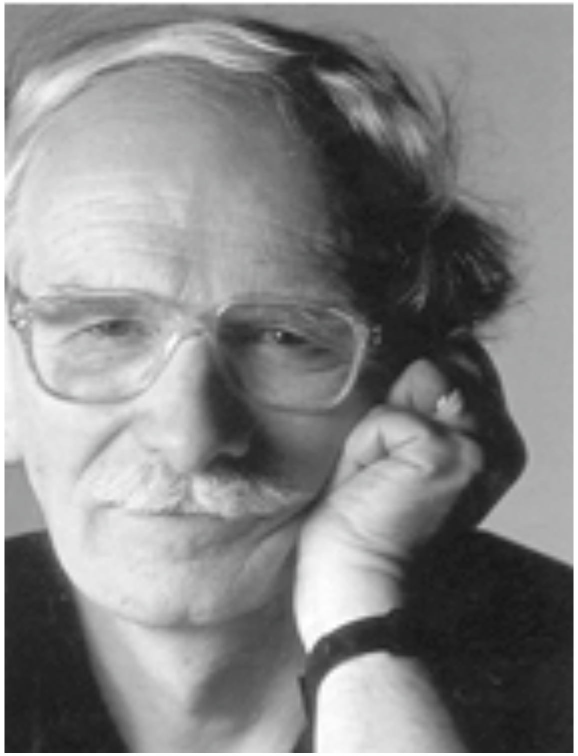
SMA + représentation sensorimotrice de la jambe



Circuit sous-cortical (MGN + cervelet) régule les aspects sensoriels de l'activité métrique ("beat")

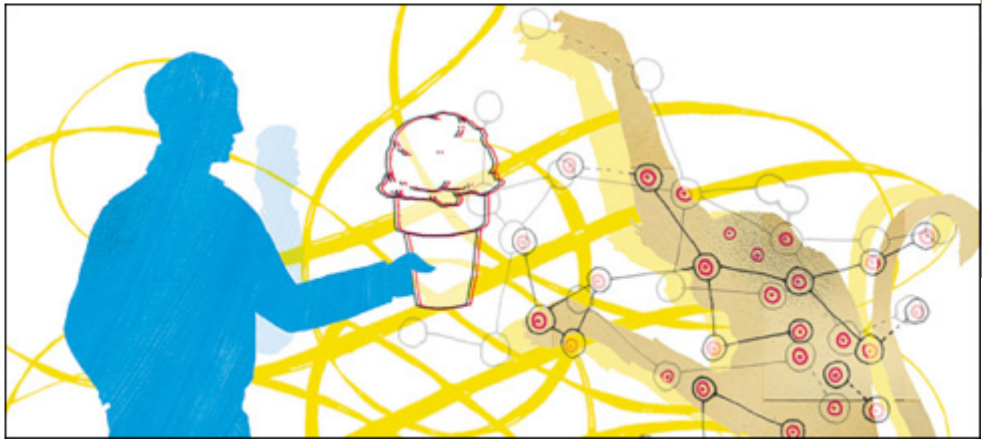
Aire 44 droite ("anti-Broca") activée dans toutes les conditions motrices mais aussi dans tâches perceptives : "syntaxe supralinguistique?"

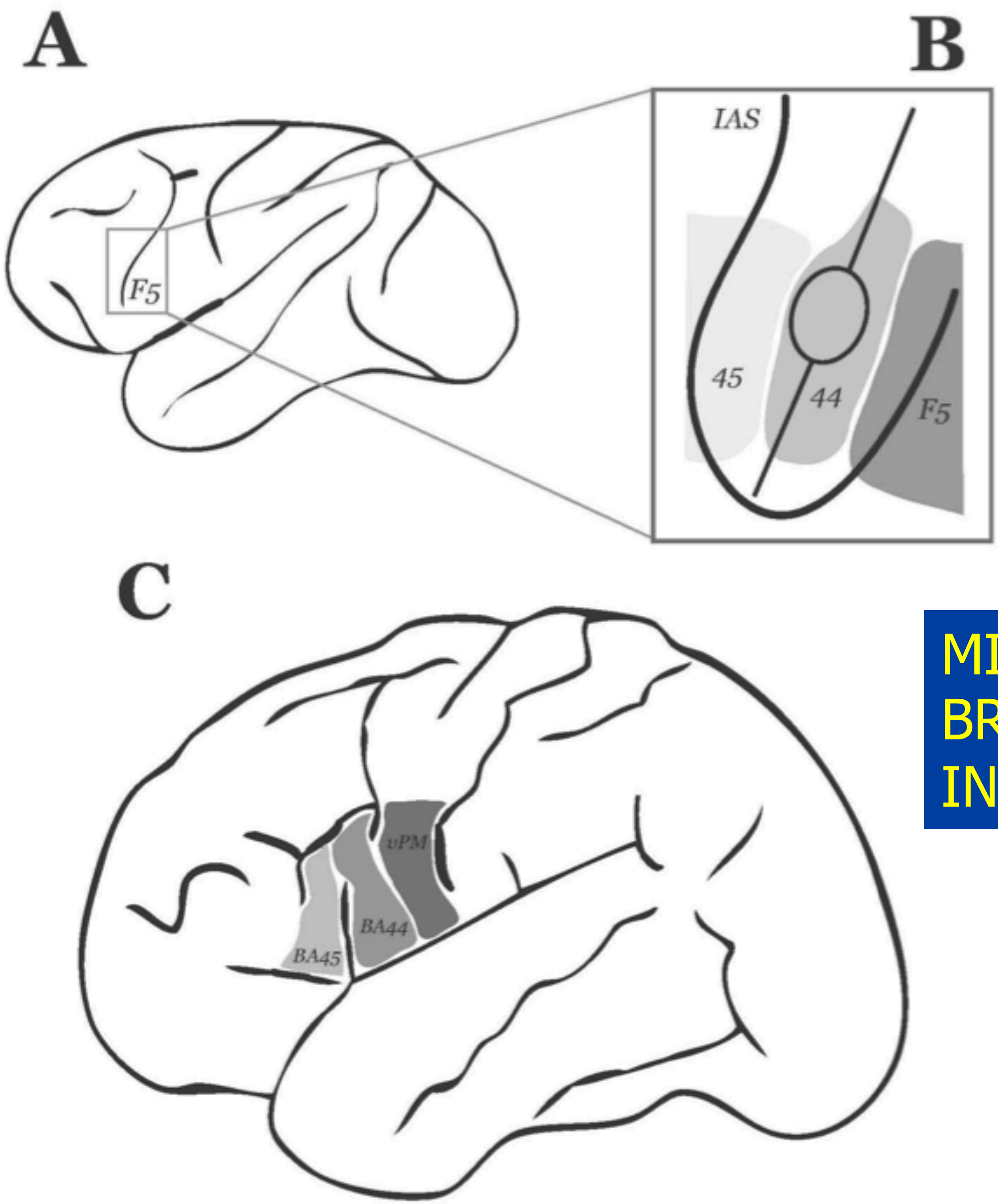




Giacomo Rizzolatti

Single
neuron
recording



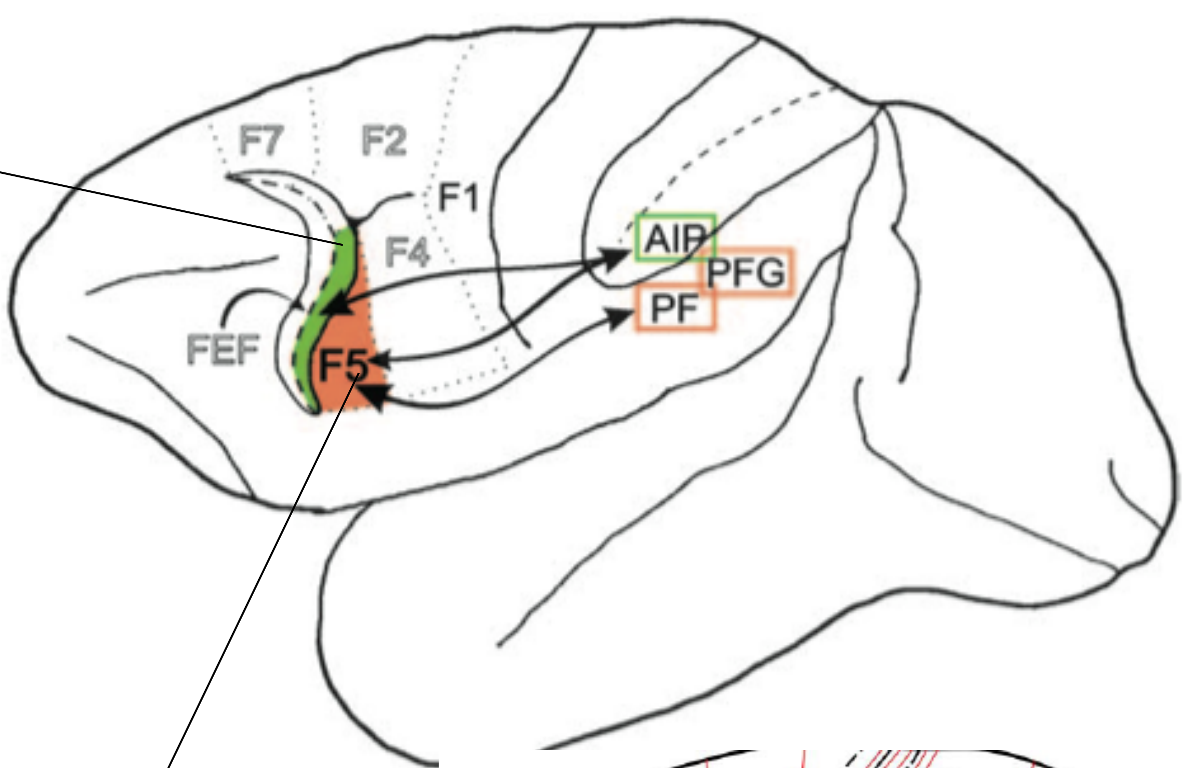


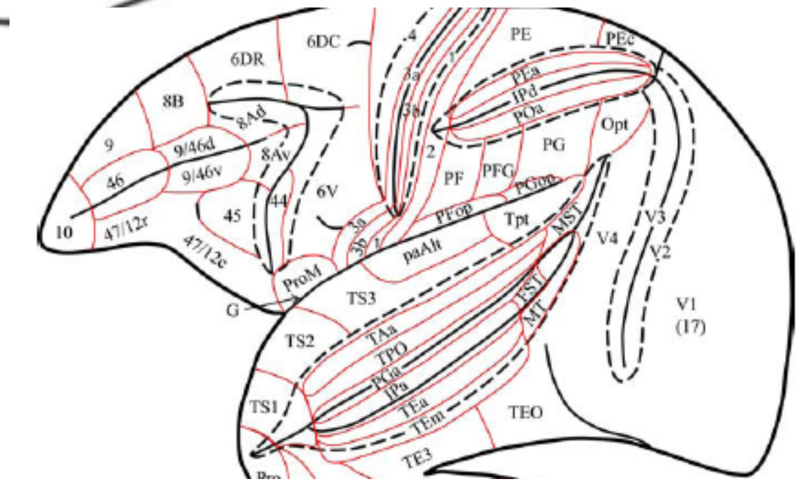
MIRROR NEURONS / BRAIN LOCALIZATION IN MONKEY AND MAN

Posterior edge of arcuate sulcus
= canonical neurons

Among classical
= general purpose
motor neurons

F5 convexity
= mirror neurons





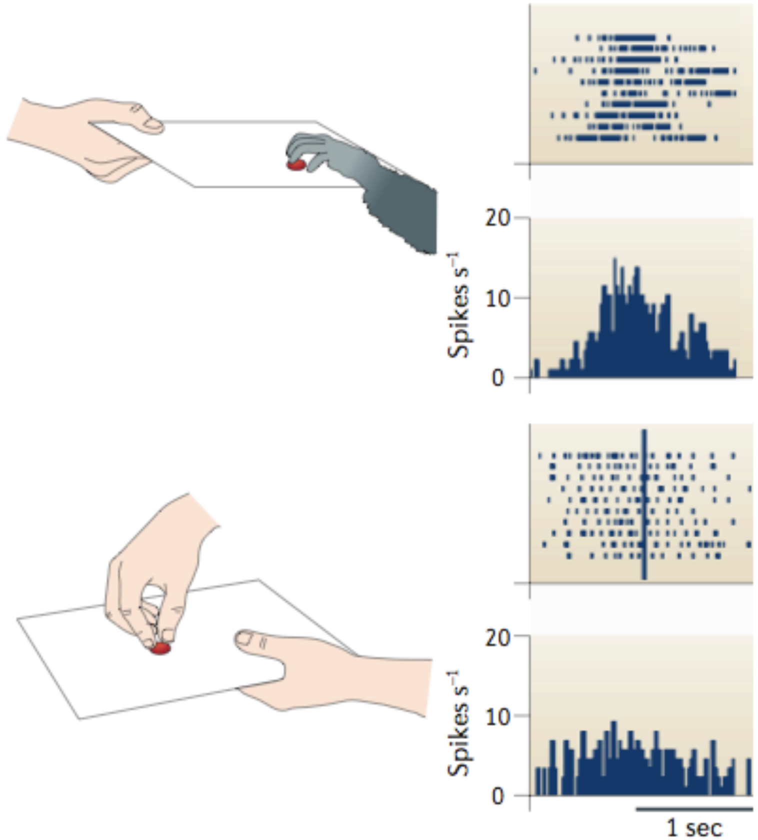
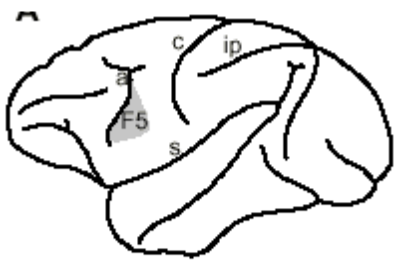


Figure 2 | **Mirror neurons in area F5.** The recordings show neural discharges of a mirror neuron in area F5 of the macaque inferior frontal cortex when the monkey grasps food (top) and when the monkey observes the experimenter grasping the food (bottom)[19]. Note that both tasks elicit strong neural responses in area F5. Modified, with permission, from REF. 115 © (2001) Macmillan Publishers Ltd.

