Psychologie Cognitive

La décision

Licence 3

Gilles Lafargue

Qu'est-ce que décider ?
terminologie

- Choix et libre-arbitre / choix et conscience
- Choisir entre plusieurs alternatives
- Choisir d'agir ou de ne pas agir
  - résister à la tentation, quantité d'effort consenti (énergisation du comportement),
- Choisir quand agir
- Formation de jugements subjectifs (préférences,..)

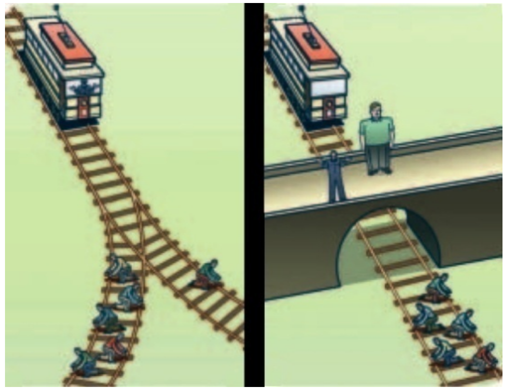
Qu'est-ce que décider ?

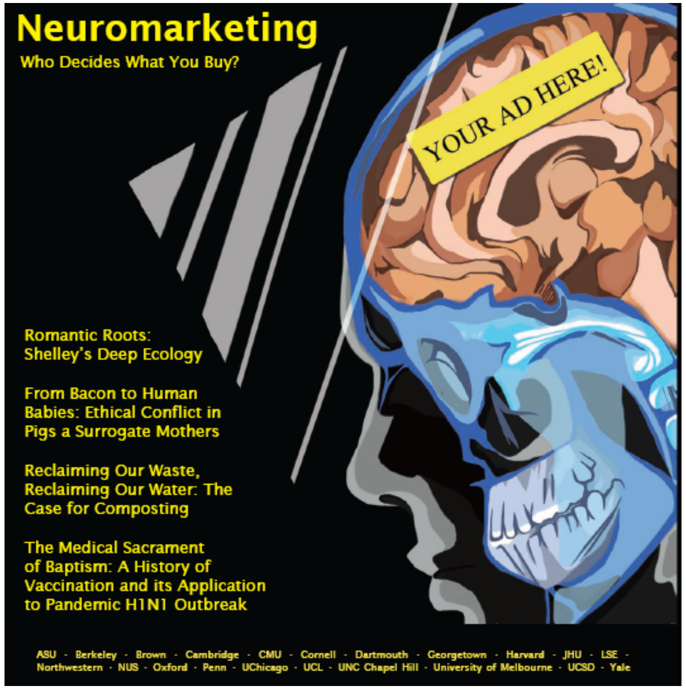
terminologie

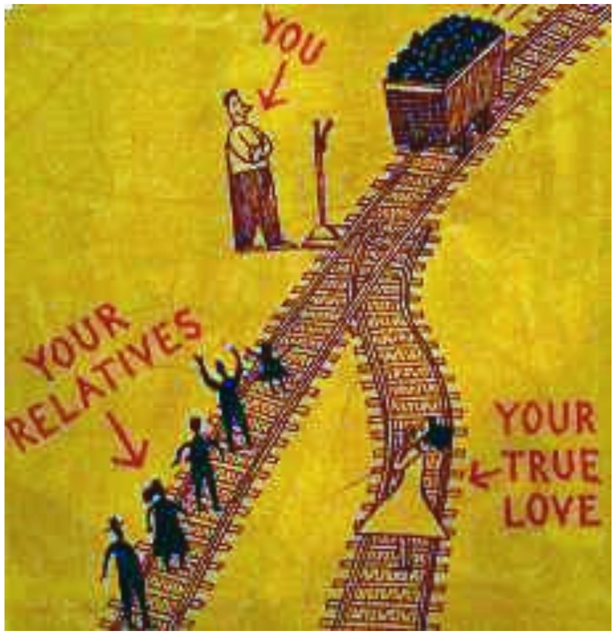
- Choix d'un but, d'un objet, d'un mouvement, d'un comportement
- Formation des croyances, des préférences
- Décisions motrices, Décisions d'achat, choix moraux, choix politiques

- Notion de valeur, de capacité à anticiper les conséquences des actions


Avoir
la barre
dès le matin
Mars
Et ça repart >>




Neuromarketing
Who Decides What You Buy?
YOUR AD HERE!
Romantic Roots:
Shelley's Deep Ecology
From Bacon to Human
Babies: Ethical Conflict in
Pigs a Surrogate Mothers
Reclaiming Our Waste,
Reclaiming Our Water: The
Case for Composting
The Medical Sacrament
of Baptism: A History of
Vaccination and its Application
to Pandemic H1N1 Outbreak
ASU · Berkeley · Brown · Cambridge · CMU · Cornell · Dartmouth · Georgetown · Harvard · JHU · LSE ·
Northwestern · NUS · Oxford · Penn · UChicago · UCL · UNC Chapel Hill · University of Melbourne · UCSD · Yale


YOU
YOUR RELATIVES
YOUR TRUE LOVE

1. Introduction : libre arbitre et psychologie cognitive /
Psychologie cognitive et décision

2. Conscience et prise de décision (rappel du cours de L2)

3. Nos décisions dites conscientes peuvent être influencées par des stimuli non perçus consciemment

4. Pour prendre une décision importante une délibération consciente n’est pas toujours nécessaire

5. Le cerveau assigne des valeurs et anticipe les conséquences des actions

Introduction : Libre-arbitre et prise de décision

- Le libre-arbitre est l'idée selon laquelle nous faisons des choix ou pensons, indépendamment de tout ce qui pourrait ressembler à un processus physique.

- Selon cette perspective, les choix ne sont pas causés par des événements physiques mais émergent pleinement formés de lieux inaccessibles à la description physique.

Introduction : Libre-arbitre et prise de décision

- Le libre arbitre est une version contemporaine de l'âme, concept qui renvoie à l'idée que nos pensées et sentiments dérivent d'une entité indépendante et distincte des mécanismes physiques qui font fonctionner notre corps.

- Le libre arbitre ne peut être un produit de la sélection naturelle dans la mesure où ceci le placerait dans une chaîne d'événements physiques connectés causalement.

Introduction : Libre-arbitre et prise de décision

- Par définition, le libre arbitre, qui fait référence à un phénomène intrinsèquement inobservable, n'est pas un concept pertinent scientifiquement.
  - contradiction dans les termes entre *acte libre* et *explication causale*.

- **La psychologie cognitive s'intéresse aux processus et aux mécanismes en jeu dans le choix ou la prise de décision**

Introduction : Libre-arbitre et prise de décision

- La question, pour la psychologie cognitive, n'est pas de savoir si une personnes aurait pu agir différemment qu'elle a agi en étant exactement dans les mêmes circonstances.

- Une voie pour la psychologie cognitive est de rendre compte des distinctions faites par le sens commun
  - Choix délibéré/automatique, conscients/non conscients, actes volontaires/involontaires, origine endogène/exogène du comportement, personne responsable/irresponsable, phénoménologie de l'action

- La psychologie cognitive étudie les différents types de processus qui sous-tendent la sélection et le contrôle des différents types d'actions

La face cachée de l'action

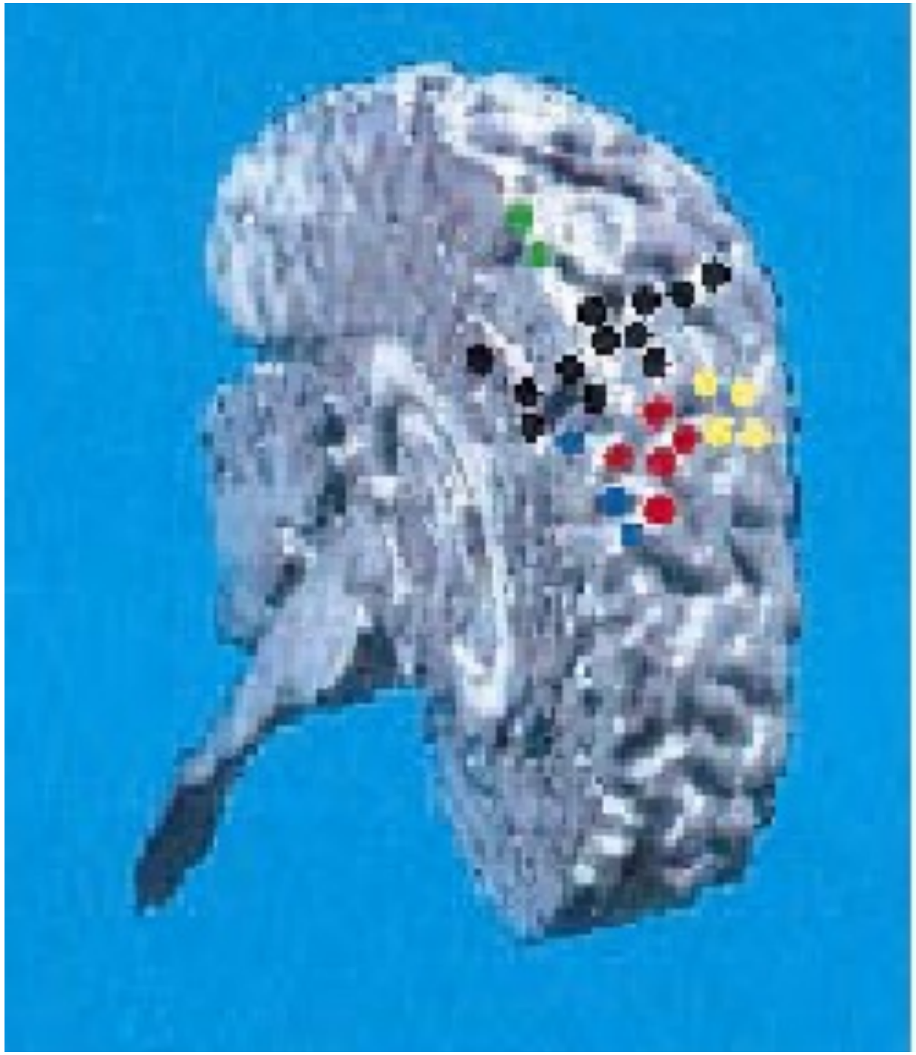
L'intention motrice

Expérience consciente de la volonté d'effectuer un mouvement précis

déclenchée par le neuro-chirurgien

Fried et al. (1991). Direct stimulation of the supplementary motor area in man. A strip of electrodes is used to stimulate the cerebral cortex as part of pre-operative procedure before neurosurgery for severe epilepsy. When the SMA (electrodes outlined in red) was stimulated, subjects reported the sensation of an urge to move their limbs. More intense stimulation at the same locations provoked physical movements of the corresponding limb

Éclats de rire induits par SE de la partie antérieure de l’AMS



Fried et al. (1998). Electrical current stimulates laughter, ***Nature***, 391, 650.

Rires

Interruption du langage

Interruption de la capacité à nommer les objets

Interruption des activités manuelles

Mouvements impliquant les bras et les avant-bras

Sensations de frôlement

- Les humains ont la capacité à former des idées abstraites, de nouvelles idées, non reliées directement aux besoins immédiats de survie, qui peuvent jouer un rôle important dans la prise de décision.

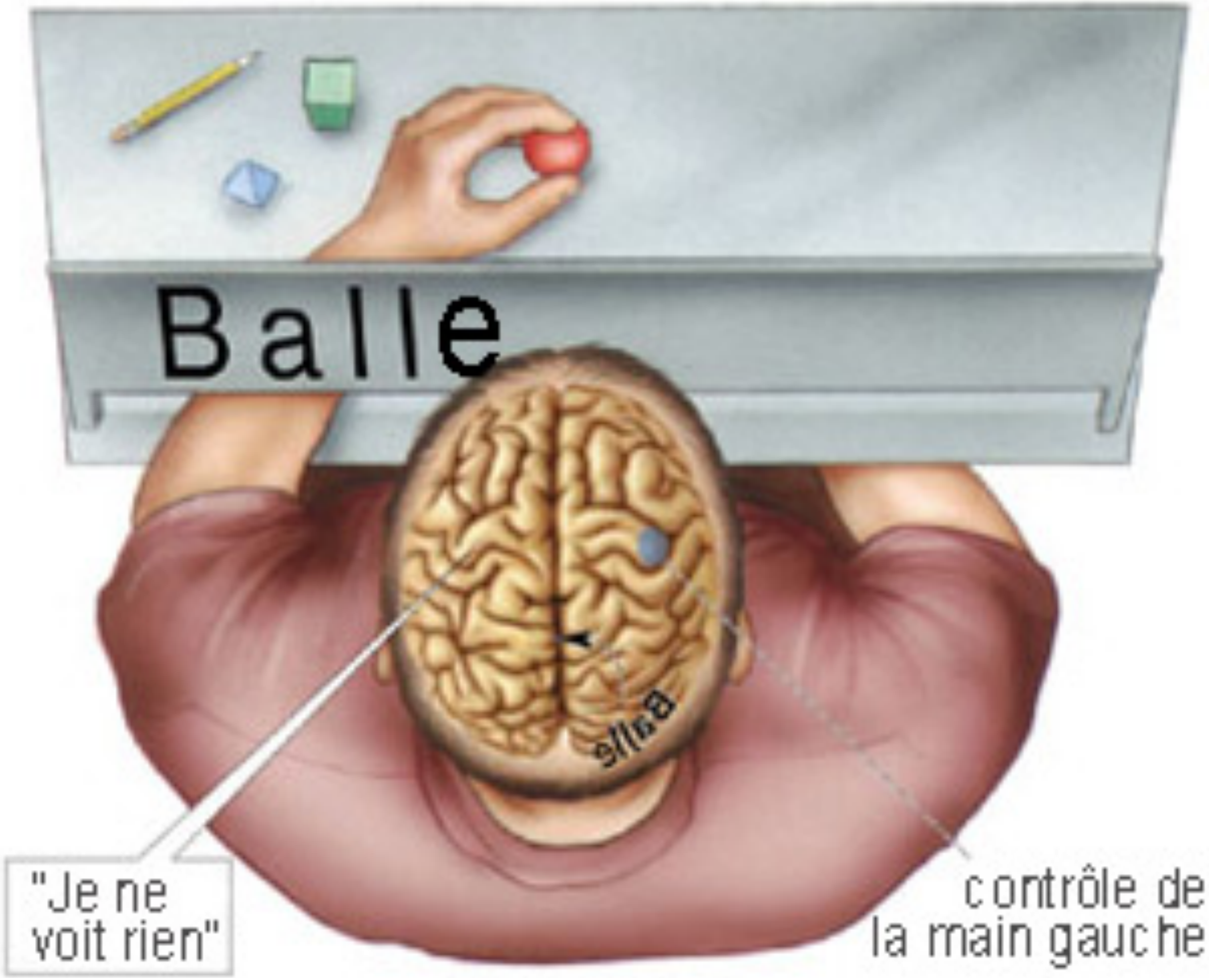
- **Il existe chez le sujet sain une capacité de flexibilité des choix, une capacité pour l'innovation cognitive**.
  - Il est même possible de faire des choix contraires à tous les impératifs biologiques
    - Exemple de la grève de la faim (on peut mourir pour des idées)