2 AUGUST 2002 VOL 297 SCIENCE www.sciencemag.org



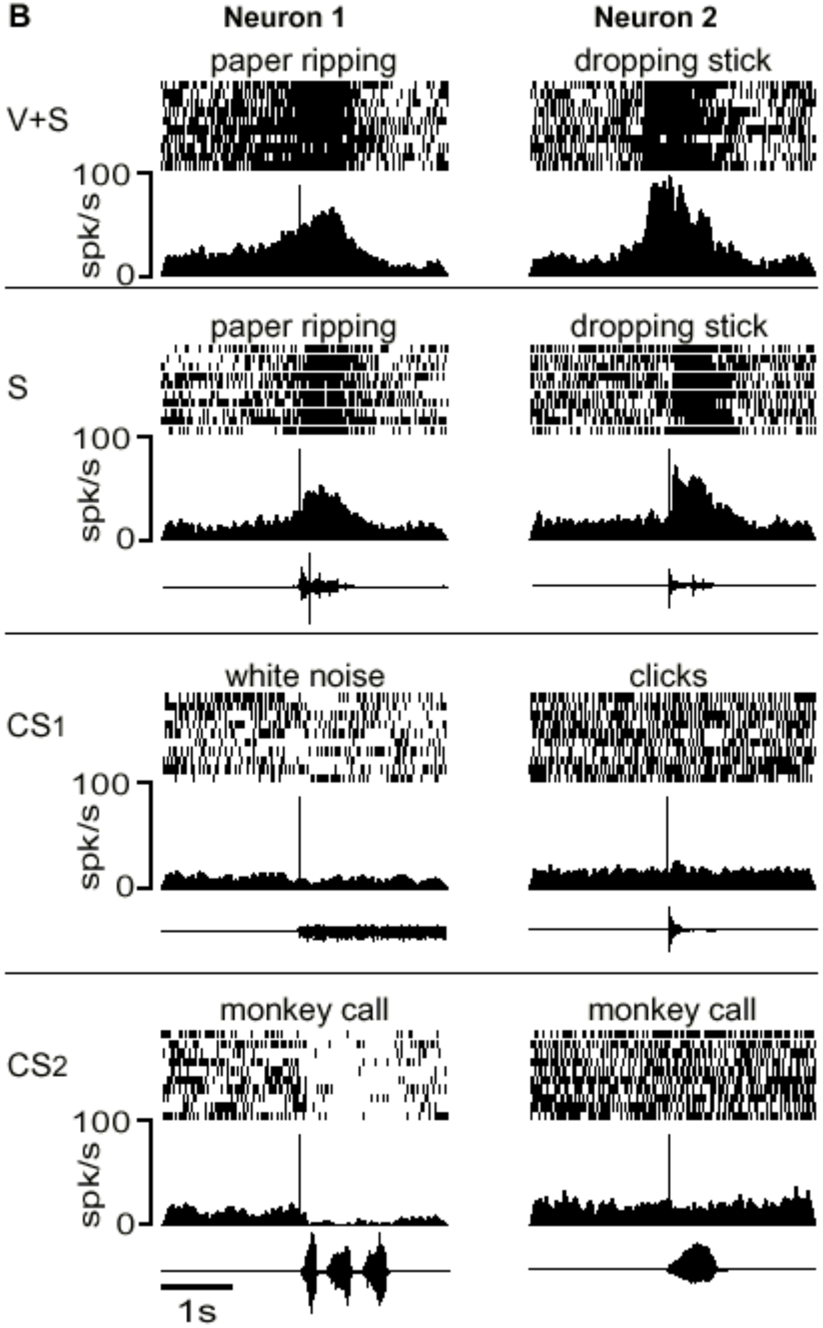


Fig. 1. (**A**) Lateral view of macaque brain with the location of area F5, shaded in gray. Major sulci: a, arcuate; c, central; ip, intraparietal; s, sylvian sulcus. (**B**) Two examples of neurons responding to the sound of actions. Rastergrams are shown together with spike density functions. Text above each rastergram describes the sound or action used to test the neuron. Vertical lines indicate the time when the sound occurred. Traces under the spike density functions in S and in CS conditions are oscillograms of the sounds used to test the neurons. Only 1 of the 10 different instances of the sounds is shown.

Hearing Sounds, Understanding Actions: Action Representation in Mirror Neurons

Evelyne Kohler,[1] Christian Keysers,[1] M. Alessandra Umiltà,[1] Leonardo Fogassi,[2] Vittorio Gallese,[1] Giacomo Rizzolatti[1]*

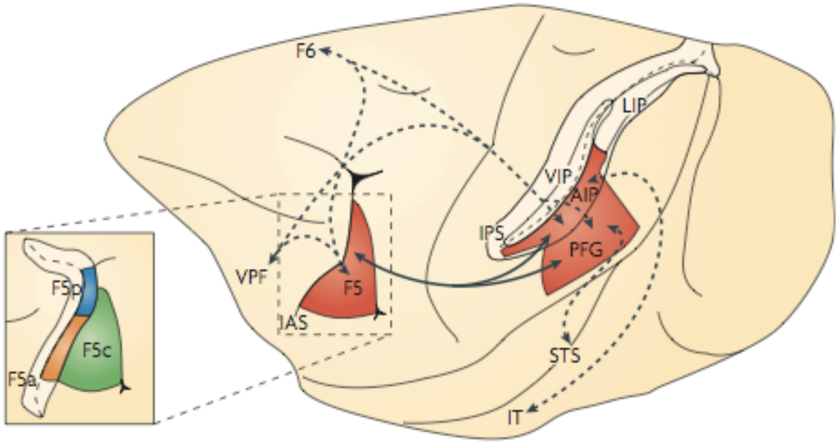
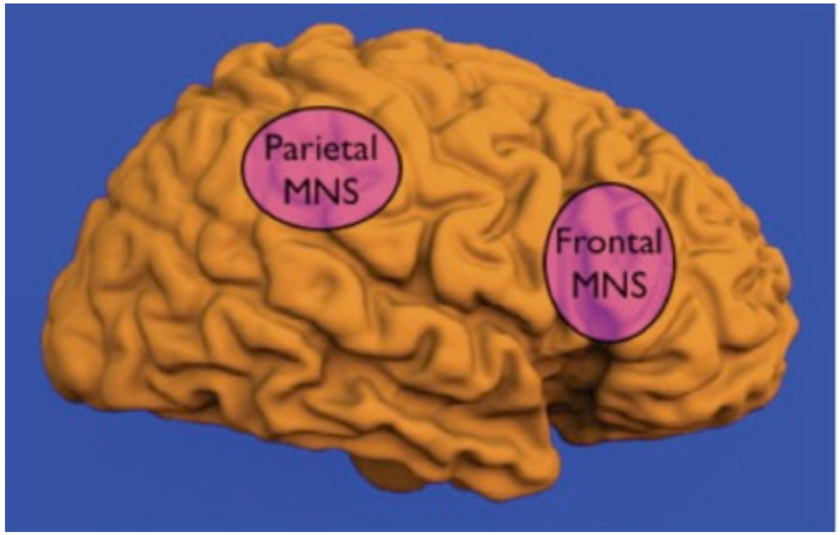
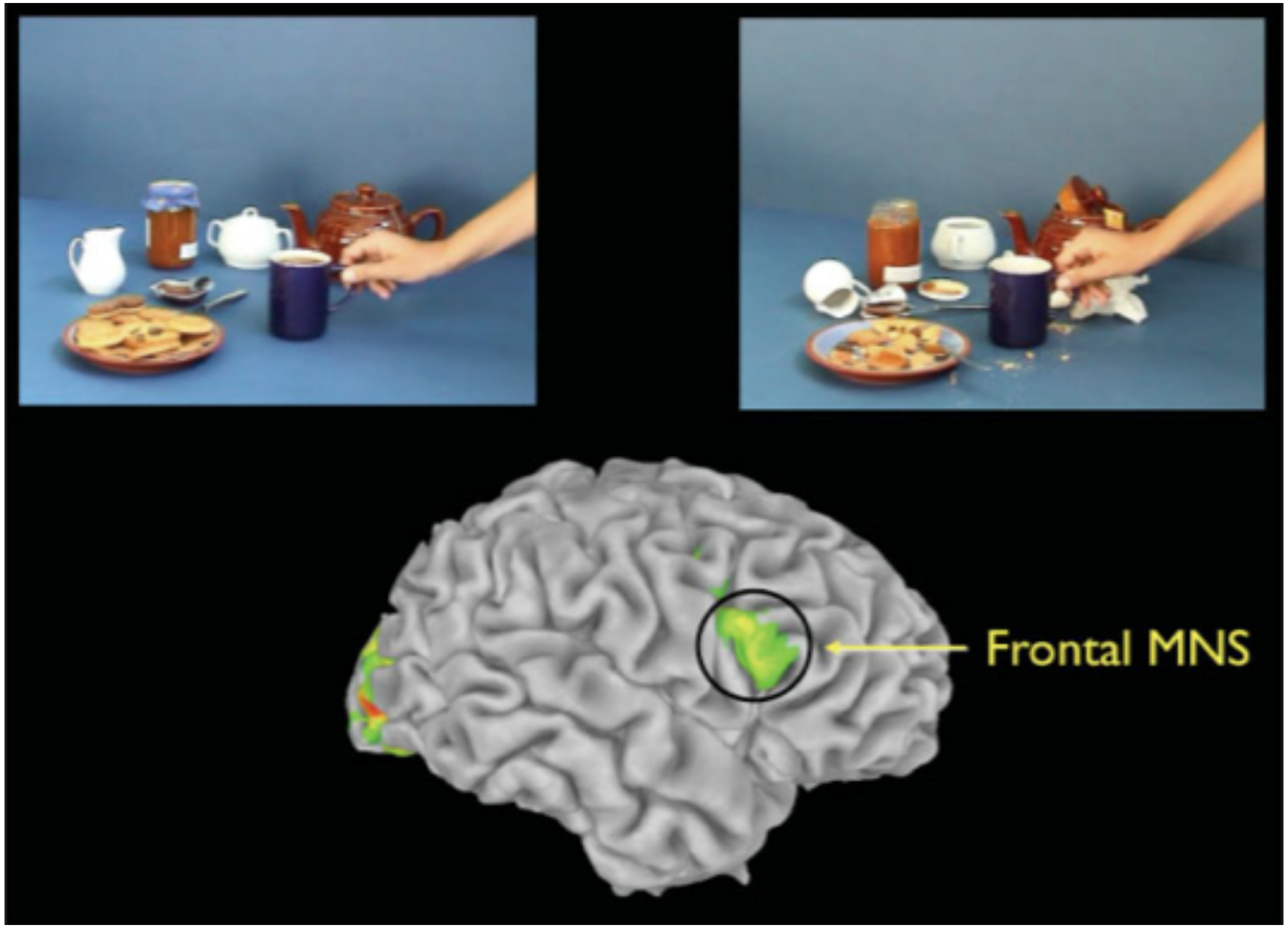


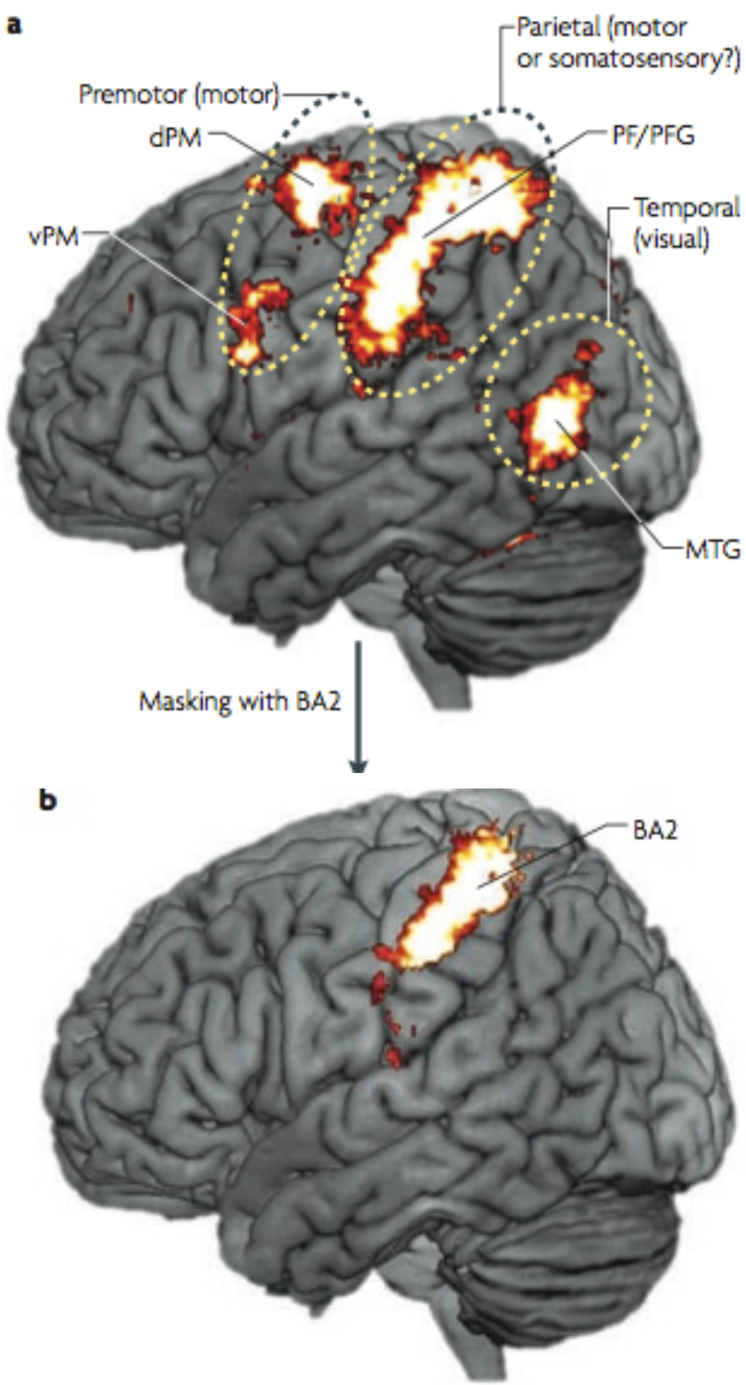
Figure 1 | **The parieto-frontal mirror network.** Lateral view of the macaque brain. The coloured areas represent the areas of the parieto-frontal circuit containing mirror neurons: the ventral premotor cortex (area F5), area PFG (located between parietal areas PF and PG) and the anterior intraparietal area (AIP). Note that the intraparietal sulcus (IPS) has been opened (light yellow) to show the areas inside. The parieto-frontal circuit receives high-order visual information from areas located inside the superior temporal sulcus (STS) and the inferior temporal lobe (IT). Neither of these temporal regions has motor properties. The parieto-frontal circuit is under control of the frontal lobe (area F6 or pre-supplementary motor area and the ventral prefrontal cortex (VPF)). The inset provides an enlarged view of area F5, showing also its sectors (F5a and F5p) buried inside the arcuate sulcus. IAS, inferior limb of the arcuate sulcus; LIP, lateral intraparietal area; VIP, ventral intraparietal area.



In humans, as in monkey, there exists a system of mirror neurons involving a restricted set of cortical areas in two specific locations : ventral pre-motor and parietal



Mirror neurons differently encode the same gesture in two different contexts



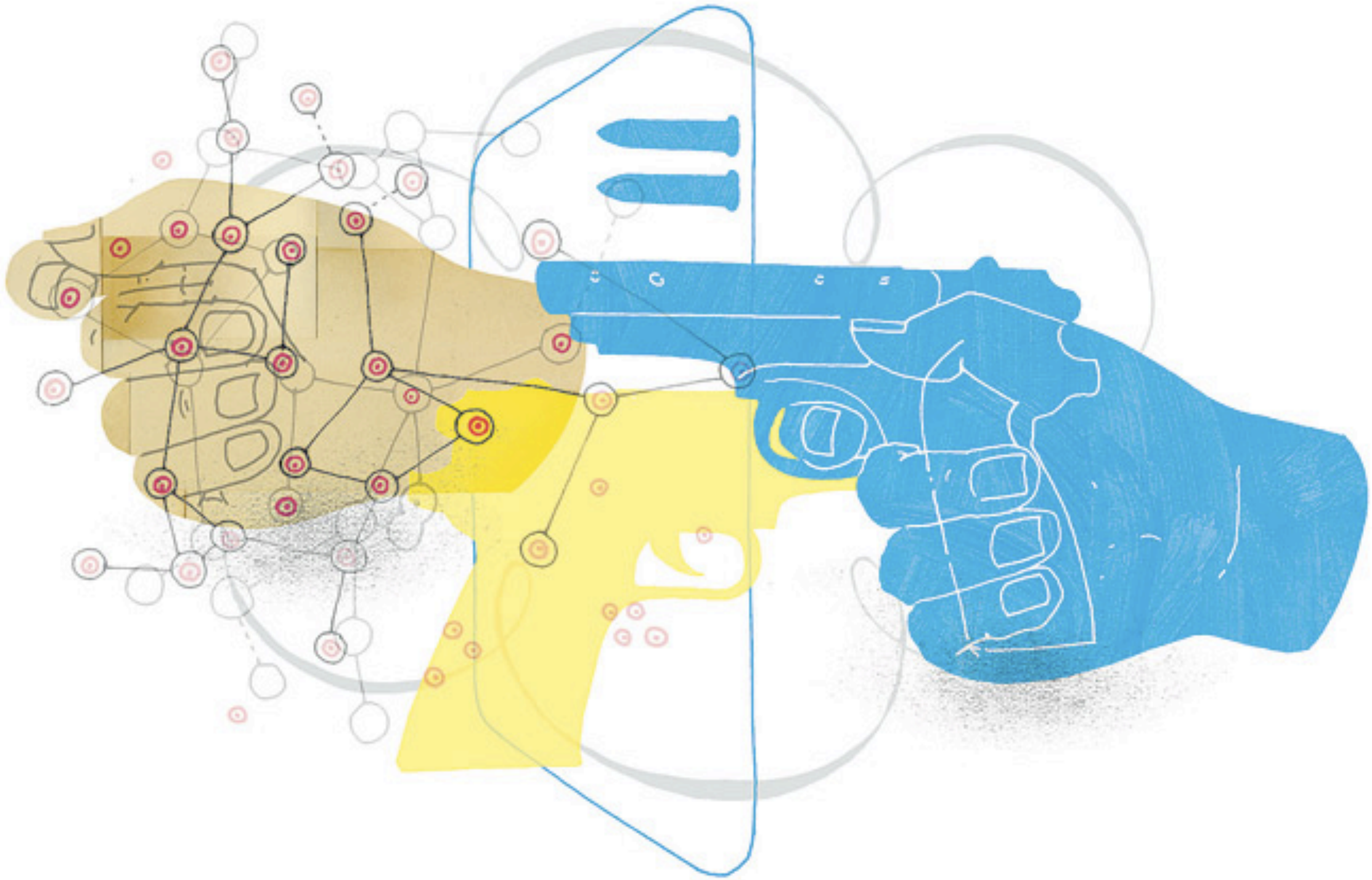
Shared voxels in both action observation and action execution:

-dorsal premotor cortex (dPM) and ventral premotor cortex (vPM), which are involved in motor control;

- posterior mid-temporal gyrus (MTG), which is involved in visual perception;

-and a large cluster encompassing multiple regions of the parietal lobe

much of the parietal shared voxels actually fall into BA2, the association somatosensory cortex. This indicates that activity in this part of the cluster probably represents **vicarious haptic** activity instead of vicarious motor activity.



Leigh Wells

MODELS OF AGGRESSION Mirror neurons are at their best when humans are face to face. But at least one study found that the cells, along with several brain areas involved in aggression, were activated when children watched a violent television program. That activation increased the chances that the children would behave aggressively minutes or hours later.

Neuron, Vol. 40, 655–664, October 30, 2003, Copyright ©2003 by Cell Press

Both of Us Disgusted in *My* Insula: The Common Neural Basis of Seeing and Feeling Disgust

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Vittorio Gallese,[2] and Giacomo Rizzolatti[2,*]
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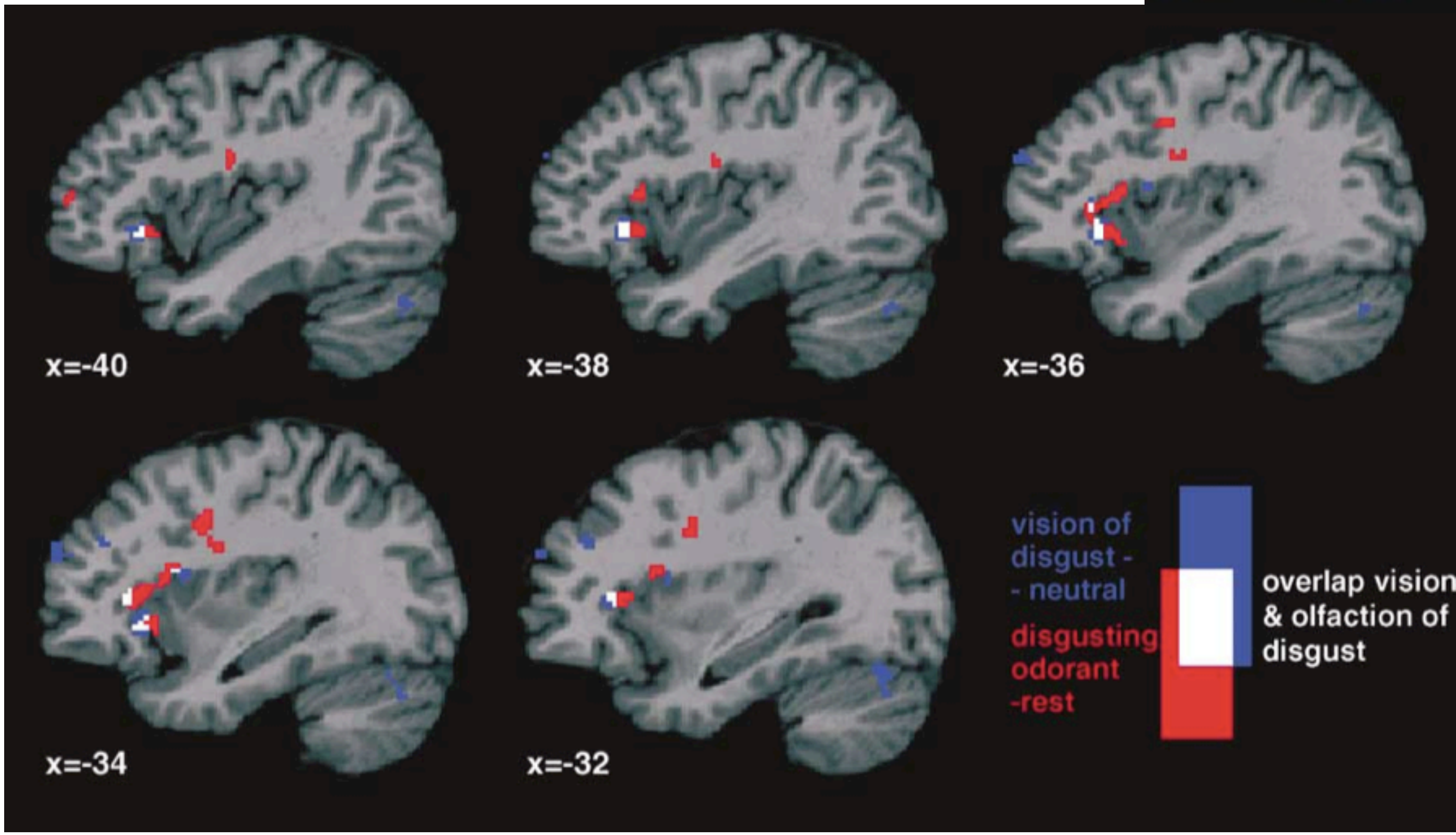

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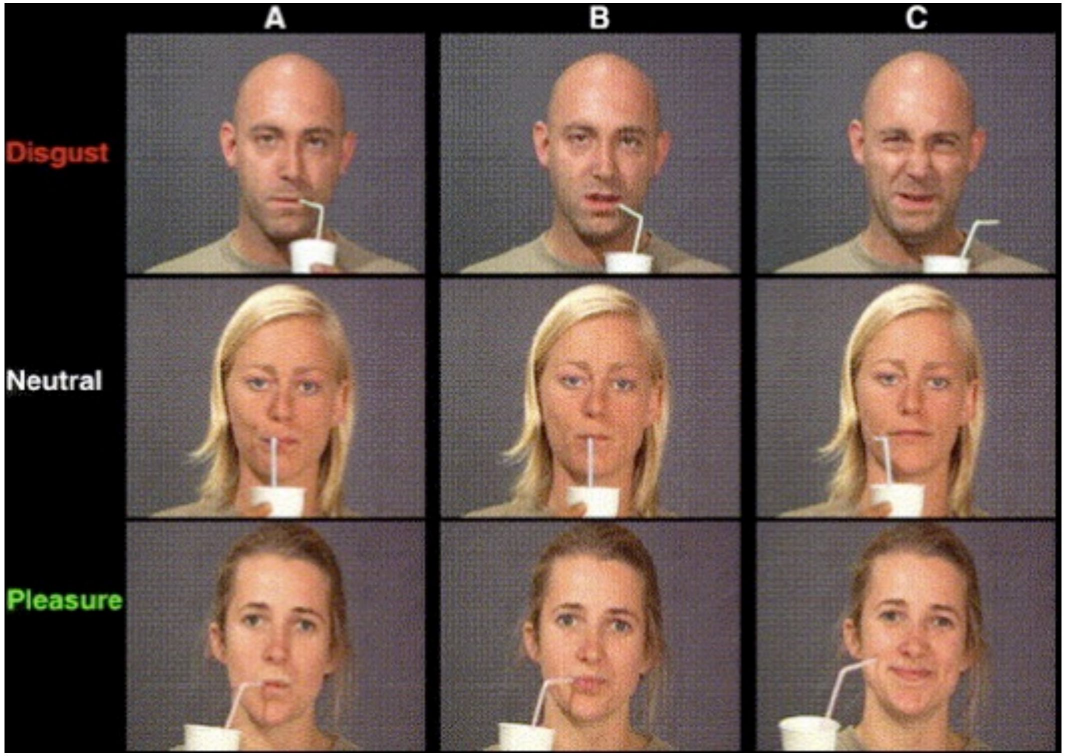
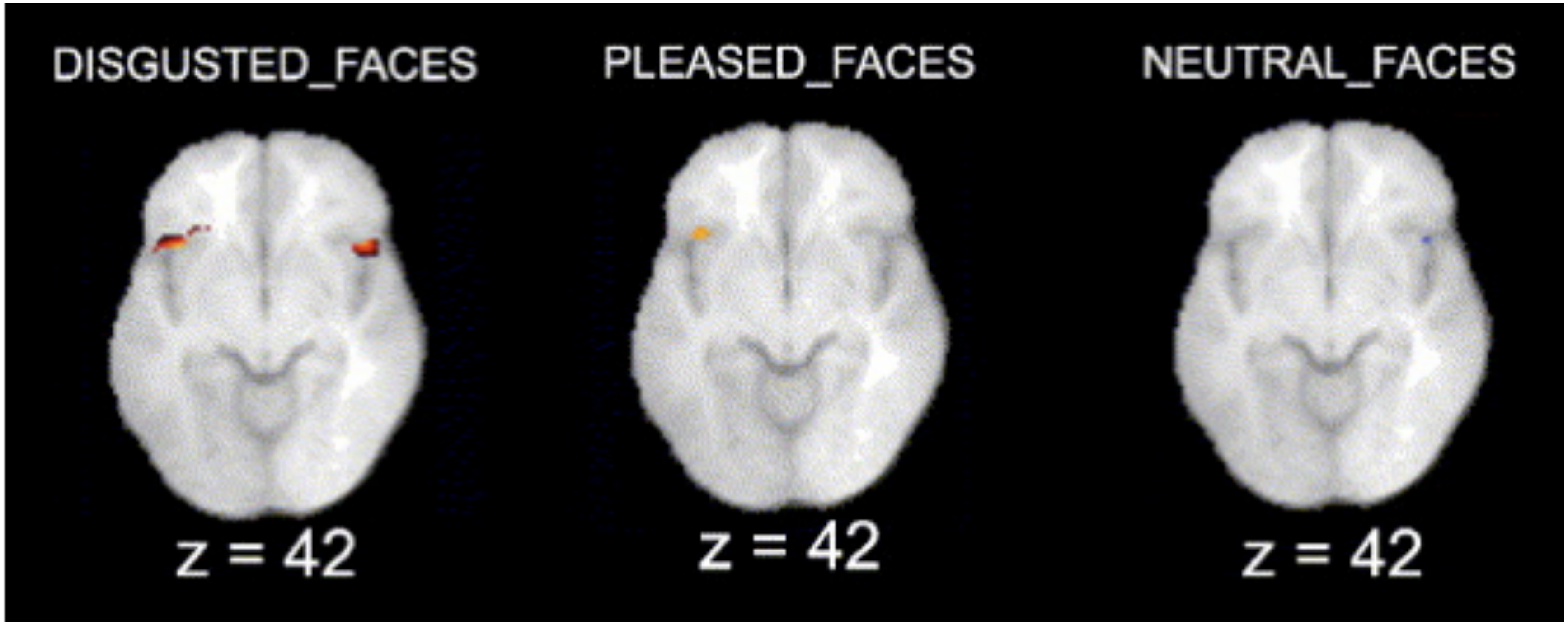
NeuroImage 34 (2007) 1744 – 1753