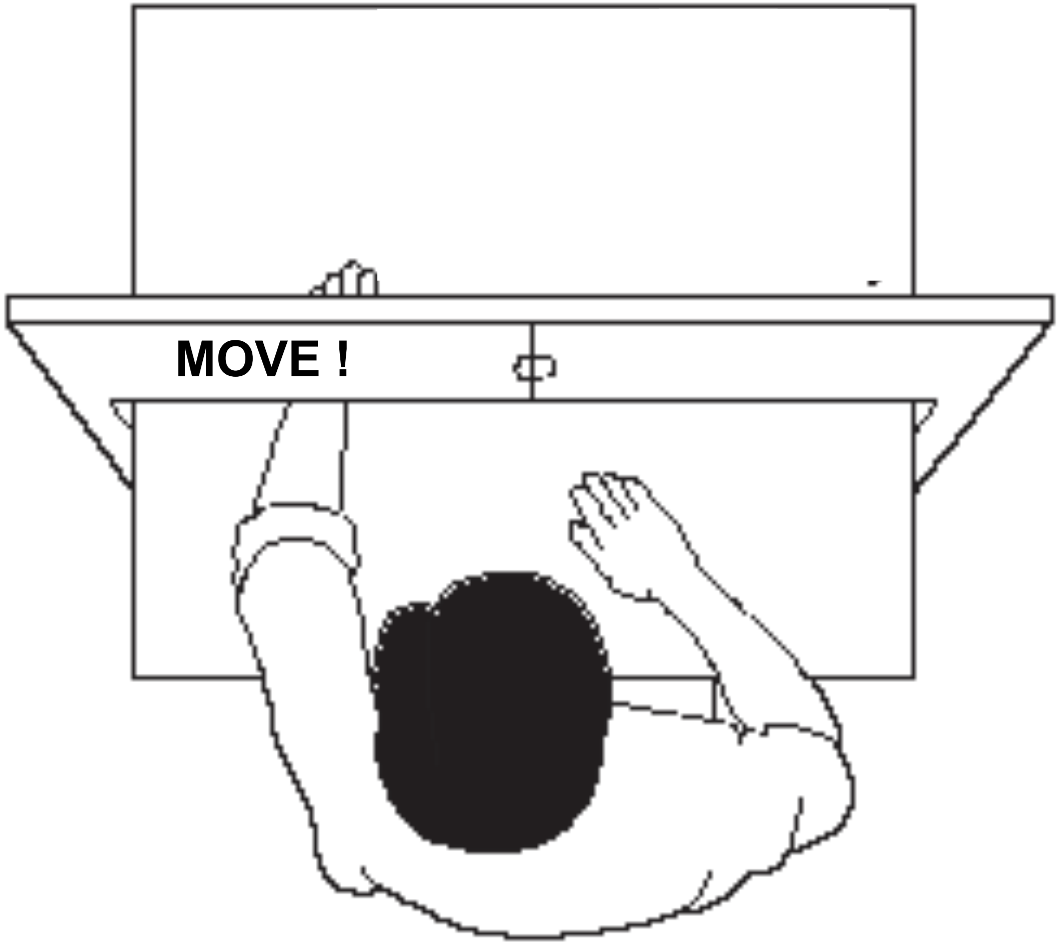
- Une façon de comprendre, non pas le libre arbitre, mais les mécanismes de la flexibilité des choix est d’étudier des pathologies du choix et de considérer qu’elles représentent des extrêmes dans la capacité normale des humains pour l’innovation cognitive

Comportements d'imitation ou d'utilisation après lésions préfrontales

A gauche, comportements d'imitation

A droite, comportements d'utilisation


Balle
"Je ne voit rien"
contrôle de la main gauche


MOVE !

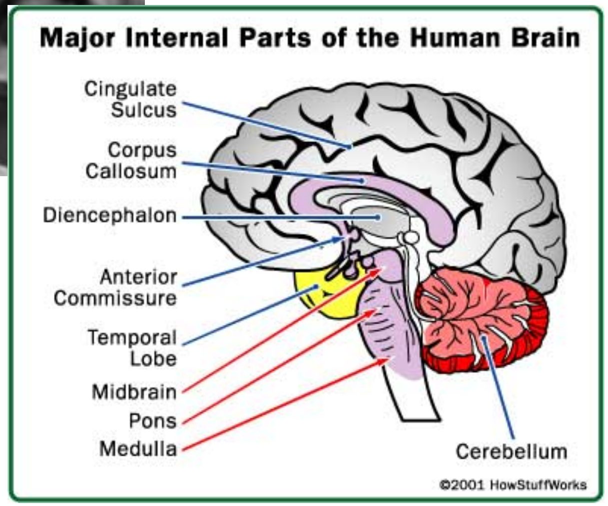
L'héminégligence spatiale

Décrite par Holmes dès 1918

Etudes détaillées d'Emilio Bisiach: « négligence représentationnelle »

- Le patient décrit les images comme identiques… mais préfère habiter dans la maison de droite.
- Amorçage sémantique par des mots ou des images présentés du côté négligé (McGlinchey-Berroth et al., 1993)

Main anarchique / Main étrangère

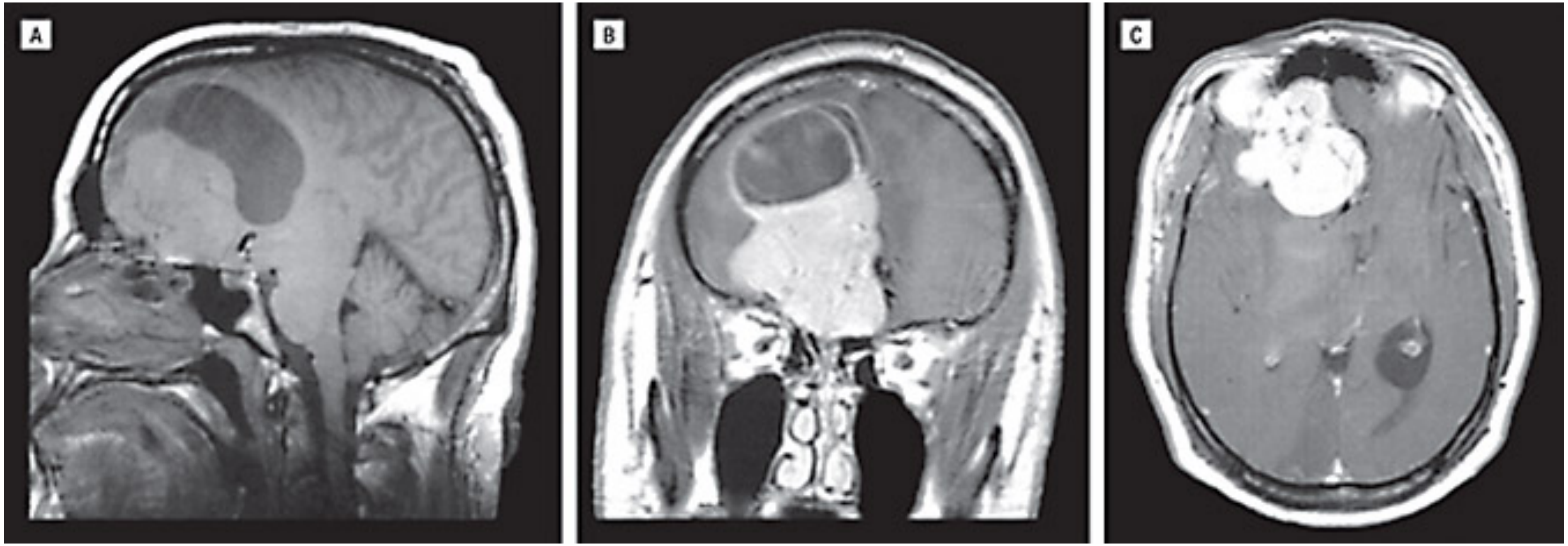


Rendu accro au jeu et au sexe par un médicament, un Nantais obtient réparation

LEMONDE.FR avec AFP | 31.03.11

Le tribunal de Nantes a donné raison, jeudi 31 mars, à Didier Jambart, un homme atteint de la maladie de Parkinson qui demandait réparation au laboratoire GlaxoSmithKline (GSK), fabricant d'un médicament contre cette maladie dont les effets secondaires l'avaient rendu accro au sexe et au jeu.

Jeffrey M. Burns, MD; Russell H. Swerdlow, MD , 2003, ***Right Orbitofrontal Tumor With Pedophilia Symptom*** *and Constructional Apraxia Sign, Archive Neurology. 2003;Vol. 60,* 437-440



Brain Abnormalities in Murderers Indicated by Positron Emission Tomography

Adrian Raine, Monte Buchsbaum, and Lori LaCasse

Murderers pleading not guilty by reason of insanity (NGRI) are thought to have brain dysfunction, but there have been no previous studies reporting direct measures of both cortical and subcortical brain functioning in this specific group. Positron emission tomography brain imaging using a continuous performance challenge task was conducted on 41 murderers pleading not guilty by reason of insanity and 41 age- and sex-matched controls. Murderers were characterized by reduced glucose metabolism in the prefrontal cortex, superior parietal gyrus, left angular gyrus, and the corpus callosum, while abnormal asymmetries of activity (left hemisphere lower than right) were also found in the amygdala, thalamus, and medial temporal lobe. These preliminary findings provide initial indications of a network of abnormal cortical and subcortical brain processes that may predispose to violence in murderers pleading NGRI.

Key Words: Violence, murder, positron emission tomography, prefrontal, amygdala, hippocampus, thalamus, corpus callosum, angular gyrus, parietal, occipital

BIOL PSYCHIATRY 1997;42:495–508

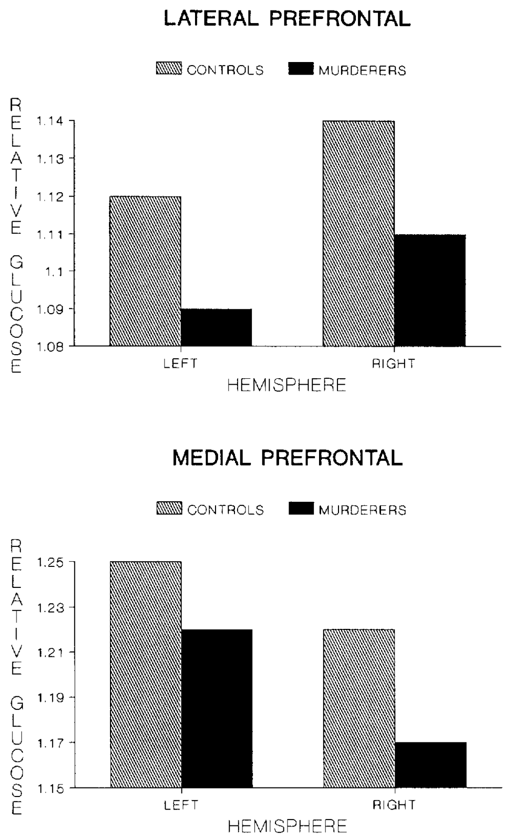


Figure 3. Relative glucose metabolic rates for murders and controls in lateral prefrontal cortex (above) and medial prefrontal cortex (below). Murderers have significantly lower lateral ($p <$ .02) and medial ($p <$ .02) prefrontal functioning in both hemispheres.