Empathy for positive and negative emotions in the gustatory cortex

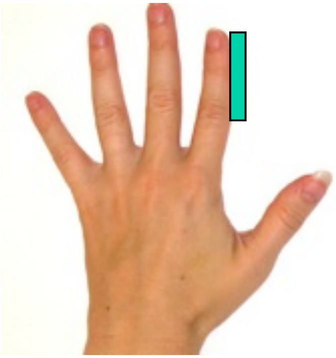
Mbemba Jabbi,[a,b] Marte Swart,[a,c] and Christian Keysers[a,*]



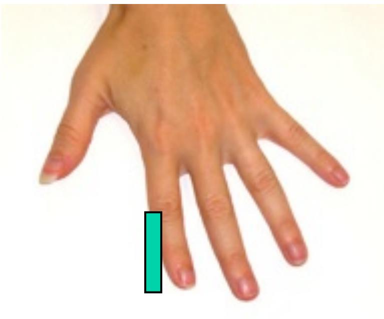


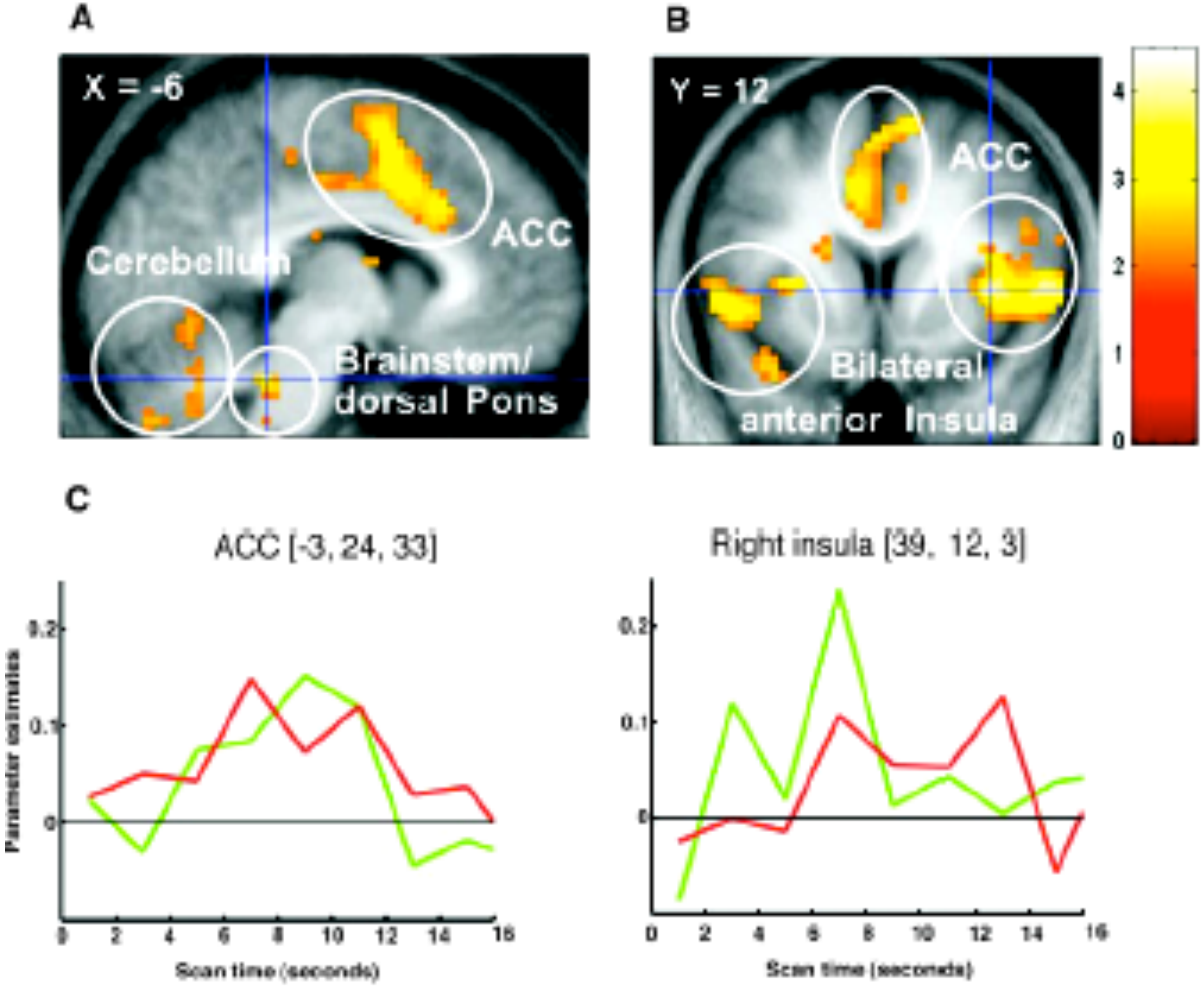
“Feeling” someone else’ s pain…

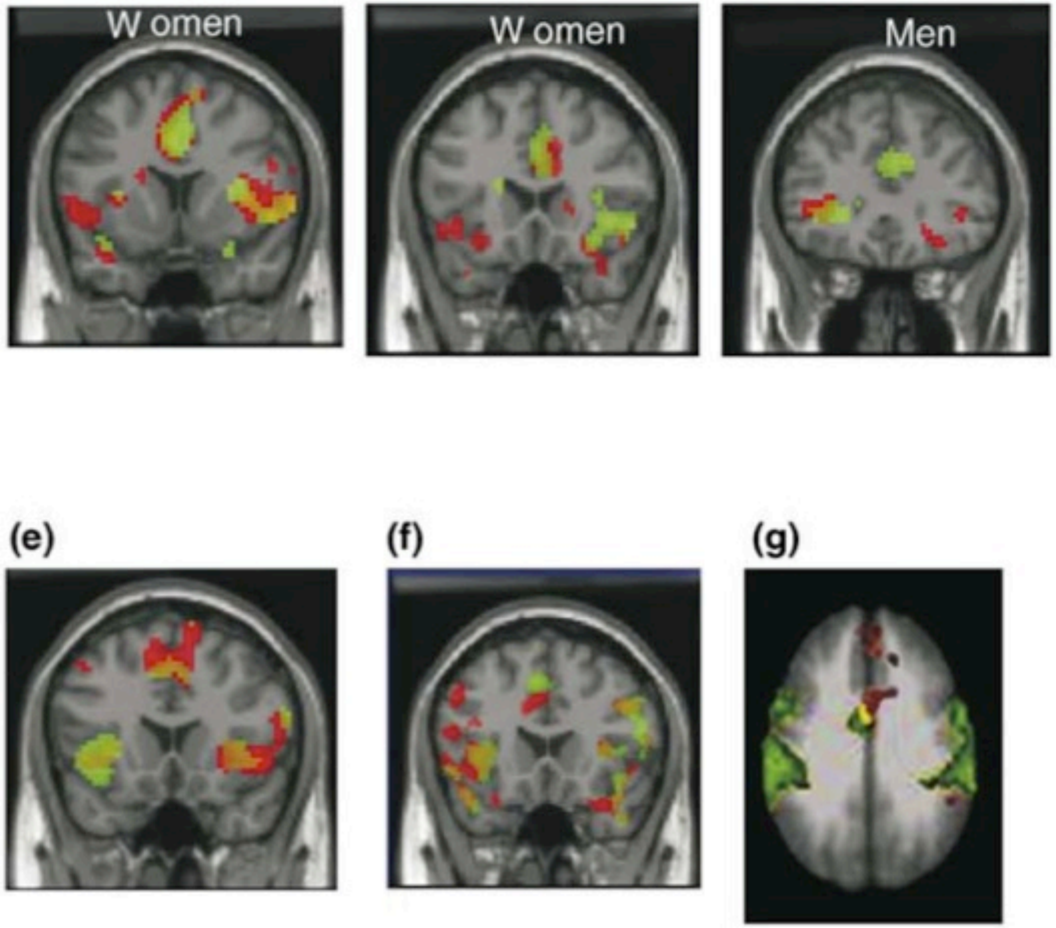
Own pain:



Significant other’ s pain:

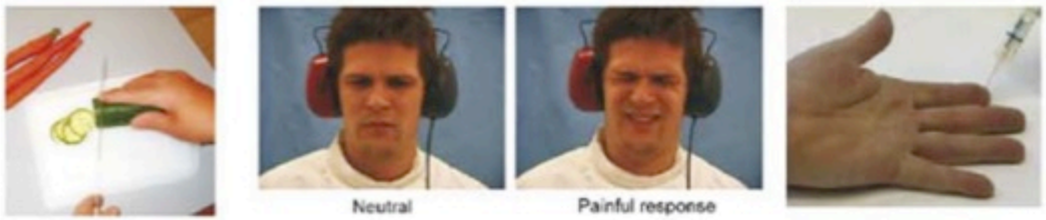






Oneself pain

Other's



Singer, T. et al. (2004) Empathy for pain involves the affective but not sensory components of pain. Science 303, 1157–1162

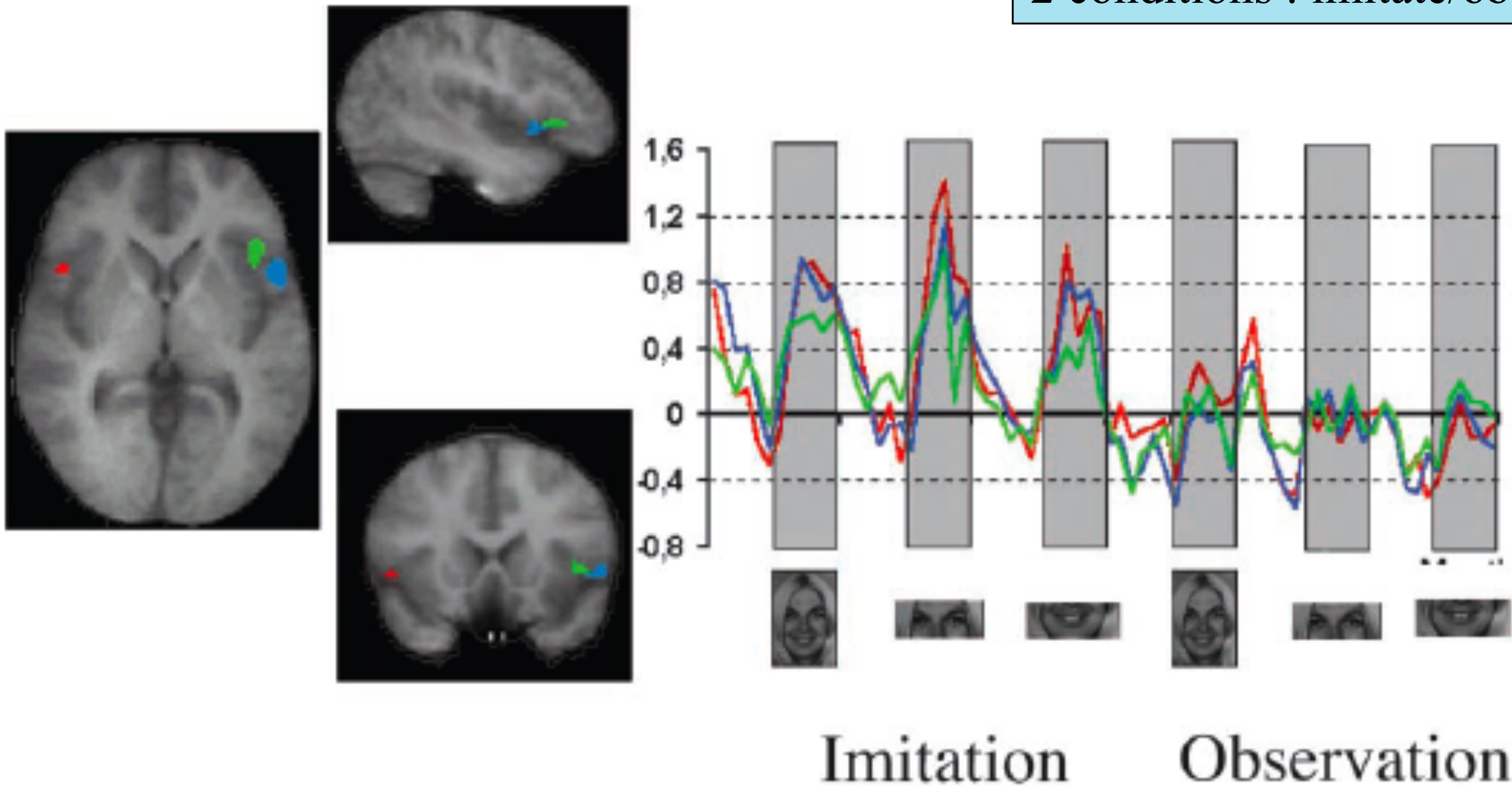
Neural mechanisms of empathy in humans: A relay from neural systems for imitation to limbic areas

Laurie Carr[†], Marco Iacoboni[†‡§¶], Marie-Charlotte Dubeau[†], John C. Mazziotta[†§‖**††], and Gian Luigi Lenzi[‡‡]

[†]Ahmanson-Lovelace Brain Mapping Center, Neuropsychiatric Institute, Departments of [‡]Psychiatry and Biobehavioral Sciences, [‖]Neurology, [**]Pharmacology, and [††]Radiological Sciences, and [§]Brain Research Institute, David Geffen School of Medicine, University of California, Los Angeles, CA 90095; and [‡‡]Department of Neurological Sciences, University "La Sapienza," Rome, Italy 00185

Presentation of photographs of human faces representing 6 types of emotions (total face, mouth or eyes)