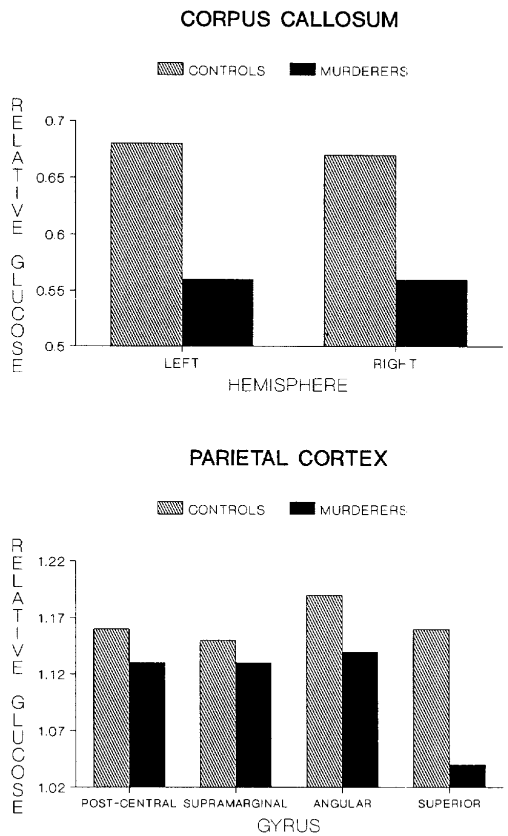


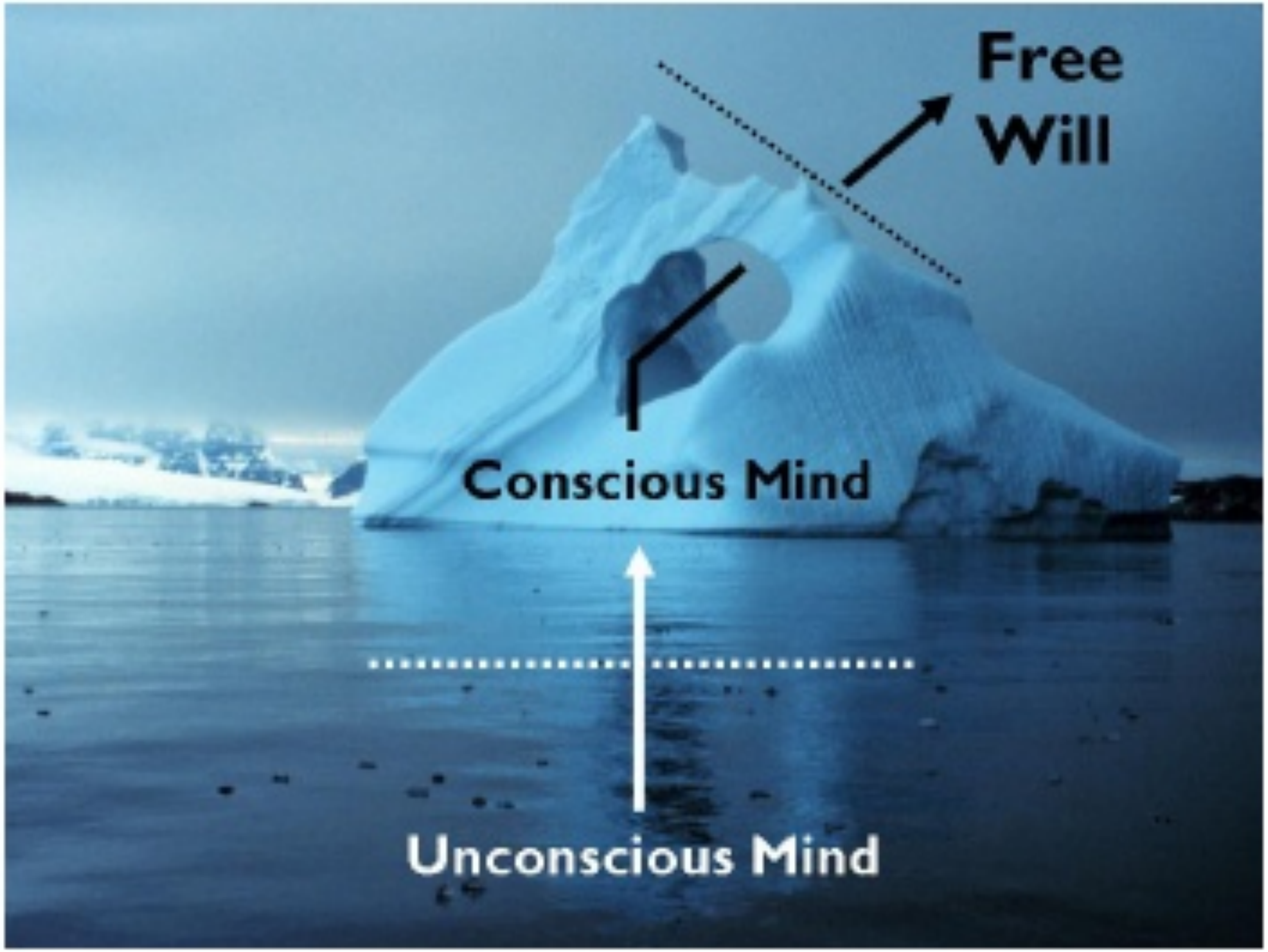
Figure 4. Relative glucose metabolic rates for murderers and controls in the corpus callosum and parietal cortex. Murderers have lower activity in the corpus callosum bilaterally ($p <$ .001), in the superior parietal gyri bilaterally ($p <$ .05), and also in the left angular gyrus ($p <$ .06).

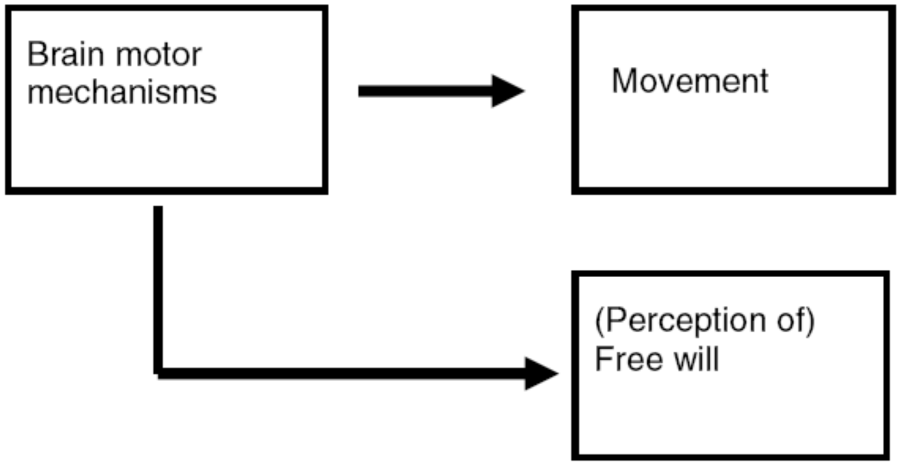
nature neuroscience

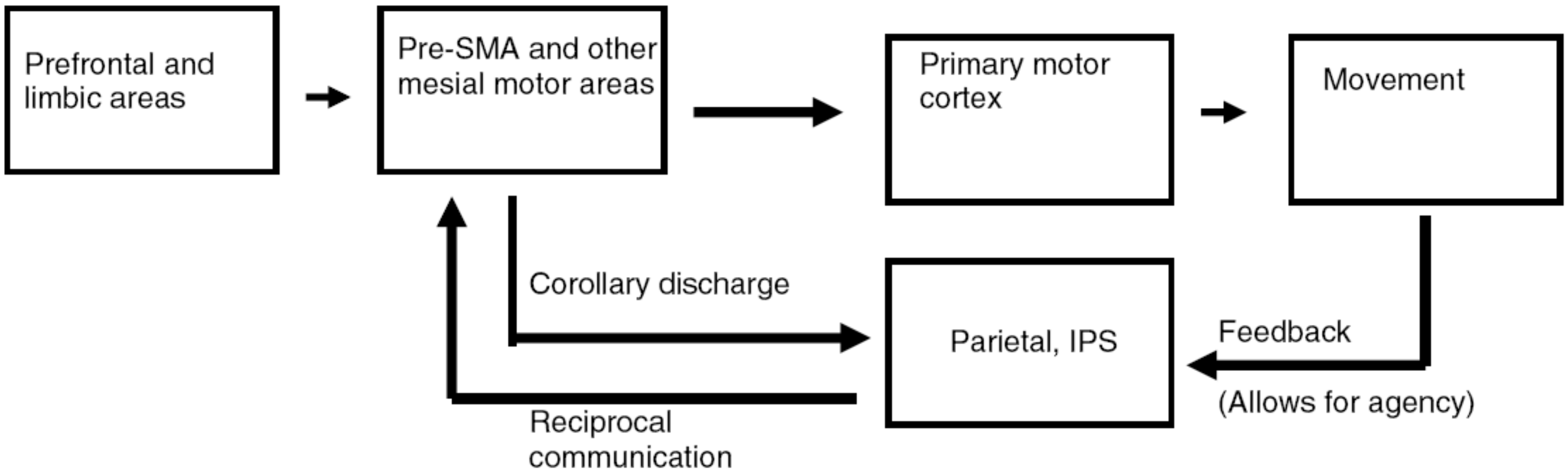
Smokers' brains compute, but ignore, a fictive error signal in a sequential investment task

Pearl H Chiu[1–4], Terry M Lohrenz[1,2,4] & P Read Montague[1–3]

Addicted individuals pursue substances of abuse even in the clear presence of positive outcomes that may be foregone and negative outcomes that may occur. Computational models of addiction depict the addicted state as a feature of a valuation disease, where drug-induced reward prediction error signals steer decisions toward continued drug use. Related models admit the possibility that valuation and choice are also directed by 'fictive' outcomes (outcomes that have not been experienced) that possess their own detectable error signals. We hypothesize that, in addiction, anomalies in these fictive error signals contribute to the diminished influence of potential consequences. Using a simple investment game and functional magnetic resonance imaging in chronic cigarette smokers, we measured neural and behavioral responses to error signals derived from actual experience and from fictive outcomes. In nonsmokers, both fictive and experiential error signals predicted subjects' choices and possessed distinct neural correlates. In chronic smokers, choices were not guided by error signals derived from what might have happened, despite ongoing and robust neural correlates of these fictive errors. These data provide human neuroimaging support for computational models of addiction and suggest the addition of fictive learning signals to reinforcement learning accounts of drug dependence.


Free
Will
Conscious Mind
Unconscious Mind


Brain motor mechanisms
Movement
(Perception of) Free will

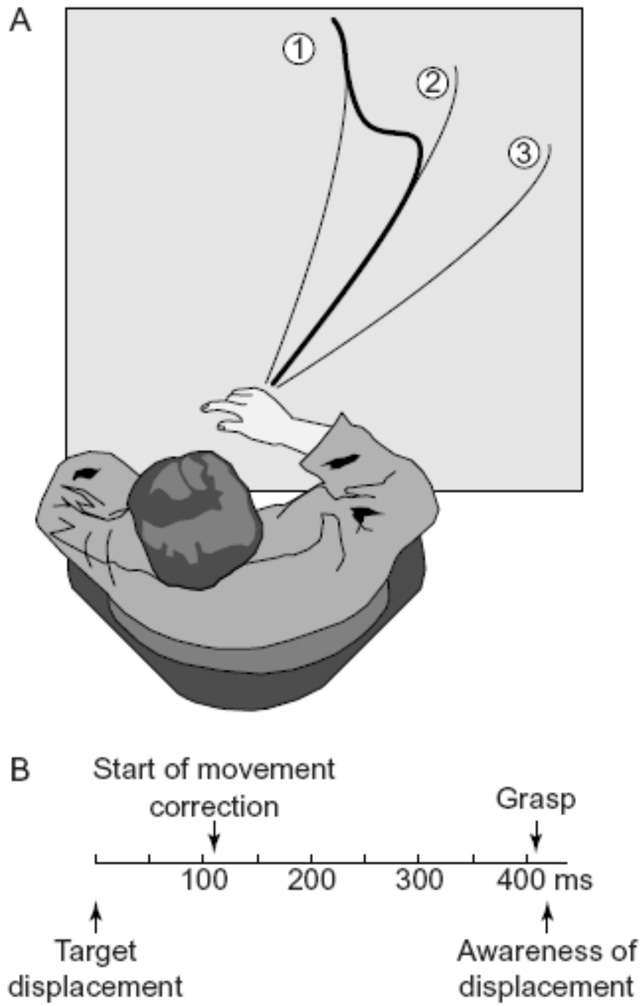

Prefrontal and limbic areas
Pre-SMA and other mesial motor areas
Primary motor cortex
Movement
Corollary discharge
Parietal, IPS
Feedback
(Allows for agency)
Reciprocal communication

I. Conscience et prise de décision

- Nous avons un sentiment très fort de contrôle de nos actions… Nous pensons que nos actes sont « causés » par nos choix délibérés, par nos intentions conscientes

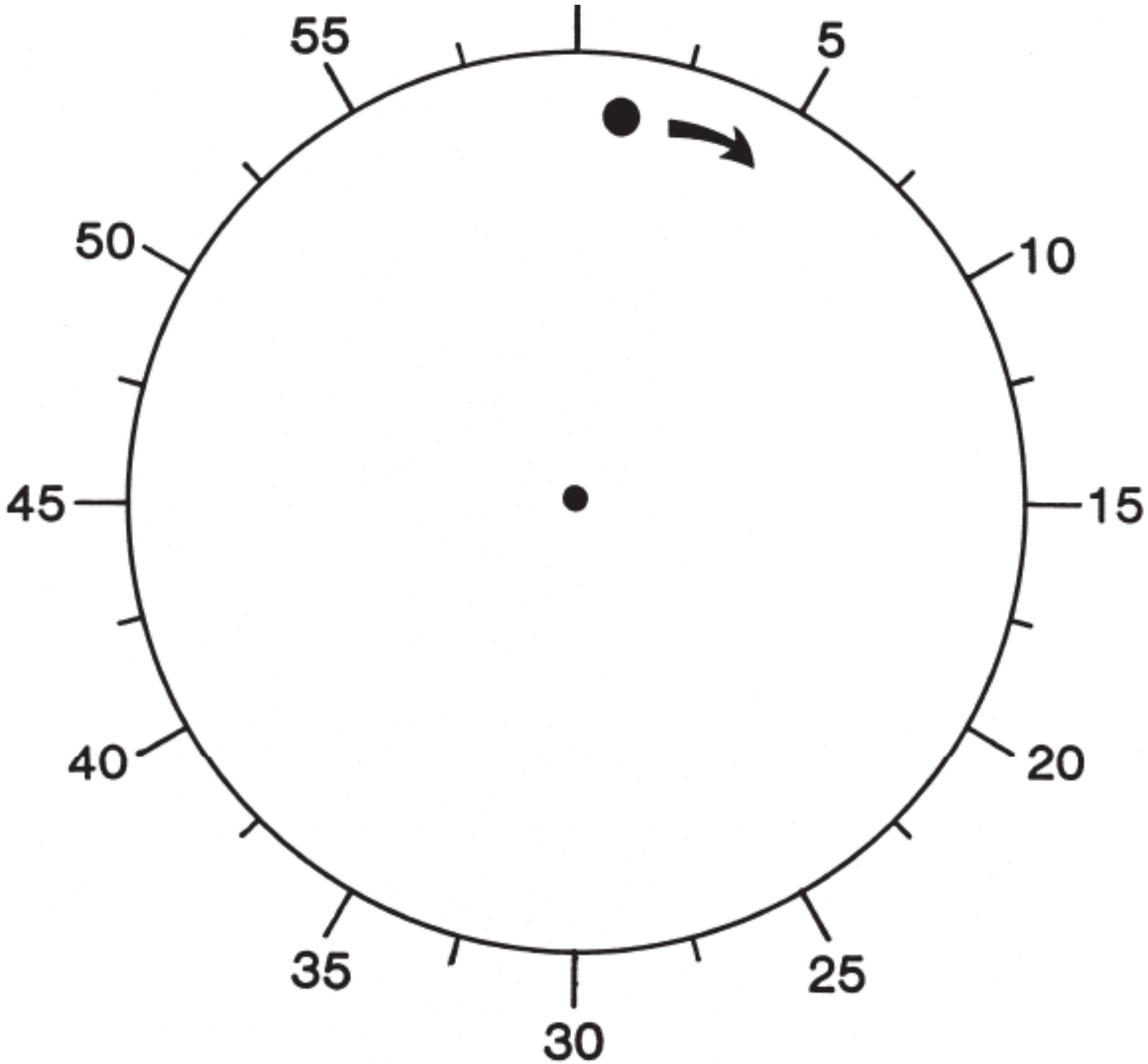
- De nombreuses expériences de psychologie cognitive et de neurosciences ont montré que la conscience a un rôle minimum dans le contrôle du comportement immédiat