2 conditions : imitate/observe



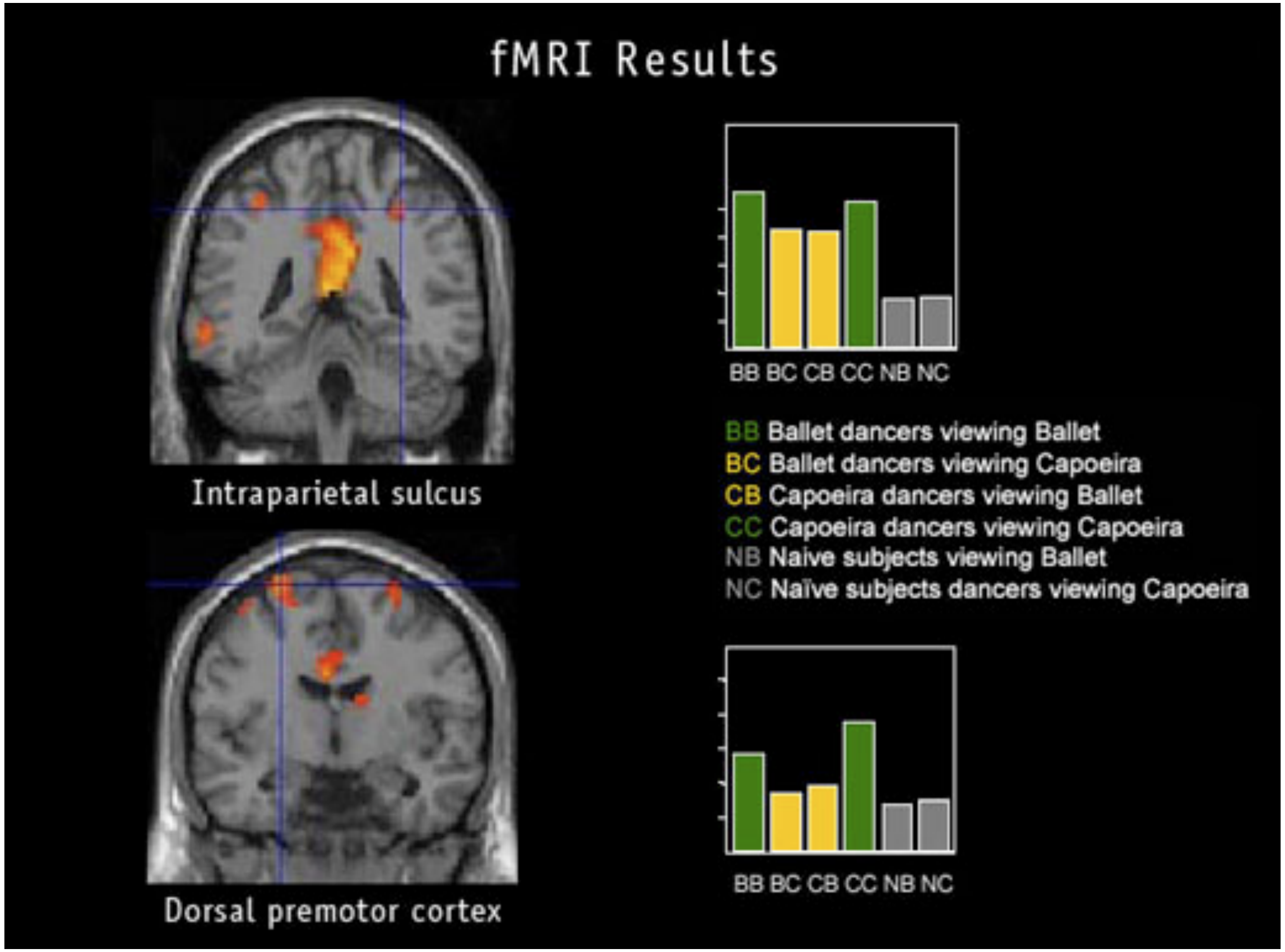
Imitation and observation activate in common a network including premotor cortex and insula

Imitation >observation for right insula and IFG bilat.

En résumé (1): neurones miroir

- Il existe dans le cortex cérébral du singe, et sans doute également de l'homme, un sous-ensemble de neurones moteurs dont la caractéristique est de se mettre en activité tout autant lorsque l'individu effectue une action mais également lorsqu'il observe un autre individu effectuer la même action
- Ce système est centré sur deux régions corticales : le cortex prémoteur postéro-inférieur (aire de Broca) et le cortex pariétal postérieur, deux régions de cortex associatif en interconnexion fonctionnelle réciproque étroite. D'autres régions auraient également un "fonctionnement miroir", en particulier l'insula, dont l'implication dans la perception des émotions d'autrui est actuellement bien établie, et le cortex somato-sensoriel primaire, qui traite l'ensemble des informations sensitives accompagnant nos actes, comme ceux d'autrui
- Parmi les rôles suspectés chez l'homme de ce système : l'imitation et l'apprentissage par imitation, la compréhension des actions et des intentions d'autrui (théorie de l'esprit), l'acquisition du langage, les relations interpersonnelles et les compétences sociales, mais aussi : l'empathie, l'intersubjectivité, certains comportements violents …

Daniel Glaser
University College London



Daniel Glaser
University College London

Current Biology 16, 1905–1910, October 10, 2006 ©2006 Elsevier Ltd All rights reserv

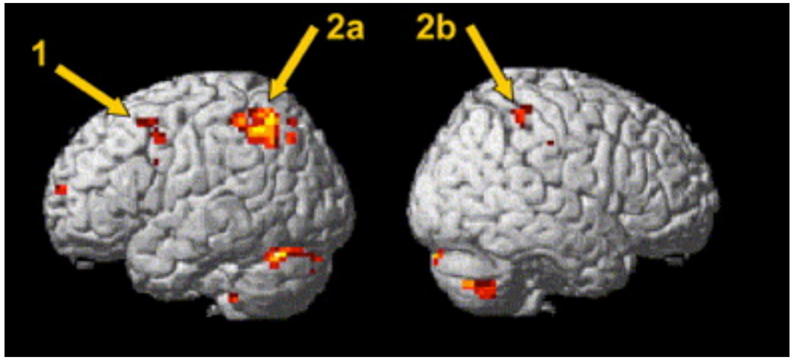
Seeing or Doing? Influence of Visual and Motor Familiarity in Action Observation

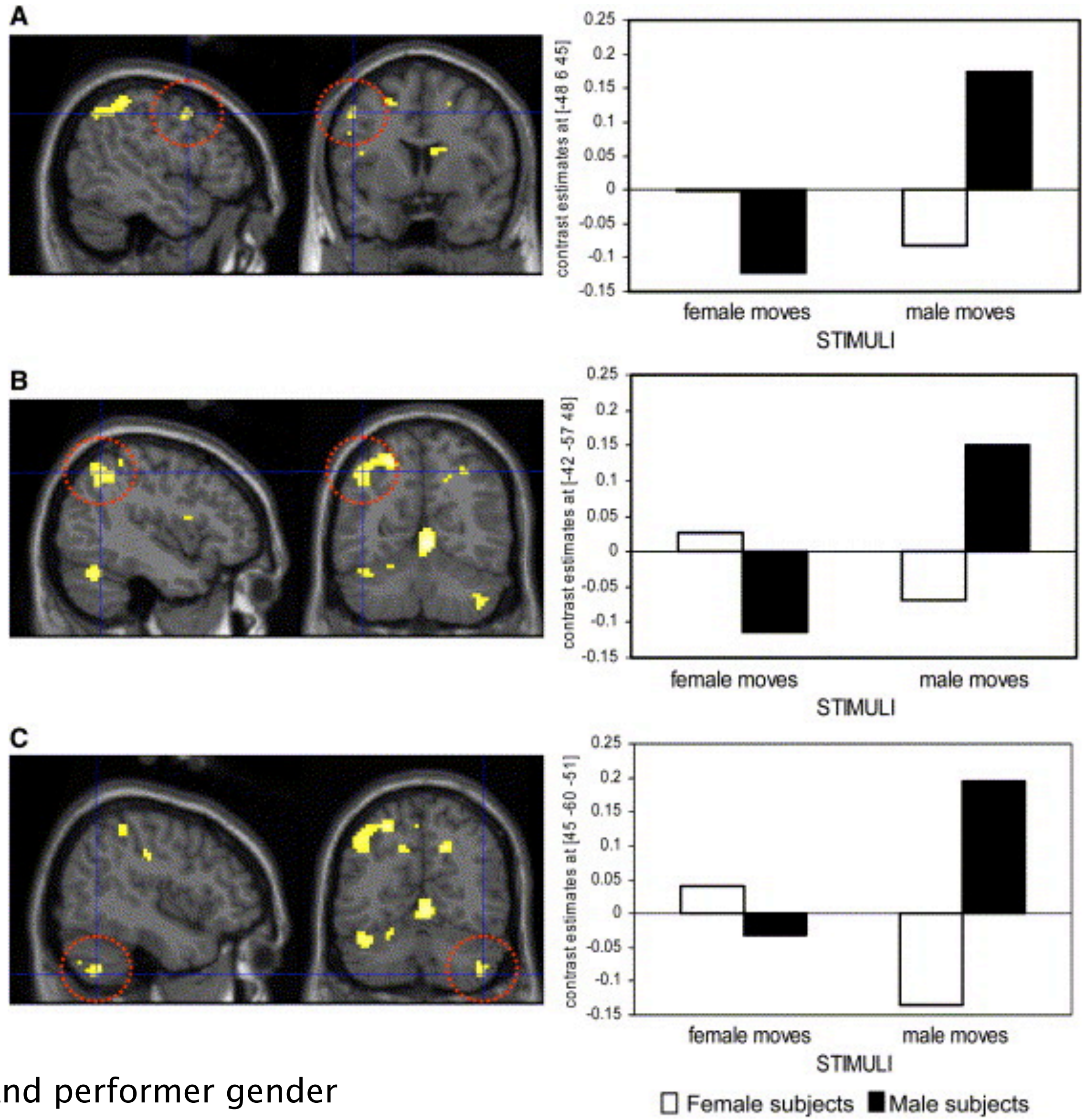
Beatriz Calvo-Merino,[1,*] Julie Grèzes,[2]
Daniel E. Glaser,[1] Richard E. Passingham,[3,4]
and Patrick Haggard[1,*]
[1] Institute of Cognitive Neuroscience and
Department of Psychology
University College London

that the
network

Results

Observi





interaction between subject gender and performer gender

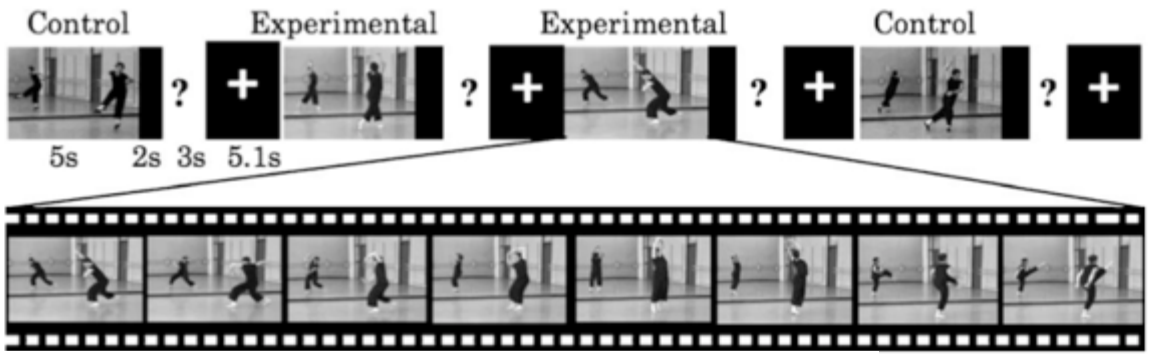
ELSEVIER

www.elsevier.com/locate/ynimg
NeuroImage 31 (2006) 1257 – 1267

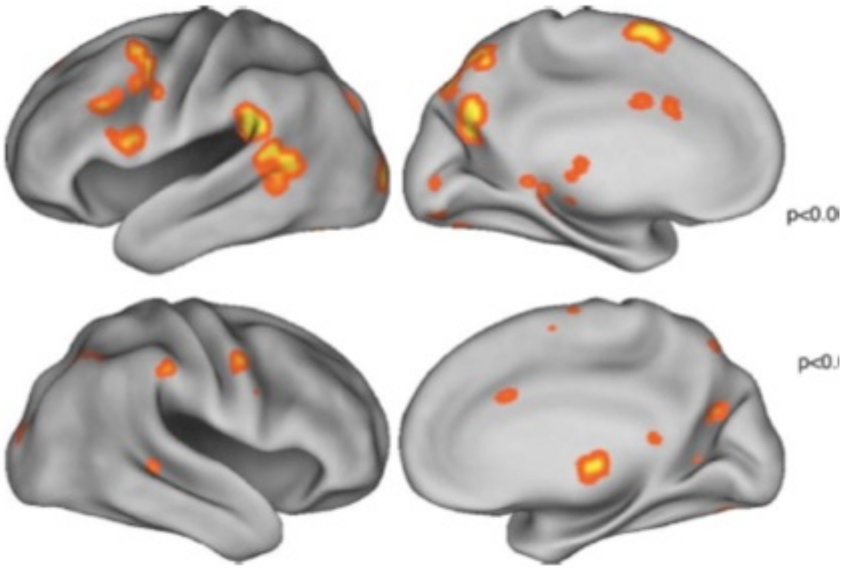
Building a motor simulation de novo: Observation of dance by dancers

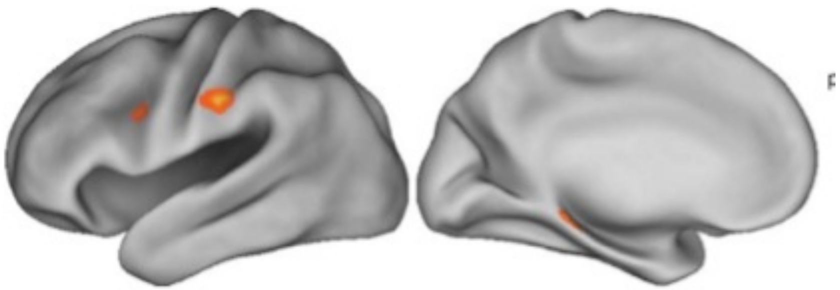
Emily S. Cross, Antonia F. de C. Hamilton, and Scott T. Grafton*