Dissociation entre comportement et conscience de l'action chez le sujet valide

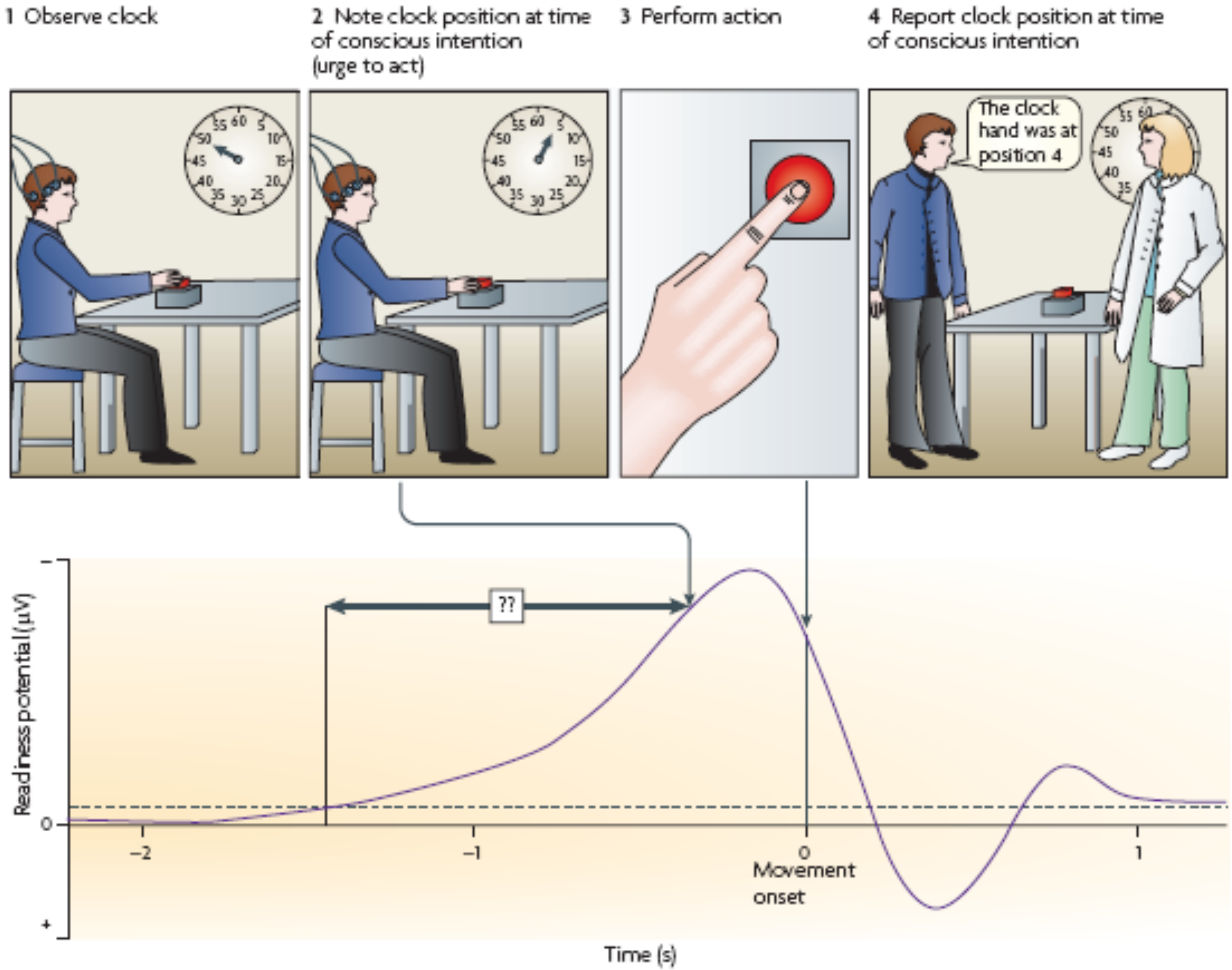


Castiello et al., Brain, 1998

L’ expérience de Benjamin Libet


55
5
50
10
45
15
40
20
35
25
30

Box 1 | **Measuring conscious intention**



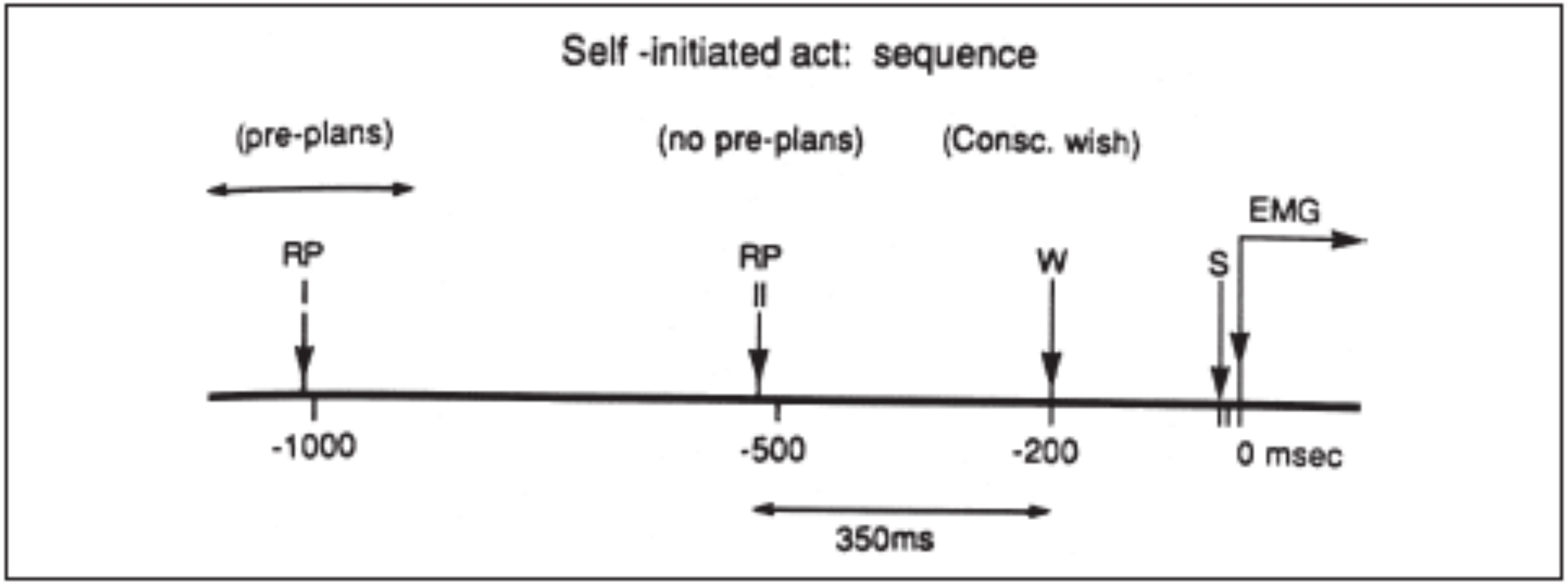


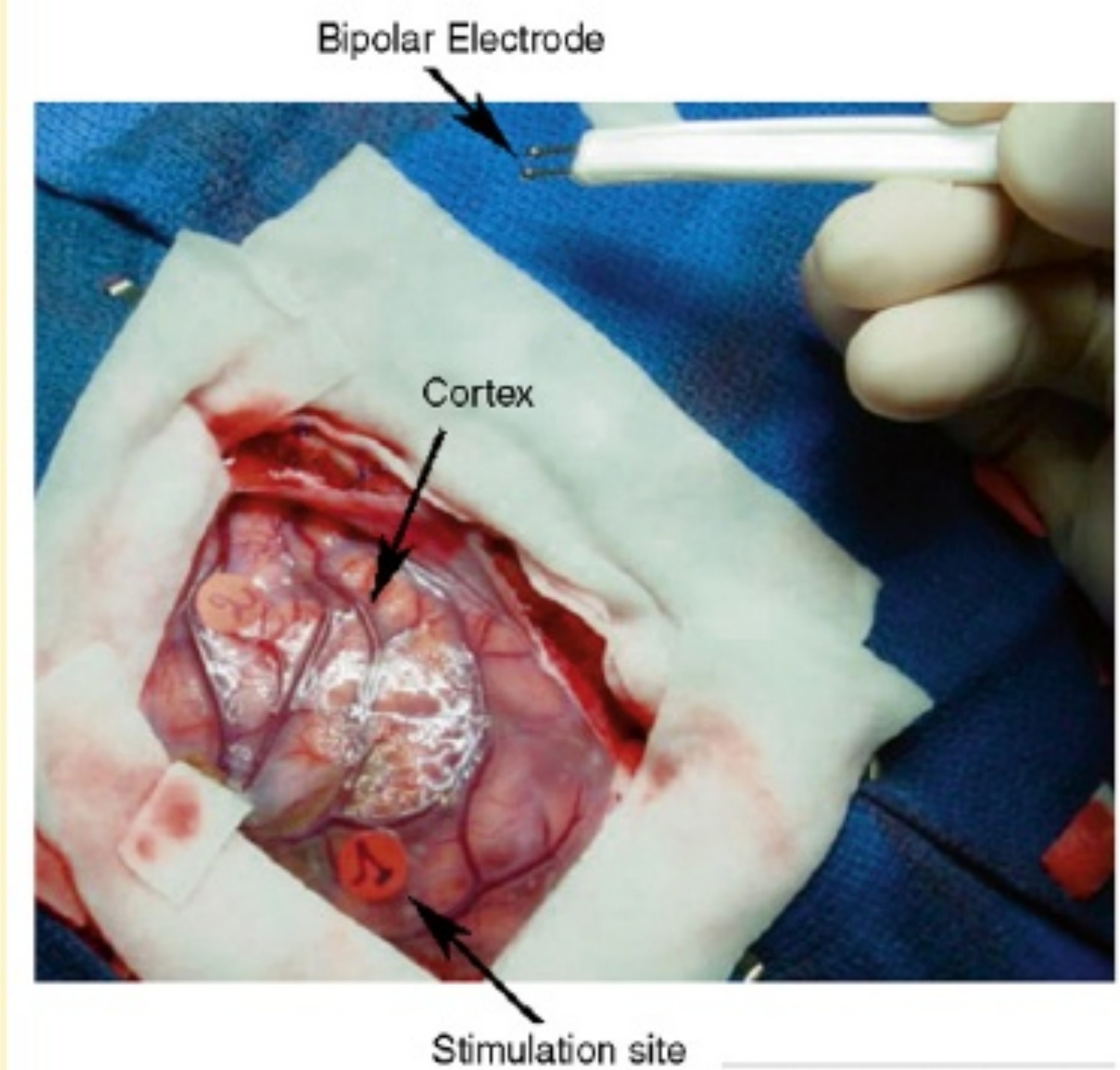
Figure 3

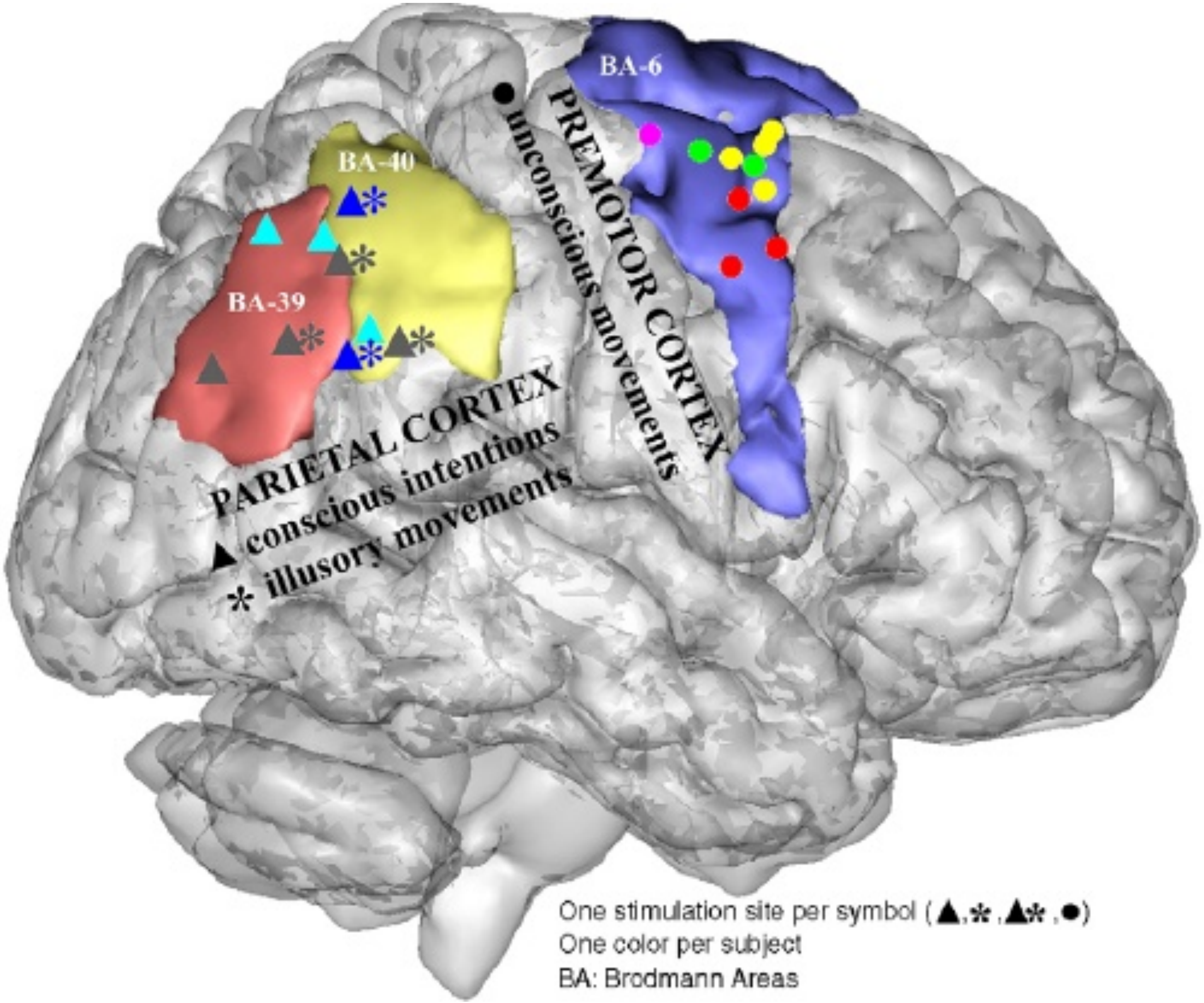
Diagram of sequence of events, cerebral and subjective, that precede a fully self-initiated voluntary act. Relative to 0 time, detected in the electromyogram (EMG) of the suddenly activated muscle, the readiness potential (RP)(an indicator of related cerebral neuronal activities) begins first, at about –1050 ms. when some pre-planning is reported (RP I) or about –550 ms. with spontaneous acts lacking immediate pre planning (RP II). Subjective awareness of the wish to move (W) appears at about –200 ms., some 350 ms. after onset even of RP II; however, W does appear well before the act (EMG). Subjective timings reported for awareness of the randomly delivered S (skin) stimulus average about –50 ms. relative to actual delivery time. (From Libet, 1989.)

Movement Intention After Parietal Cortex Stimulation in Humans
Michel Desmurget, *et al.*
Science **324**, 811 (2009);
DOI: 10.1126/science.1169896

Michel Desmurget,[1,2] Karen T. Reilly,[1,2] Nathalie Richard,[1,2] Alexandru Szathmari,[3] Carmine Mottolese,[3] Angela Sirigu[1,2]*

Parietal and premotor cortex regions are serious contenders for bringing motor intentions and motor responses into awareness. We used electrical stimulation in seven patients undergoing awake brain surgery. Stimulating the right inferior parietal regions triggered a strong intention and desire to move the contralateral hand, arm, or foot, whereas stimulating the left inferior parietal region provoked the intention to move the lips and to talk. When stimulation intensity was increased in parietal areas, participants believed they had really performed these movements, although no electromyographic activity was detected. Stimulation of the premotor region triggered overt mouth and contralateral limb movements. Yet, patients firmly denied that they had moved. Conscious intention and motor awareness thus arise from increased parietal activity before movement execution.


Bipolar Electrode
Cortex
Stimulation site


BA-6
BA-40
BA-39
PREMOTOR CORTEX
● unconscious movements
PARIETAL CORTEX
▲ conscious intentions
* illusory movements
One stimulation site per symbol (▲, *, ▲*, ●)
One color per subject
BA: Brodmann Areas

Nos décisions dites conscientes peuvent être influencées par des stimuli non perçus consciemment

On Making the Right Choice: The Deliberation-Without-Attention Effect

Ap Dijksterhuis,* Maarten W. Bos, Loran F. Nordgren, Rick B. van Baaren

Contrary to conventional wisdom, it is not always advantageous to engage in thorough conscious deliberation before choosing. On the basis of recent insights into the characteristics of conscious and unconscious thought, we tested the hypothesis that simple choices (such as between different towels or different sets of oven mitts) indeed produce better results after conscious thought, but that choices in complex matters (such as between different houses or different cars) should be left to unconscious thought. Named the "deliberation-without-attention" hypothesis, it was confirmed in four studies on consumer choice, both in the laboratory as well as among actual shoppers, that purchases of complex products were viewed more favorably when decisions had been made in the absence of attentive deliberation.

hardly developed beyond the status of "folk wisdom." It has been postulated or investigated by scientists infrequently [but see (*10–13*)]. The question addressed here is whether this view is justified. We hypothesize that it is not.

First, conscious thought does not always lead to sound choices. For example, participants who chose their favorite poster among a set of five after thorough contemplation showed less postchoice satisfaction than participants who only looked at them briefly (*14*, *15*). Furthermore, conscious deliberation can make multiple evaluations of the same object less consistent over time (*16*). Two reasons why conscious deliberation sometimes leads to poor judgments have been identified. First, consciousness has a low capacity (*17*, *18*), causing choosers to take

SCIENCE VOL 311 17 FEBRUARY 2006

All participants read information about four hypothetical cars. Depending on the condition, each car was characterized by 4 attributes (simple) or by 12 attributes (complex). The attributes were either positive or negative. **One car was characterized by 75% positive attributes, two by 50% positive attributes, and one by 25% positive attributes.**

After reading the information about the four cars, participants were assigned either to a conscious thought condition or to an unconscious thought condition. In the conscious thought condition, participants were asked to think about the cars for 4 min before they chose their favorite car. **In the unconscious thought condition, participants were distracted for 4 min (they solved anagrams)** and were told that after the period of distraction they would be asked to choose the best car.

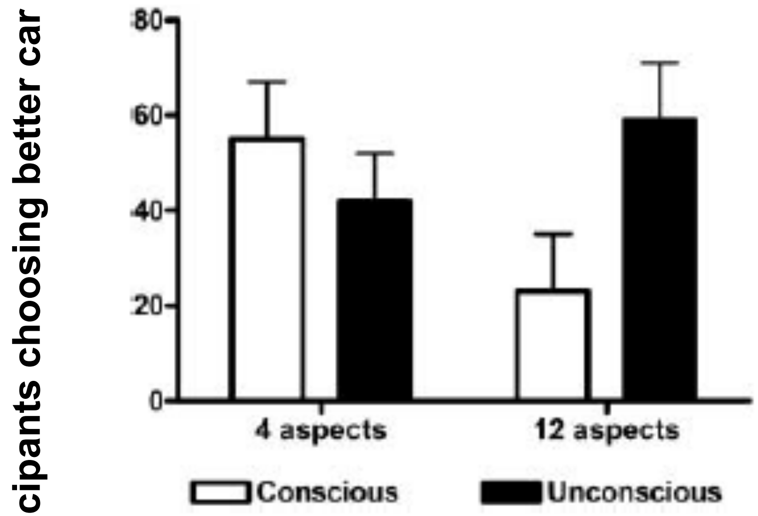
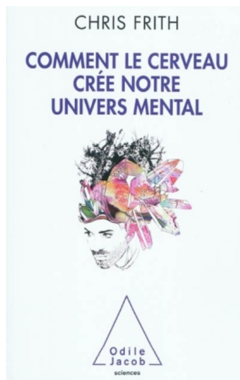


Fig. 1. Percentage of participants who chose the most desirable car as a function of complexity of decision and of mode of thought (n = 18 to 22 in each condition). Error bars represent the standard error.

- La conscience nous permet probablement, avant tout, d'expliquer et de justifier nos décisions (a posteriori)
  - *the ability to justify our actions seems to be more important than the actions themselves (Chris Frith)*
  - *The function of consciousness is to enable us to discuss our decision making with other people . Discussions about decision-making affect people's behaviour (Chris Frith)*
  - *In the long term, sharing our introspections about decision making leads to cultural rules for making decisions at the individual level as well as the group level (Chris Frith)*



The Journal of Neuroscience, January 1, 1998, 18(1):411–418

Masked Presentations of Emotional Facial Expressions Modulate Amygdala Activity without Explicit Knowledge

Paul J. Whalen, Scott L. Rauch, Nancy L. Etcoff, Sean C. McInerney, Michael B. Lee, and Michael A. Jenike

Psychiatric Neuroimaging Research Group and Nuclear Magnetic Resonance Center, Massachusetts General Hospital and Harvard Medical School, Boston, MA 02115

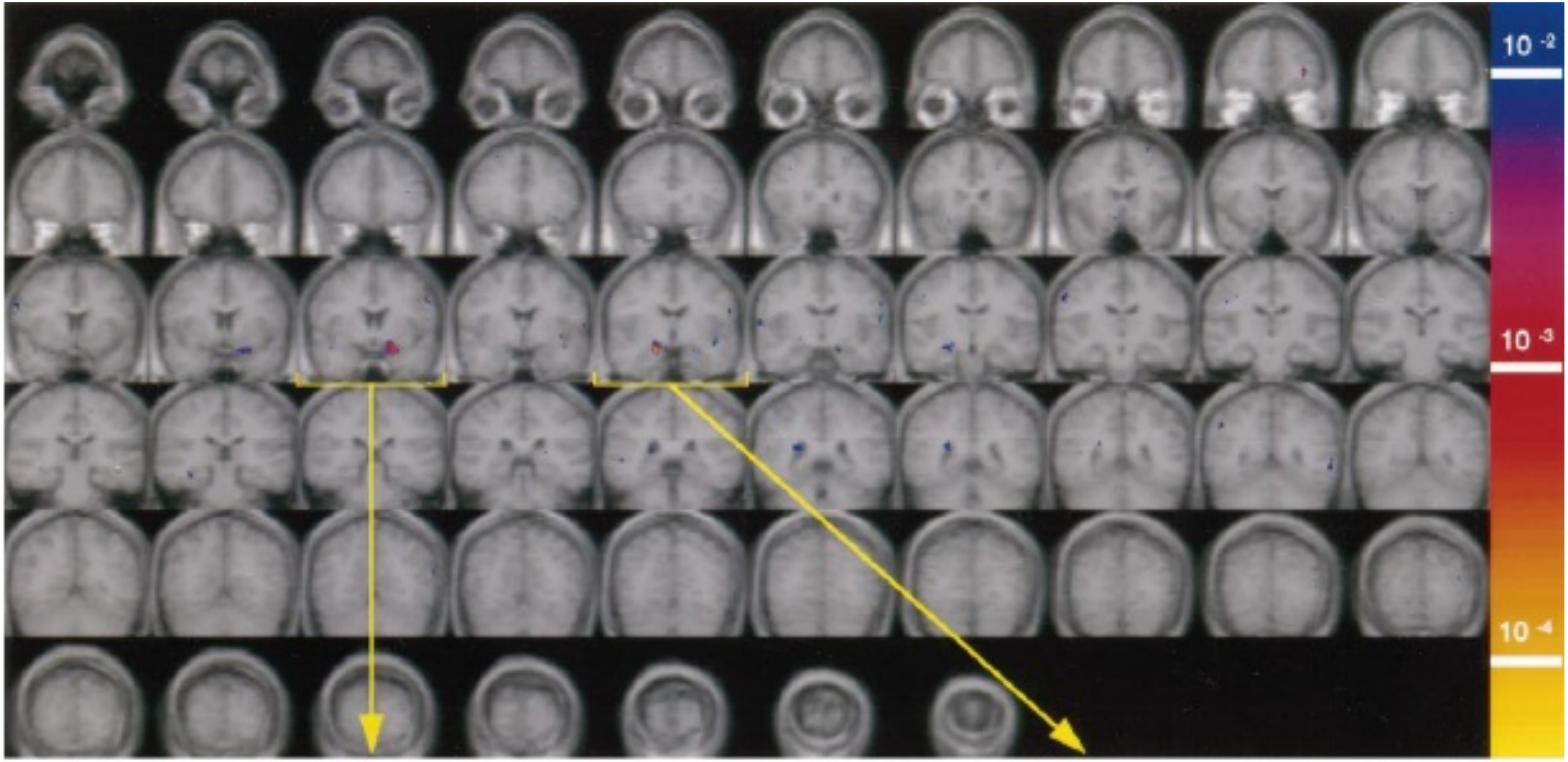
Functional magnetic resonance imaging (fMRI) of the human brain was used to study whether the amygdala is activated in response to emotional stimuli, even in the absence of explicit knowledge that such stimuli were presented. Pictures of human faces bearing fearful or happy expressions were presented to 10 normal, healthy subjects by using a backward masking procedure that resulted in 8 of 10 subjects reporting that they had not seen these facial expressions. The backward masking procedure consisted of 33 msec presentations of fearful or happy facial expressions, their offset coincident with the onset of 167 msec presentations of neutral facial expressions. Although subjects reported seeing only neutral faces, blood oxygen level-dependent (BOLD) fMRI signal in the amygdala was significantly higher during viewing of masked fearful faces than during the viewing of masked happy faces. This difference was composed of significant signal increases in the amygdala to masked fearful faces as well as significant signal decreases to masked happy faces, consistent with the notion that the level of amygdala activation is affected differentially by the emotional valence of external stimuli. In addition, these facial expressions activated the sublenticular substantia innominata (SI), where signal increases were observed to both fearful and happy faces—suggesting a spatial dissociation of territories that respond to emotional valence versus salience or arousal value. This study, using fMRI in conjunction with masked stimulus presentations, represents an initial step toward determining the role of the amygdala in nonconscious processing.