Comparison between observing video sequences of movements being learned (5h/week during 5 weeks) and non-learned movements. Then they must judge their capacity to perform the same movements (self-rating)



Activation of both parts of the mirror neuron system (IPS & IFG), especially if modulated by auto-evaluation





Rehearsed vs non rehearsed

Modulated by self-rating

Human Brain Mapping 27:239–250(2006)

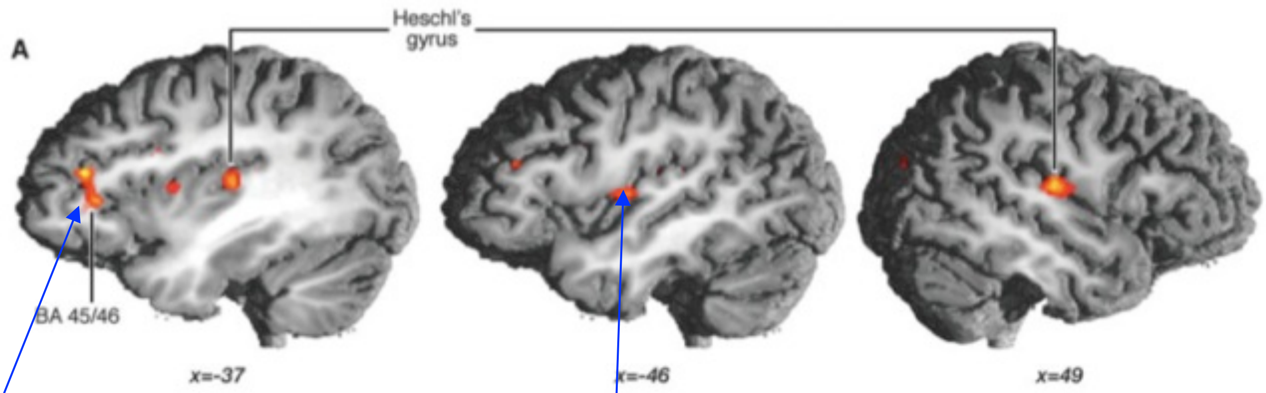
Investigating Emotion With Music: An fMRI Study

Stefan Koelsch,* Thomas Fritz, D. Yves v. Cramon, Karsten Müller, and Angela D. Friederici

Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

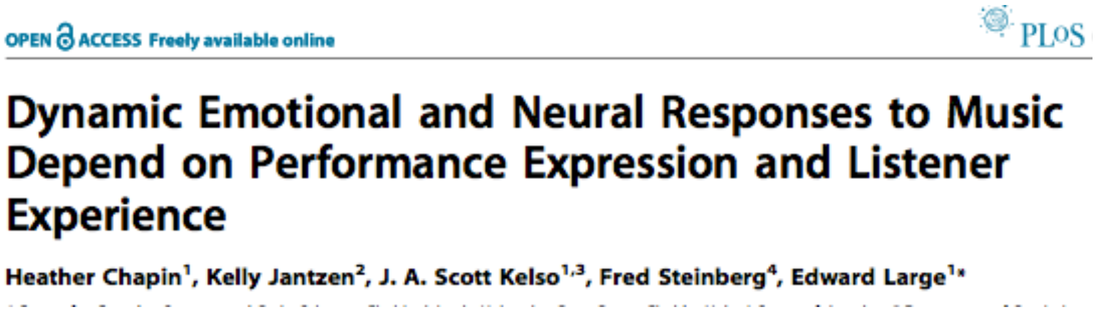
Comparison of active listening of pleasant and non-pleasant (electronically manipulated) musical extracts with fMRI: activation Heschl, ant-sup Insula and BA 45/46 (Broca).

Pleasant > Unpleasant



" **IFG activations** appear to reflect processes of music-syntactic analysis and working memory operations"

"widespread interconnections with both premotor cortex and limbic structures render it likely that the **anterior superior insula** plays a role in the activation of the Rolandic operculum during the emotional perception of the musical stimuli."



Expressive vs "mechanical" performance

Frederic Chopin Etude in E major, Op.10, No. 3
(« tristesse »)

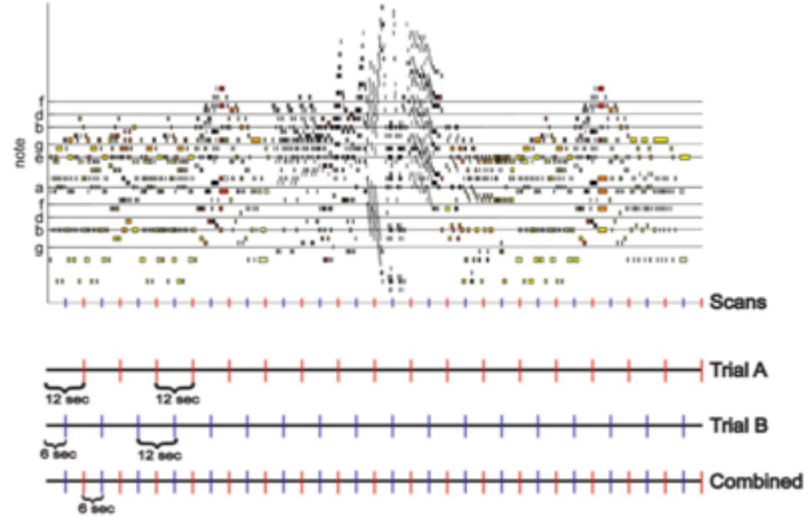
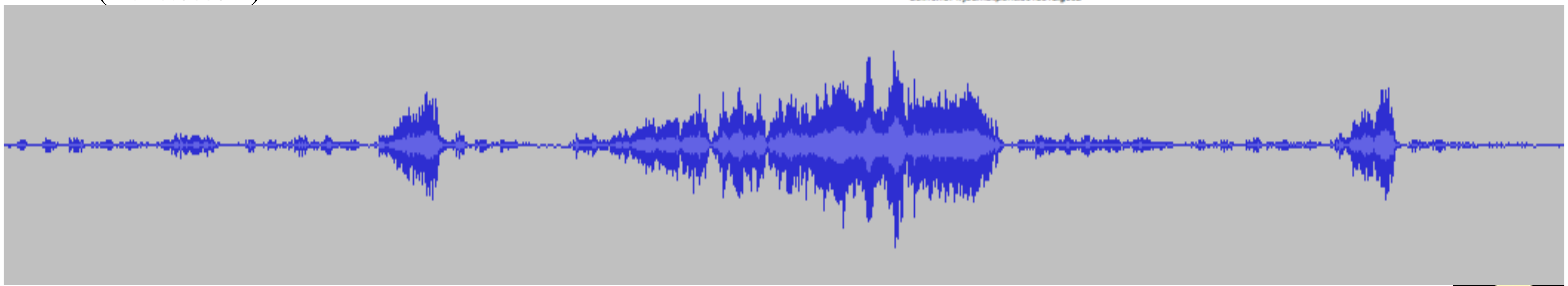
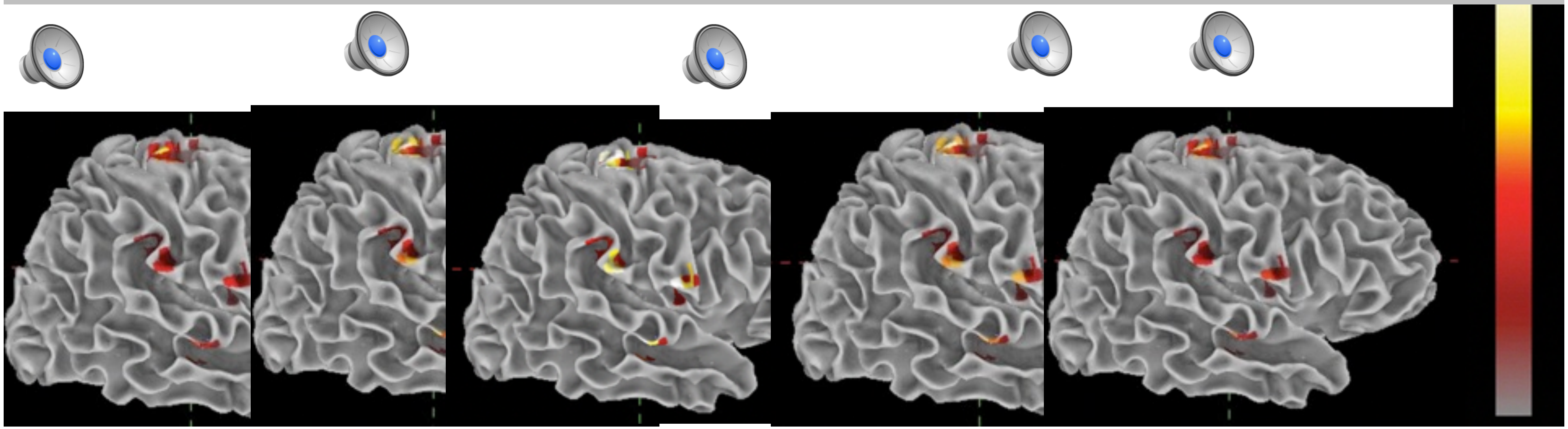


Figure 2. Piano roll notation and fMRI scan times. Piano roll notates Chopin's Etude in E major, opus 10, no .3.
doi:10.1371/journal.pone.0013812.g002





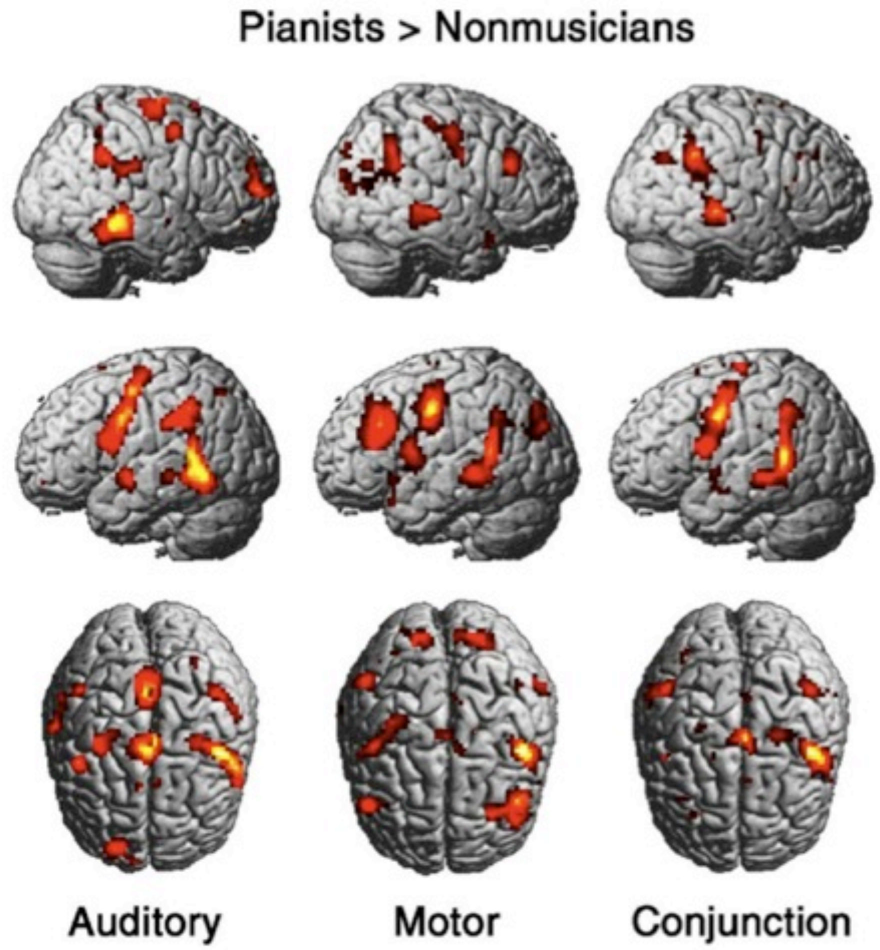
Shared networks for auditory and motor processing in professional pianists: Evidence from fMRI conjunction

Marc Bangert,[a,b,c,*] Thomas Peschel,[c,d] Gottfried Schlaug,[b] Michael Rotte,[d] Dieter Drescher,[a] Hermann Hinrichs,[d] Hans-Jochen Heinze,[d] and Eckart Altenmüller[a,*]

[a]*Institute of Music Physiology and Musicians' Medicine, Hanover University of Music and Drama, Hohenzollernstrasse 47, D-30161 Hanover, Germany*
[b]*Department of Neurology, Beth Israel Deaconess Medical Center and Harvard Medical School, 330 Brookline Ave., Boston, MA 02215, USA*

M. Bangert et al. / NeuroImage 30 (2006) 917–926

a network of neural regions in the brain are activated in both an aural task (listening to piano melodies) and a motion-oriented task ('playing' a piano keyboard with no auditory output) in professional pianists, but this coactivation is not found in non-musicians



The acoustic task (aT) required passively listening to 3-s monophonic piano sequences.
In the motion-related task (mT), subjects were prompted to arbitrarily press keys on a soundless piano keyboard during a time window of 3 s

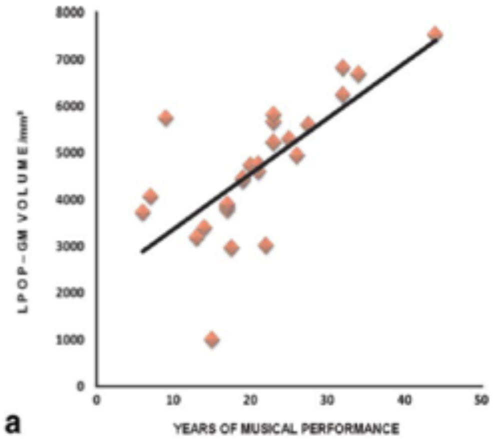
JOURNAL OF MAGNETIC RESONANCE IMAGING 33:24–32 (2011)

Original Research

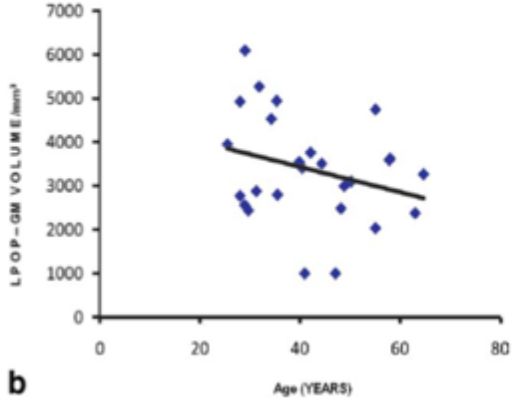
Increased Gray Matter Volume of Left Pars Opercularis in Male Orchestral Musicians Correlate Positively With Years of Musical Performance