Key words: amygdala; extended amygdala; substantia innominata; nucleus basalis of Meynert; bed nucleus of the stria terminalis; emotion; facial expression; backward masking; awareness; fMRI; neuroimaging

3. Nos décisions dites conscientes peuvent être influencées par des stimuli non perçus consciemment

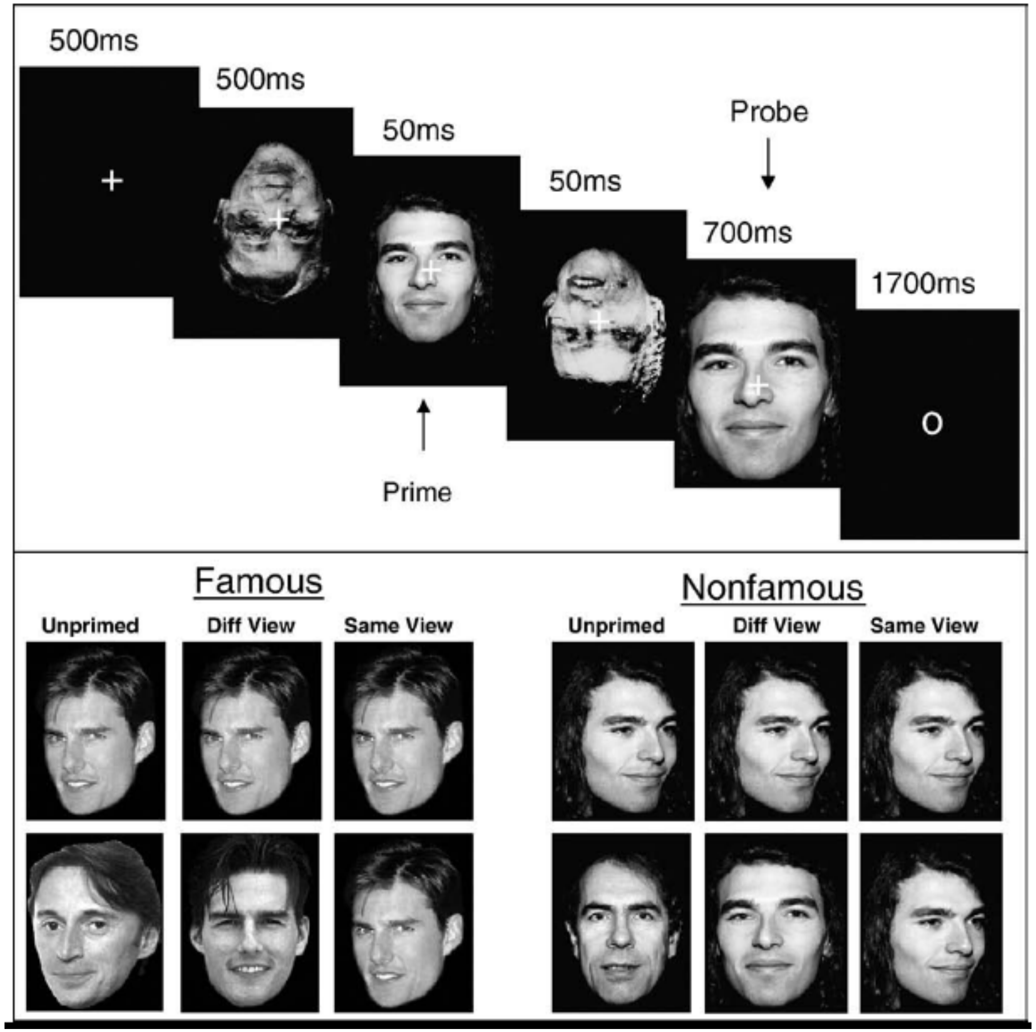
33 ms

- **Les participants disent avoir perçu uniquement des visages neutres..**
- **De tels stimuli, non perçus consciemment, peuvent-ils déclencher des activités neurales liées à leur contenu émotionnel ?**



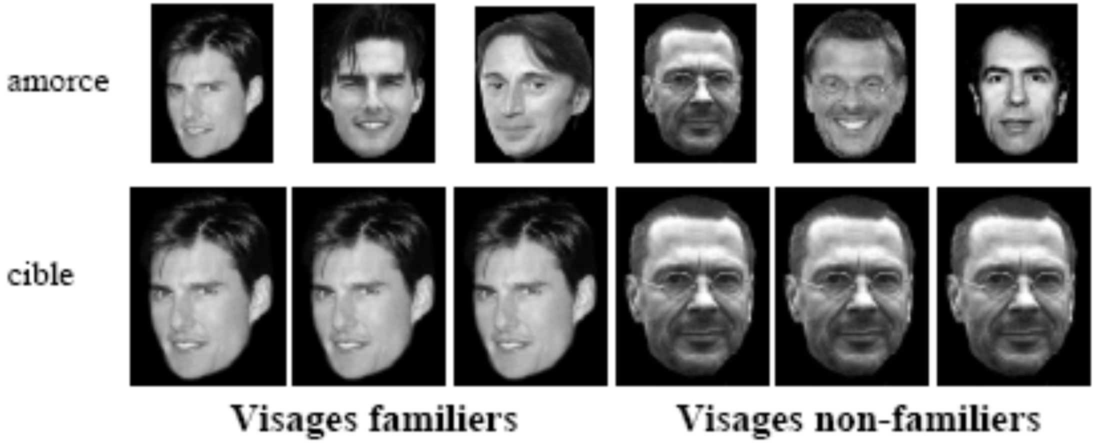
Left Amygdala/SI (y = 0; see Figure 3) Right Amygdala (y = -6; see Figure 2)

Un stimulus non-conscient peut-il influencer une réponse comportementale consciente ?

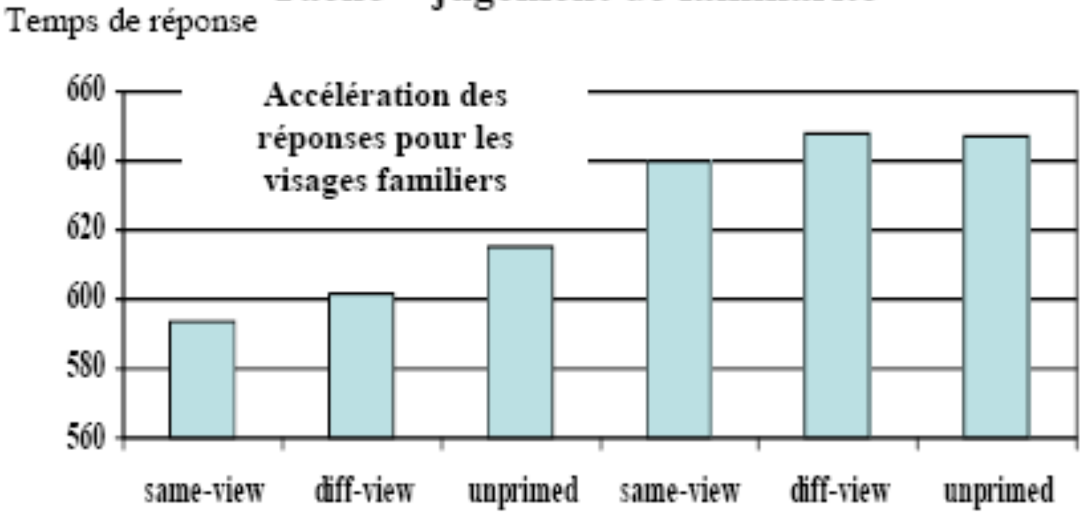


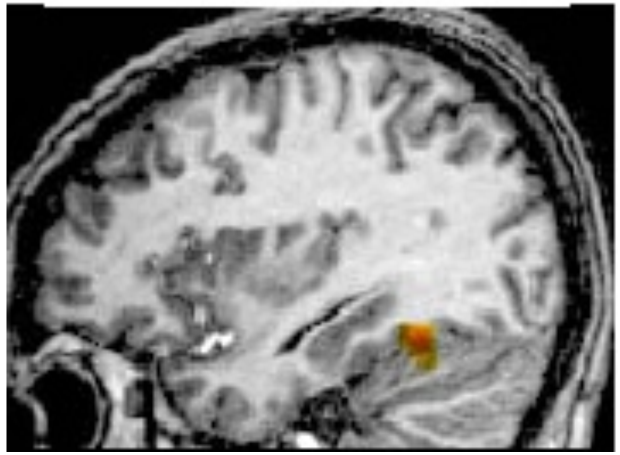
Henson, R. N., Mouchlianitis, E., Matthews, W. J., & Kouider, S. (2008). Electrophysiological correlates of masked face priming. *NeuroImage, 40*(2), 884-895.

Kouider, S., Eger, E., Dolan, R., & Henson, R. N. (2008). Activity in Face-Responsive Brain Regions is Modulated by Invisible, Attended Faces: Evidence from Masked Priming. *Cereb Cortex*.

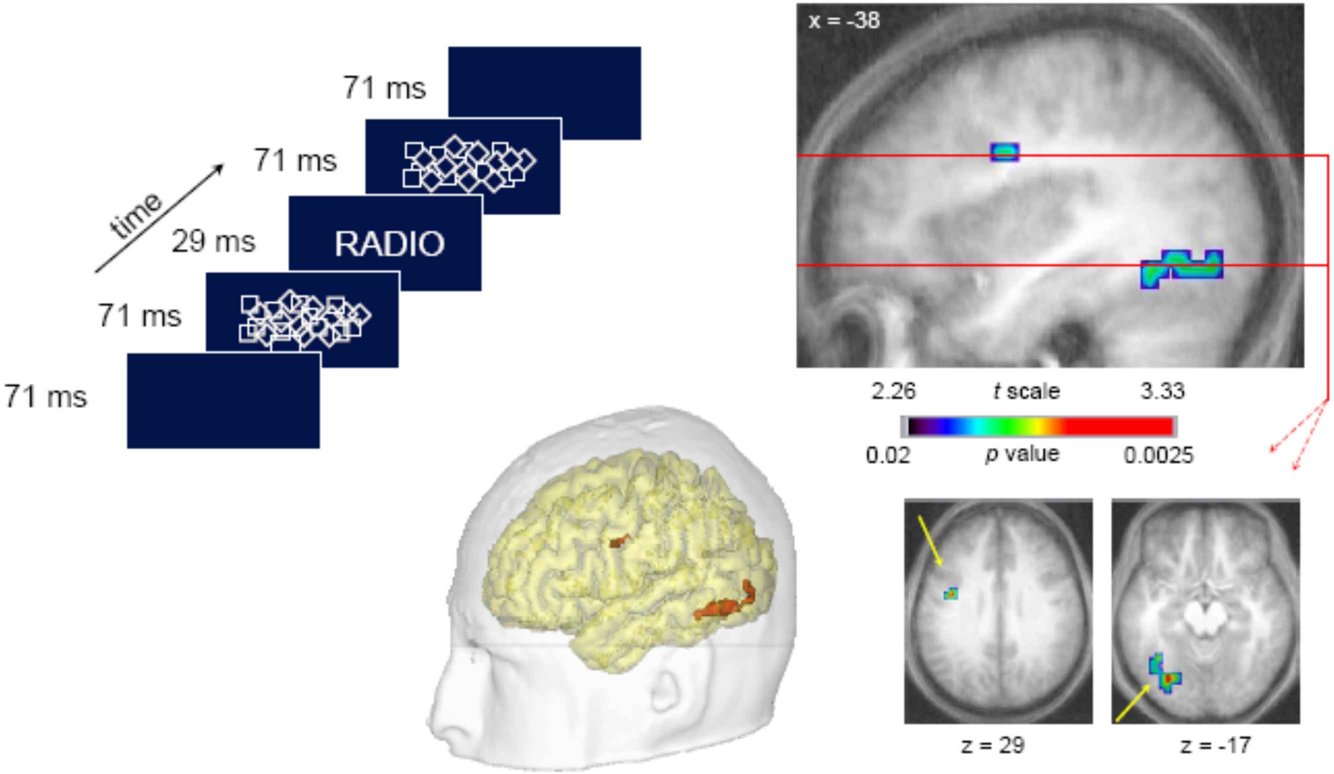


Tâche = jugement de familiarité





L'activation évoquée par des mots invisibles s'étend à une région fusiforme, l'aire de la **forme visuelle des mots.**



Dehaene et al., *Nature Neuroscience*, 2001

A direct intracranial record of emotions evoked by subliminal words

Lionel Naccache[*,†,‡,§], Raphaël Gaillard[*,†], Claude Adam[‡], Dominique Hasboun[‡], Stéphane Clémenceau[¶], Michel Baulac[‡], Stanislas Dehaene[*], and Laurent Cohen[*,‡]

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Edited by Edward E. Smith, Columbia University, New York, NY, and approved April 5, 2005 (received for review January 21, 2005)

A classical but still open issue in cognitive psychology concerns the depth of subliminal processing. Can the meaning of undetected words be accessed in the absence of consciousness? Subliminal priming experiments in normal subjects have revealed only small effects whose interpretation remains controversial. Here, we provide a direct demonstration of semantic access for unseen masked words. In three epileptic patients with intracranial electrodes, we recorded brain potentials from the amygdala, a neural structure that responds to fearful or threatening stimuli presented in various modalities, including written words. We show that the subliminal presentation of emotional words modulates the activity of the amygdala at a long latency (>800 ms). Our result indicates that subliminal words can trigger long-lasting cerebral processes, including semantic access to emotional valence.

amygdala | semantic | visual masking

words "smut" and "bile" as negative, the subliminal prime "smile" primed the negative response, not the positive one. This result suggests that the priming effect, in this particular situation, was not due to a subliminal access to semantics. Rather, subjects had learned to respond rapidly to fragments of the target strings with specific left or right key presses, and this sensorimotor learning generalized to other primes made of the same fragments (7).

Currently, the single category of words for which a convincing set of reports demonstrated nonconscious semantic processing, including generalization to novel primes, are number words (8–11). For nonnumerical words, although many important studies have suggested subliminal access to semantics (1, 12, 13), there is yet no uncontroversial evidence that fulfills the two criteria outlined above, namely convincing proof of lack of conscious perception and rejection of the direct sensorimotor specification hypothesis. The interpretation of this absence of

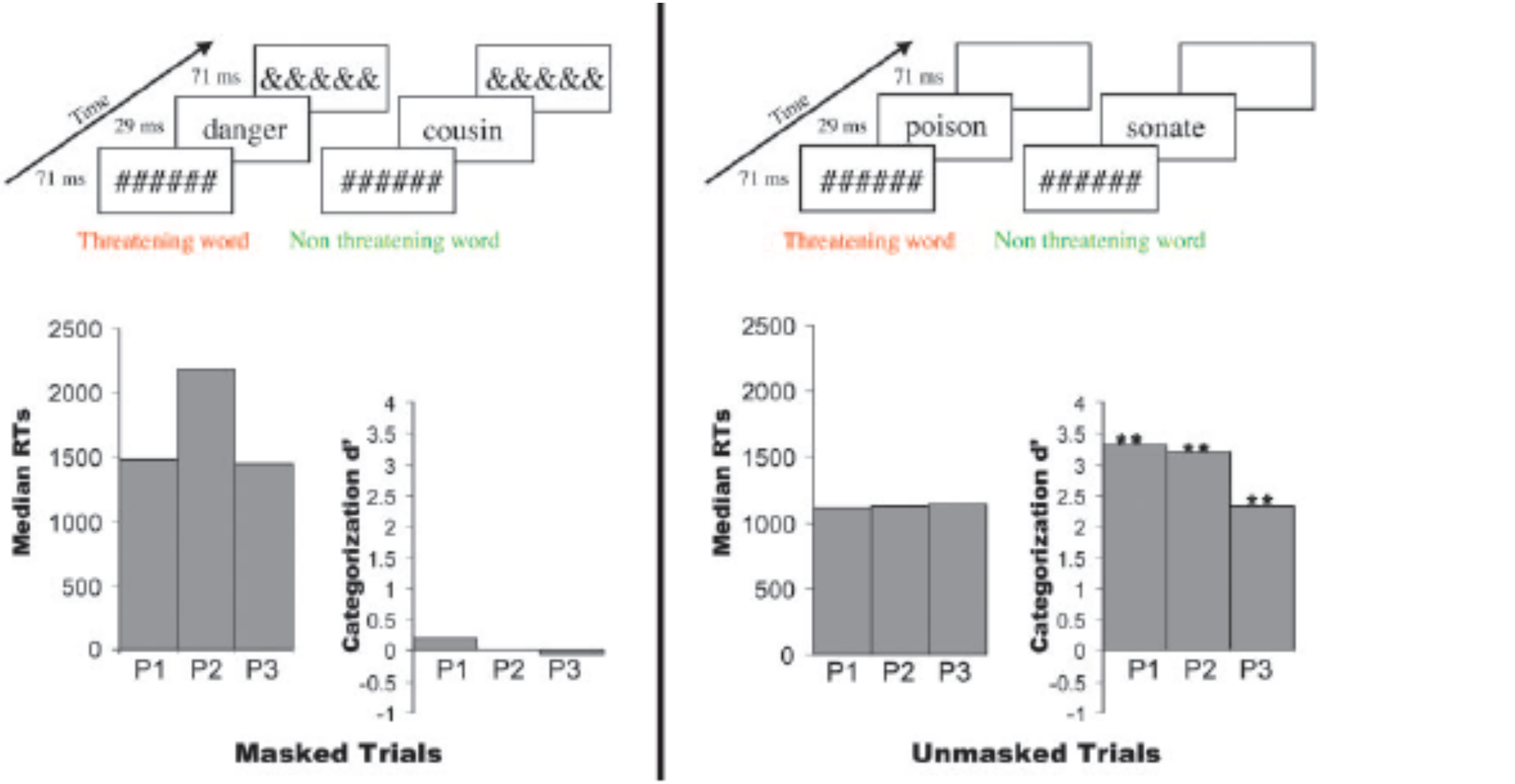


Fig. 1. Experimental paradigm and behavior. Subjects categorized a 29-ms flashed word as either threatening or neutral. Each word was preceded by a 71-ms mask made of six hash-mark symbols. Masked words were followed by 71-ms ampersands postmask, whereas, on visible trials, no postmask was presented. Reaction times (RTs, in ms) were longer for masked than for unmasked words in the three patients. Although objective word emotional valence categorization assessed by signal detection theory *d'* was excellent for unmasked words (**, $P < 0.01$ in χ^2 tests), it dropped to chance level for masked words in each of the three patients.

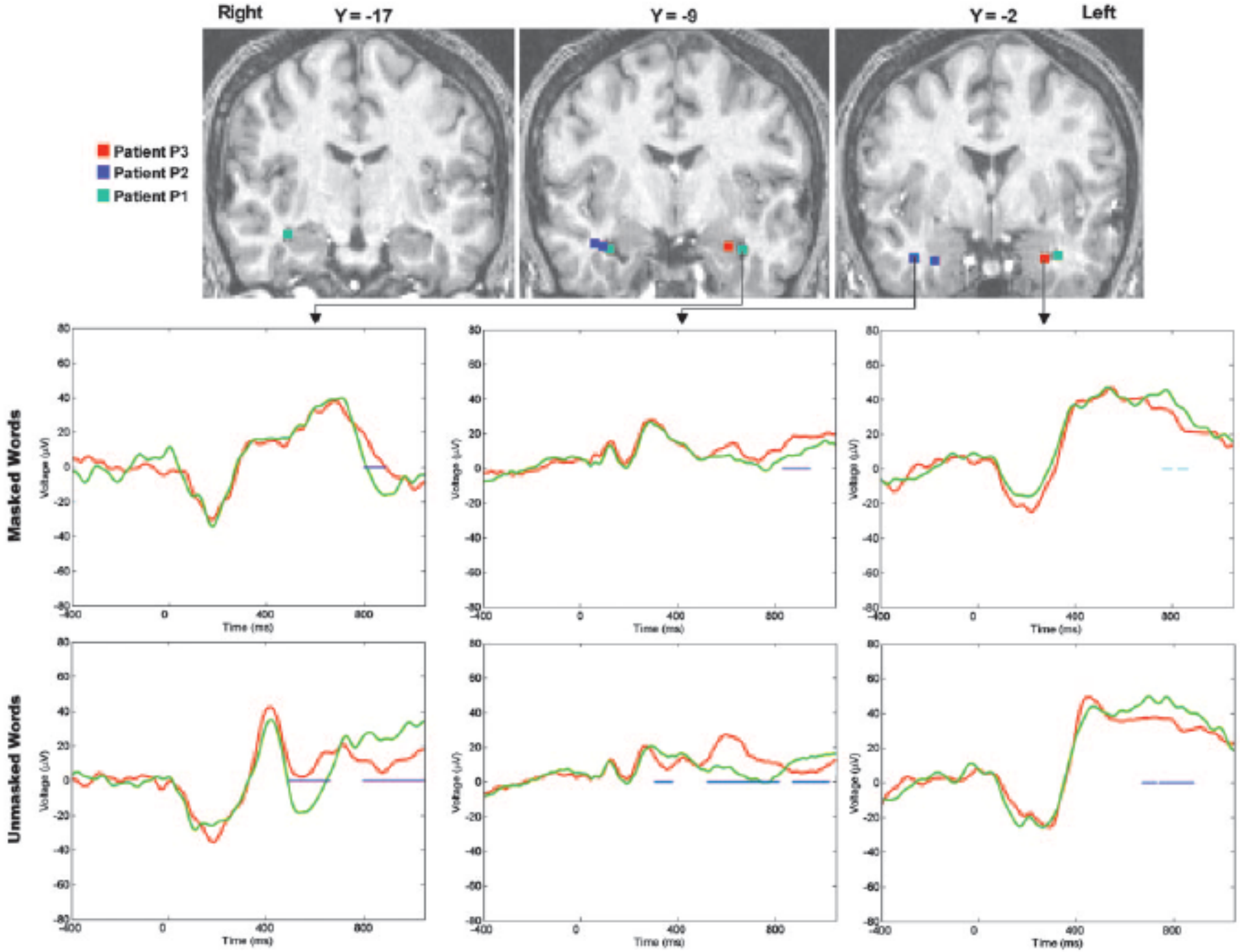


Fig. 2. Effects of threat recorded in the amygdala for nonconscious and conscious words. (*Top*) Three coronal slices of P1 normalized brain with the locations of the 10 electrodes used to record intracranial local field potential. (*Middle* and *Bottom*) For each patient, one electrode is selected (arrows), and the corresponding ERPs are shown for threatening (red) and nonthreatening (green) words in the masked (*Middle*) and unmasked (*Bottom*) conditions. Significant differences are indicated by blue (30 successive samples with $P < 0.05$ in a bilateral t test) or cyan (15 successive samples with $P < 0.05$ in a bilateral t test) horizontal bars. In the three patients, a significant difference between threatening and nonthreatening masked words was observed ≈870 ms after word presentation. A polarity inversion for the most internal and anterior electrode (rightmost panels) tentatively suggests a generator located within the lateral amygdalar nucleus. In the three patients, unmasked words elicited earlier, more ample, and sustained responses within the same electrodes.

How the Brain Translates Money into Force: A Neuroimaging Study of Subliminal Motivation
Mathias Pessiglione, *et al.*
Science **316**, 904 (2007);
DOI: 10.1126/science.1140459

How the Brain Translates Money into Force: A Neuroimaging Study of Subliminal Motivation

Mathias Pessiglione,[1,2]* Liane Schmidt,[2] Bogdan Draganski,[1] Raffael Kalisch,[1] Hakwan Lau,[1] Ray J. Dolan,[1] Chris D. Frith[1]

Unconscious motivation in humans is often inferred but rarely demonstrated empirically. We imaged motivational processes, implemented in a paradigm that varied the amount and reportability of monetary rewards for which subjects exerted physical effort. We show that, even when subjects cannot report how much money is at stake, they nevertheless deploy more force for higher amounts. Such a motivational effect is underpinned by engagement of a specific basal forebrain region. Our findings thus reveal this region as a key node in brain circuitry that enables expected rewards to energize behavior, without the need for the subjects' awareness.

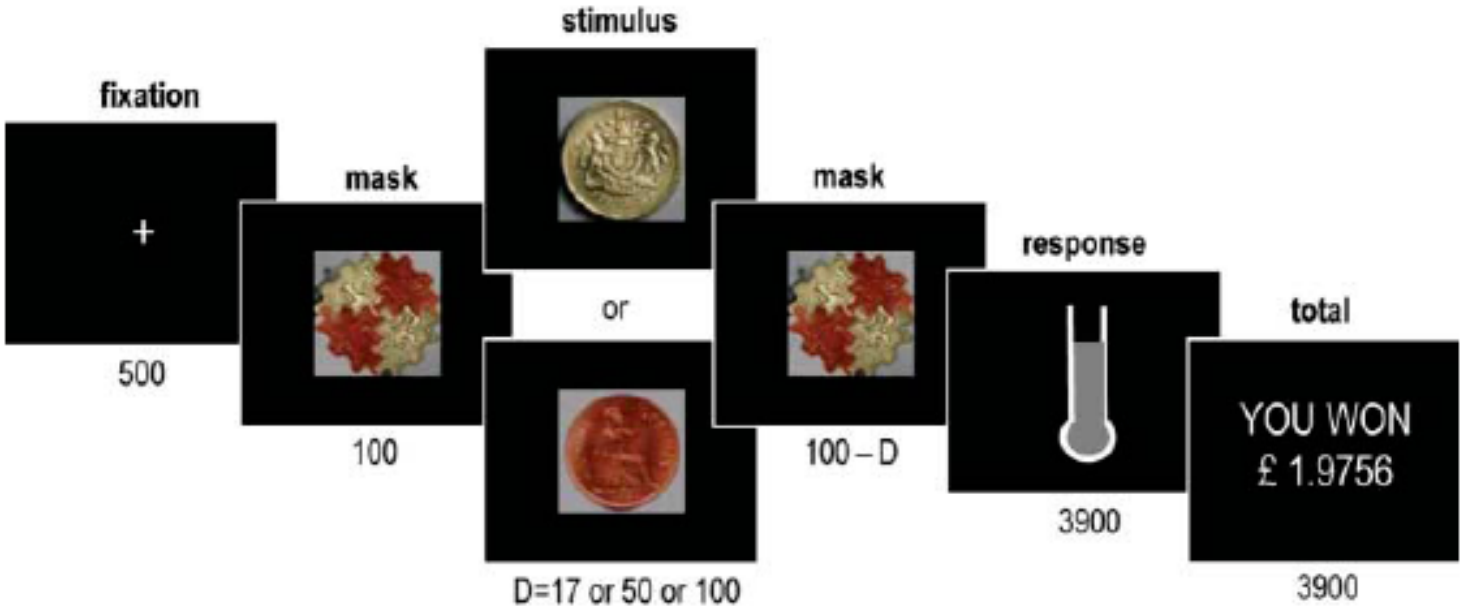


Fig. 1. The incentive force task. Successive screens displayed in one trial are shown from left to right, with durations in ms. Coin images, either one pound (£1) or one penny (1p), indicate the monetary value attributed to the top of the thermometer image. The fluid level in the thermometer represents the online force exerted on the hand grip. The last screen indicates cumulative total of the money won so far.

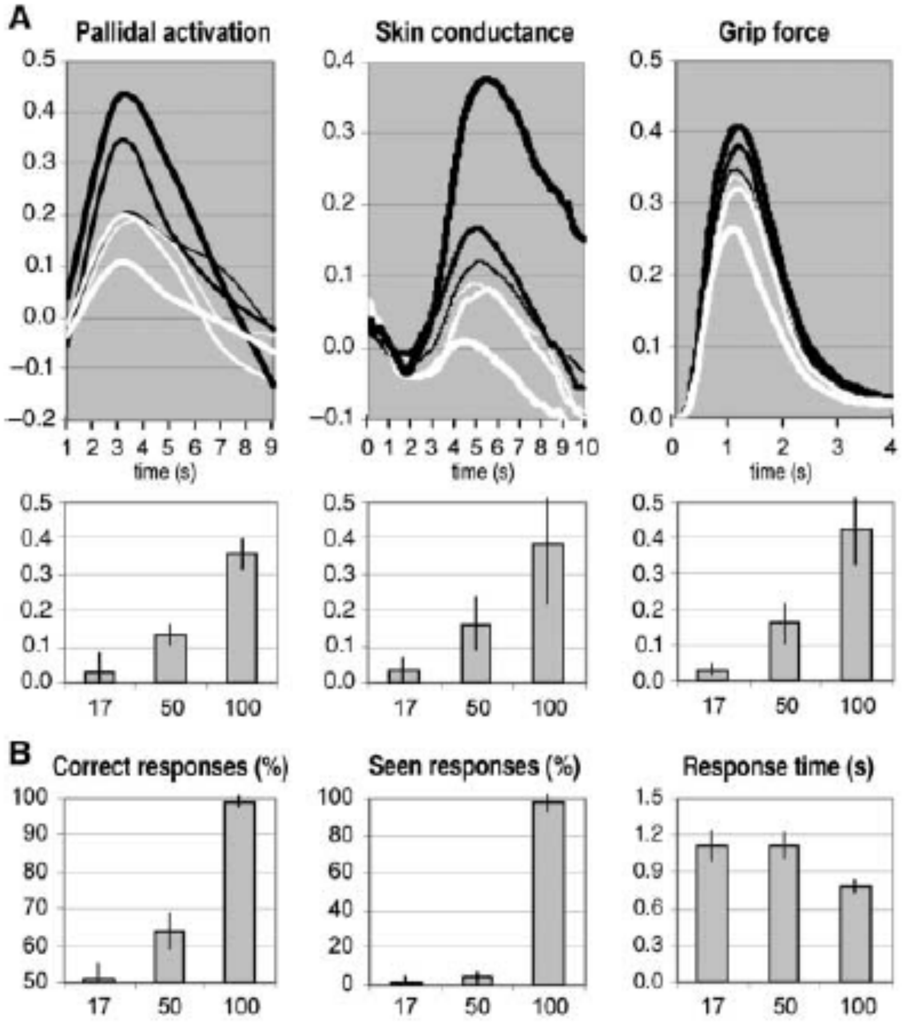
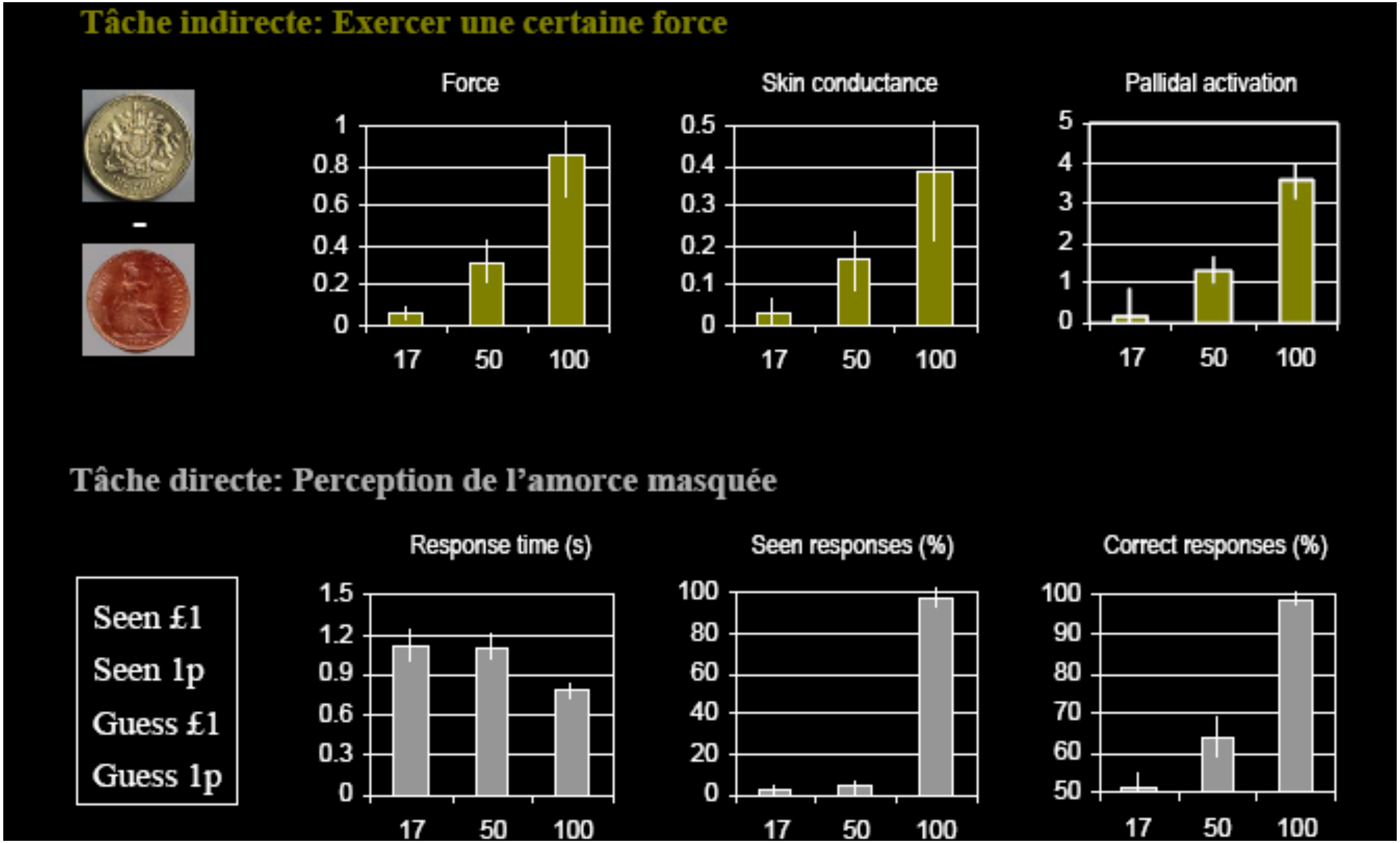