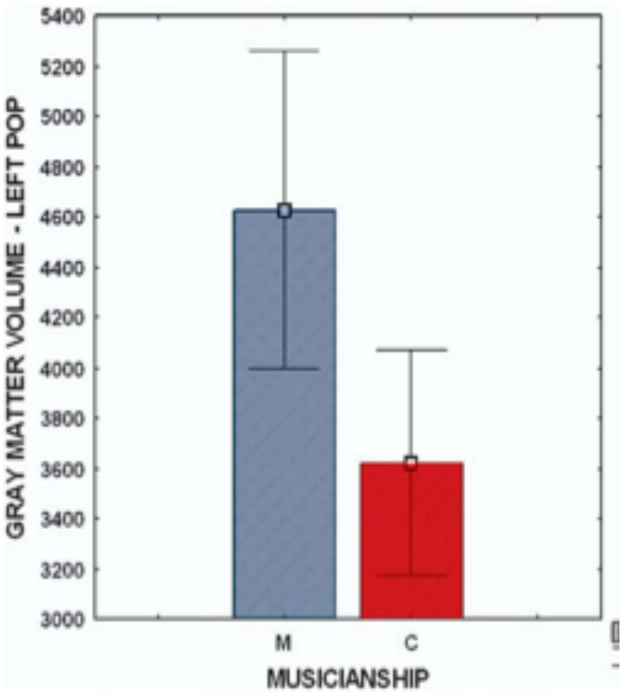
Ihssan A. Abdul-Kareem, MBChB, MRes,[1,2*] Andrej Stancak, PhD,[2,3] Laura M. Parkes, PhD,[2,4] and Vanessa Sluming, PhD[1,2]

Musicians (nb years)



Non-musicians (age)





Increased Broca's Area Size in Musicians

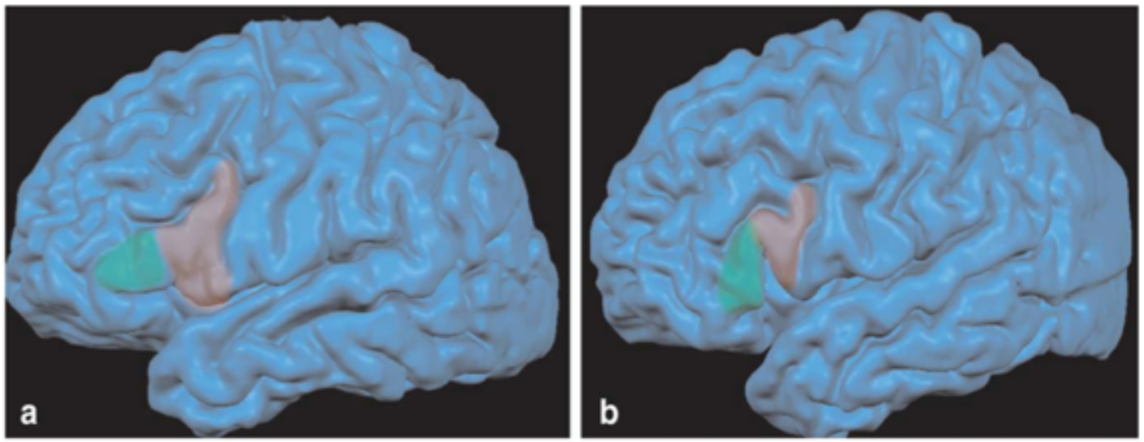


Figure 5. Demonstration of POP (red) and PTR (green) on 3D views of left hemisphere in a musician **(A)** and a nonmusician **(B)**.

308 • The Journal of Neuroscience, January 10, 2007 • 27(2):308–314

Behavioral/Systems/Cognitive

Action Representation of Sound: Audiomotor Recognition Network While Listening to Newly Acquired Actions

Amir Lahav,[1,2] Elliot Saltzman,[2,3] and Gottfried Schlaug[1]
[1]Department of Neurology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts 02215, [2]Department of Rehabilitation Sciences, Boston University, Boston, Massachusetts 02215, and [3]Haskins Laboratories, New Haven, Connecticut 06511

Non-musicians trained to play simple melodies : activation of (mainly left) IFG when listening to learned melodies (compared to same notes unlearned)

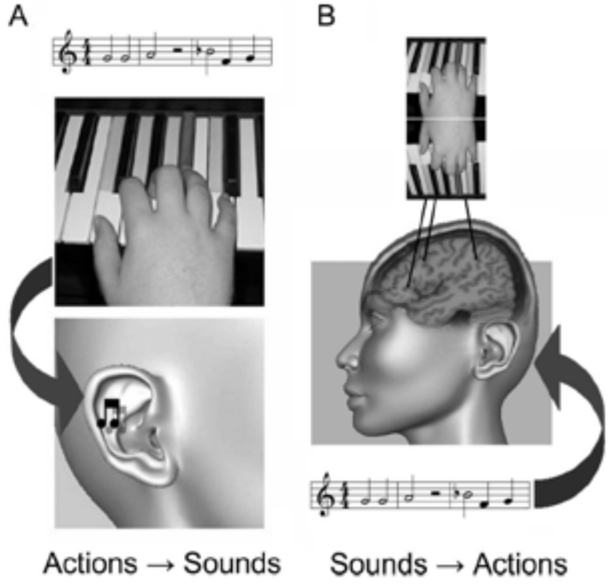
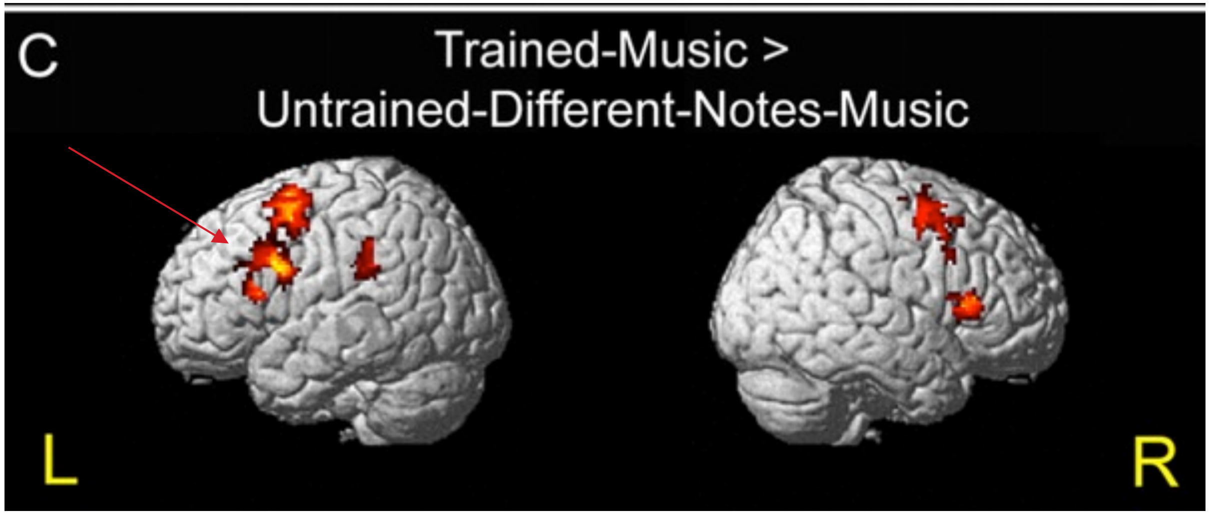


Figure 1. Action–listening illustration. ***A***, Music performance can be viewed as a complex sequence of both actions and sounds, in which sounds are made by actions. ***B***, The sound of music one knows how to play can be reflected, as if in a mirror, in the corresponding motor representations.



Our findings thus support the view that Broca's area is presumably a central region ("hub") of the mirror neuron network (Iacoboni et al., 1999; Nishitani and Hari, 2000; Hamzei et al., 2003; Rizzolatti and Craighero, 2004; Nelissen et al., 2005), demonstrating here its multifunctional role in action listening.

9632 • The Journal of Neuroscience, September 24, 2008 • 28(39):9632–9639

Behavioral/Systems/Cognitive

Cortical Plasticity Induced by Short-Term Unimodal and Multimodal Musical Training

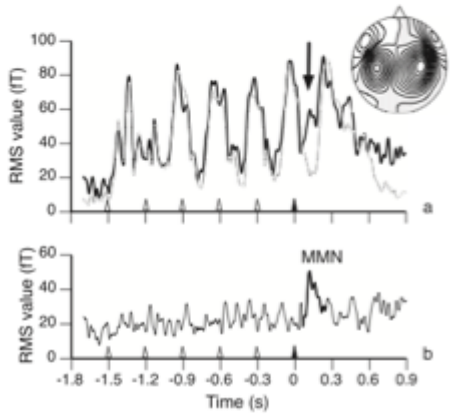
Claudia Lappe,[1*] Sibylle C. Herholz,[1*] Laurel J. Trainor,[2,3] and Christo Pantev[1]
[1]Institute for Biomagnetism and Biosignalanalysis, University of Münster, 48149 Münster, Germany, and [2]Department of Psychology, Neuroscience, and Behaviour and the [3]McMaster Institute for Music and the Mind, McMaster University, Hamilton, Ontario, Canada L8S 4K1

Cortical Plasticity Induced by Short-Term Multimodal Musical Rhythm Training

Claudia Lappe[1], Laurel J. Trainor[2], Sibylle C. Herholz[1,3], Christo Pantev[1*]
1 Institute for Biomagnetism and Biosignalanalysis, University of Muenster, Münster, Germany, 2 Department of Psychology, Neuroscience & Behaviour and the McMaster Institute for Music and the Mind, McMaster University, Hamilton, Canada, 3 Montreal Neurological Institute, McGill University, Montreal, Canada

Études en MEG de sujets non musiciens entraînés durant 8 sessions de 25 mn sur 2 semaines à jouer une mélodie des deux mains, guidés par un schéma du clavier marqué des doigtés, comparés à un groupe témoin ne jouant rien mais écoutant l'autre groupe apprendre à jouer!

9636 • J. Neurosci., September 24, 2008 • 28(39):9632–9639



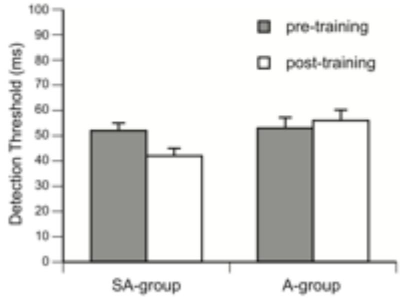
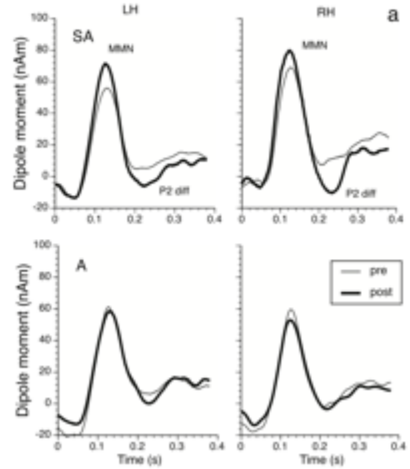


Figure 2. Group means of behavioral performance in the auditory discrimination test before and after training: pre, pretraining; post, postraining. Error bars indicate SEM.



L'entraînement sensori-moteur et auditif (SA) améliore la discrimination de manière plus nette et provoque une MMN plus ample que l'entraînement auditif seul (A), tant pour la discrimination de mélodies que de rythmes

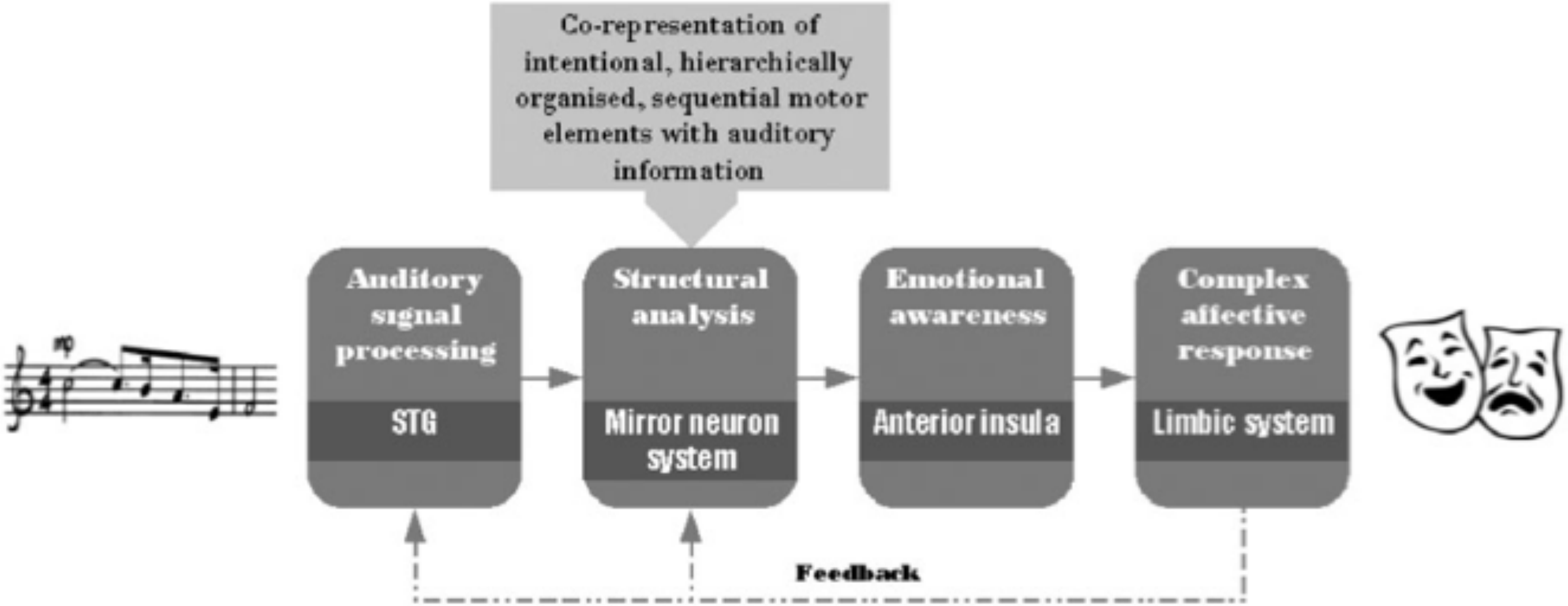
En résumé (2) : danse, musique et neurones miroir

- L'étude de danseurs experts apporte un modèle privilégié de compréhension du fonctionnement du SNM et de son rôle dans l'apprentissage de gestuelles spécifiques à chaque danse
- Il existe un ensemble croissant et convergent d'arguments montrant que la perception de la musique mais aussi la capacité à jouer (et sans doute à apprendre à jouer) d'un instrument de musique fait appel de manière singulière au fonctionnement du système des neurones miroir (idéalement placé pour établir la jonction audio-motrice entre perception et production)
- Des expériences isolant l'aspect esthétique et le plaisir musicaux convergent vers l'activation spécifique de parties du SNM, en particulier l'insula et le gyrus frontal inférieur ("Broca"), deux zones dont la proximité anatomique suggère leur rôle conjoint mais distinct dans la façon dont l'humain perçoit et "vit" la musique
- Ainsi, perception, production et émotion musicales semblent étroitement liées par l'anatomie comme par la fonction

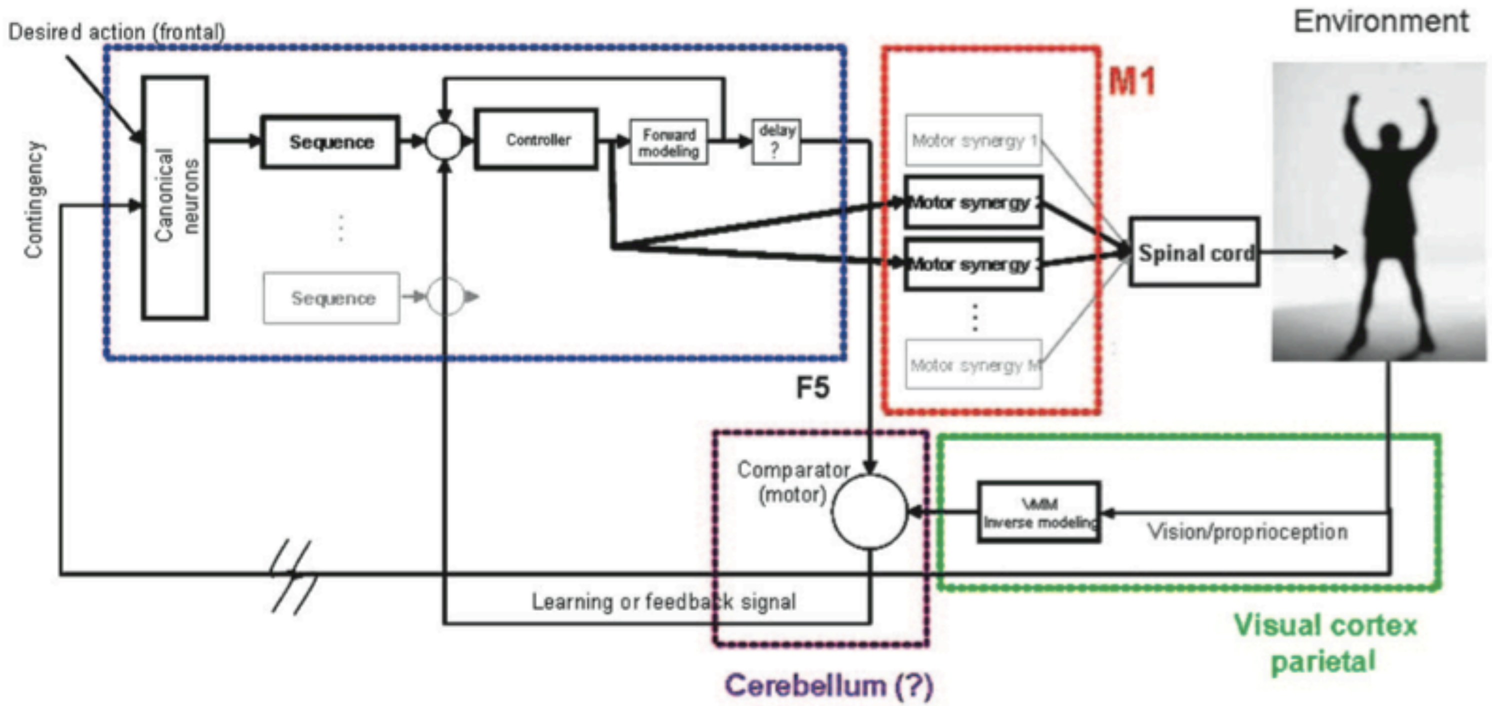
doi:10.1093/scan/nsl029 SCAN (2006) 1, 235–241

Music and mirror neurons: from motion to 'e'motion

Istvan Molnar-Szakacs[1,2,3] and Katie Overy[4]

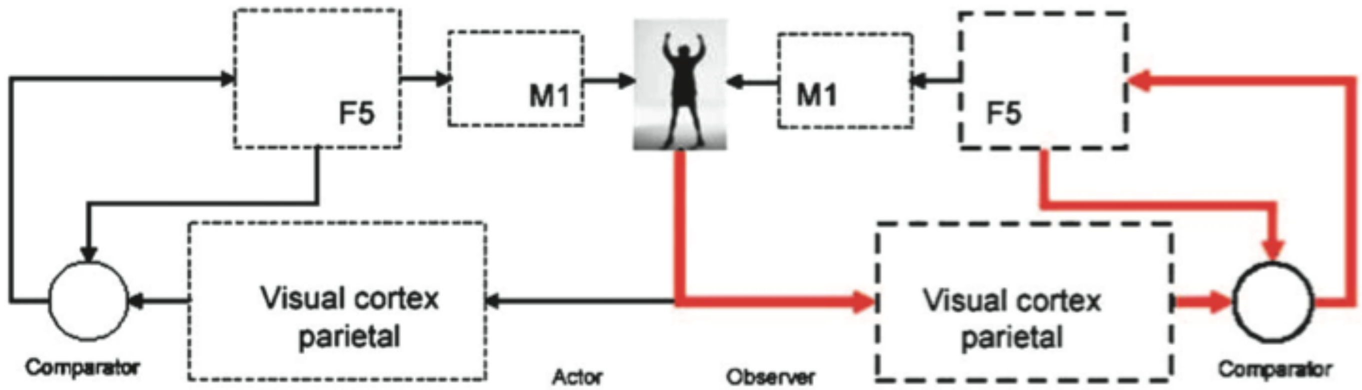


"The shared recruitment of this neural mechanism in both the sender and the perceiver of the musical message allows for co-representation and sharing of the musical experience."



A model of area F5 and the mirror-neurons system

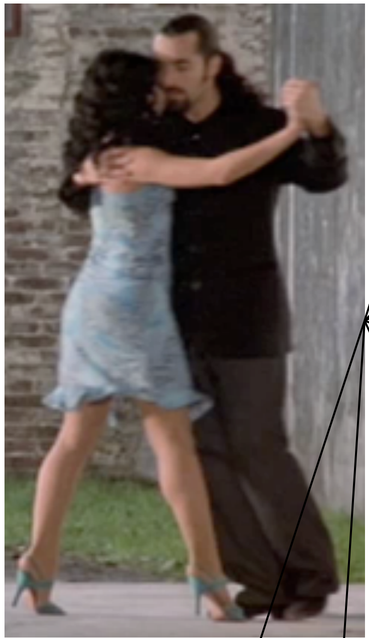
L. Craighero et al. Progress in Brain Research, 164:39-59, 2007


F5
M1
M1
F5
Visual cortex parietal
Visual cortex parietal
Comparator
Actor
Observer
Comparator

[redacted]


1
2
3
4

Tango dansé : depuis la simulation sensori-motrice à l'intersubjectivité



Perception (compréhension) du mouvement

Perception de l'intention

Partage de la sensation proprioceptive

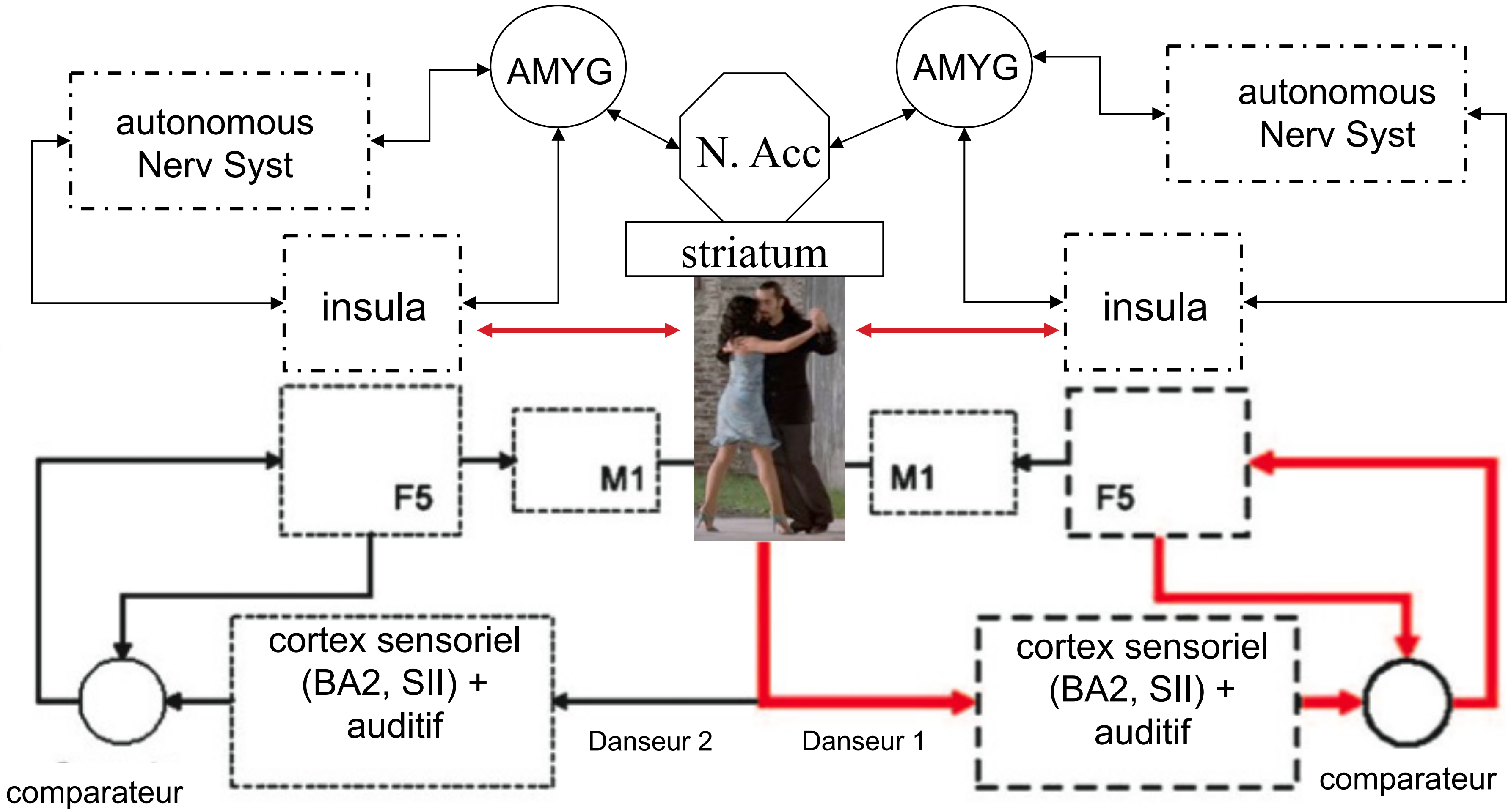
Simultanéité temporelle du mouvement

Association audio-motrice (musique-danse)

Résonance affective de la connexion danse/musique

Résonance affective de l'"abrazo" (proximité corporelle)

Empathie & intersubjectivité



Expérience réciproque de partage sensori-moteur

Effets non spécifiques

Possible effets spécifiques

Stimulation sensori-motrice non spécifique

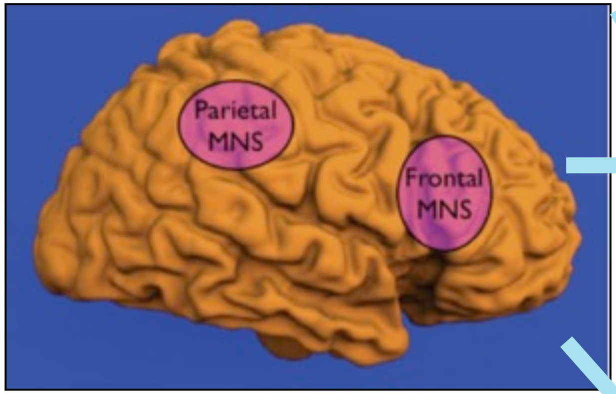
Stimule les mécanismes d'empathie

Stimule les compétences sociales

Sollicite la mémoire de travail

Favorise la synchronisation de systèmes neuronaux distincts (SNM, réseau de la cognition sociale…)

Effet motivationnel positif



Sollicitation spécifique du système des neurones-miroir

Favorise la plasticité cérébrale par apprentissage nouvelles stratégies

Active les mécanismes de transcodage intermodal

Stimule la connectivité

Effet hypothétique de la pratique du tango dansé sur le fonctionnement cognitif (e.g. chez le sujet âgé)

En conclusion,

- 1- La pratique du tango dansé améliore significativement certaines performances cognitives de sujets agés sains et atteints de troubles dégénératifs
- 2- La musique, comme la danse, font singulièrement appel à des circuits cérébraux superposables au système des neurones miroirs
- 3- Le tango, par ses caractéristiques rythmiques et sensori-motrices, a toutes chances de solliciter massivement et de façon multiple le SNM
- 4- Stimuler le SNM a été proposé comme thérapeutique de diverses conditions liées au vieillissement comme au développement

Perspectives

- Utilisation de "tangothérapie" pour "entraîner" les neurones miroirs
  - Troubles liés à la sénescence : Parkinson, vieillissement normal et pathologique….
  - Troubles moteurs par lésions vasculaires focales
  - Troubles du développement
    - Autisme et trouble des interactions sociales
    - Autres : troubles développementaux du langage
    - Combinaison musique/danse