Fig. 3. Main effects of stimulus duration. (**A**) Incentive force task. Time courses were averaged across trials for the different stimuli (black lines indicate £1 and white lines indicate 1p) and durations (thin, intermediate, and thick lines indicate 17, 50, and 100 ms, respectively). Time 0 corresponds to the moment of stimulus display. The histograms indicate the effect of motivation (£1 to 1p), and the error bars indicate SEM. Pallidal activation is expressed as percentage of blood oxygen level–dependent signal change. Force and skin conductance are expressed in proportion of the highest measure. (**B**) Perception task. Stimuli were the same as in (A). Possible responses were "seen £1," "seen 1p," "guess £1," and "guess 1p." A "correct" response means that the subject chose the stimulus that had been displayed. A "seen" response means that the subject perceived all or part of the stimulus. Error bars indicate SEM.



Tâche indirecte: Exercer une certaine force
Force
1
0.8
0.6
0.4
0.2
0
17
50
100
Skin conductance
0.5
0.4
0.3
0.2
0.1
0
17
50
100
Pallidal activation
5
4
3
2
1
0
17
50
100
Tâche directe: Perception de l'amorce masquée
Seen £1
Seen 1p
Guess £1
Guess 1p
Response time (s)
1.5
1.2
0.9
0.6
0.3
0
17
50
100
Seen responses (%)
100
80
60
40
20
0
17
50
100
Correct responses (%)
100
90
80
70
60
50
17
50
100

Research Article

Psychological Science
XX(X) 1–7

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Splitting Motivation: Unilateral Effects of Subliminal Incentives

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[1]Institut du Cerveau et de la Moelle epinière, Paris, France; [2]Institut National de la Santé et de la Recherche Médicale, Paris, France; [3]Université Pierre et Marie Curie; [4]Centre National de la Recherche Scientifique, Paris, France; and [5]Université Lille Nord-de-France

Abstract

Motivation is generally understood to denote the strength of a person's desire to attain a goal. Here we challenge this view of motivation as a person-level concept, in a study that targeted subliminal incentives to only one half of the human brain. Participants in the study squeezed a handgrip to win the greatest fraction possible of each subliminal incentive, which materialized as a coin image flashed in one visual hemifield. Motivation effects (i.e., more force exerted when the incentive was higher) were observed only for the hand controlled by the stimulated brain hemisphere. These results show that in the absence of conscious control, one brain hemisphere, and hence one side of the body, can be motivated independently of the other.

Keywords

effort, motivation, perception, reward, split-brain

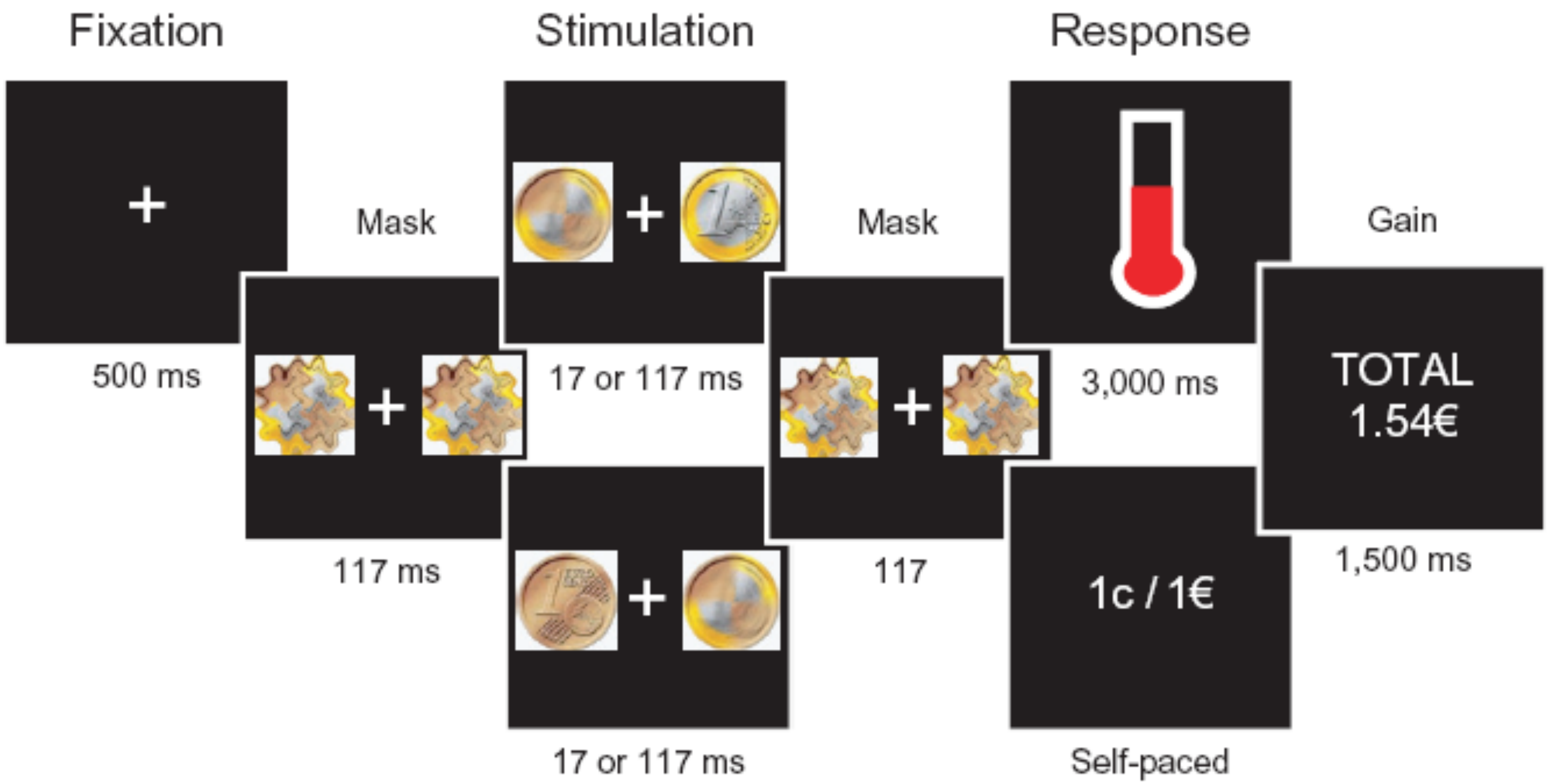


Fig. 1. Experimental procedure. Possible successive screenshots over the course of a trial are shown from left to right, along with their durations. Each trial included the following sequence: a fixation cross (500 ms), a mask (117 ms), one of two coin images presented to one visual hemifield and a scrambled image presented to the other (17 or 117 ms), another mask (117 ms), and finally a response request. On force test trials, the subjects' task was to squeeze a handgrip to raise the fluid level in the illustration of a thermometer; on perception control trials, the task was to report the value of the coin that had been shown. At trial completion, the total amount earned was displayed.

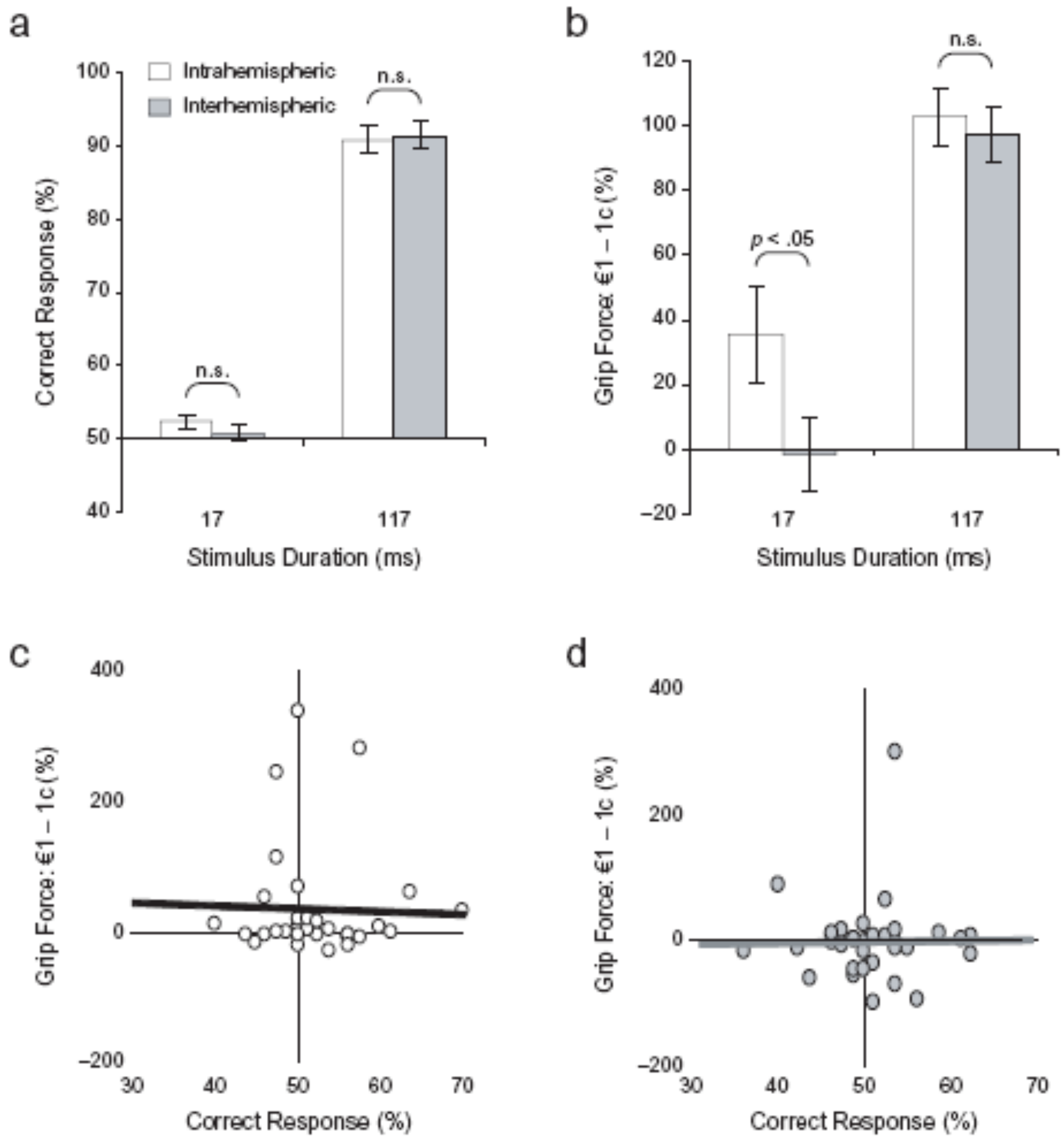


Fig. 2. Evidence for intrahemispheric subliminal motivation. The graphs in the top row show (a) the percentage of correct responses and (b) the difference in grip force between incentive conditions as a function of the stimulus duration, separately for intrahemispheric and interhemispheric trials. The graphs in the bottom row show the difference in grip force between incentive conditions as a function of the percentage of correct perceptual decision responses in (c) intrahemispheric and (d) interhemispheric trials. Dots represent data from individual subjects, and lines show the linear regression fit. Error bars represent intersubject standard errors of the mean.

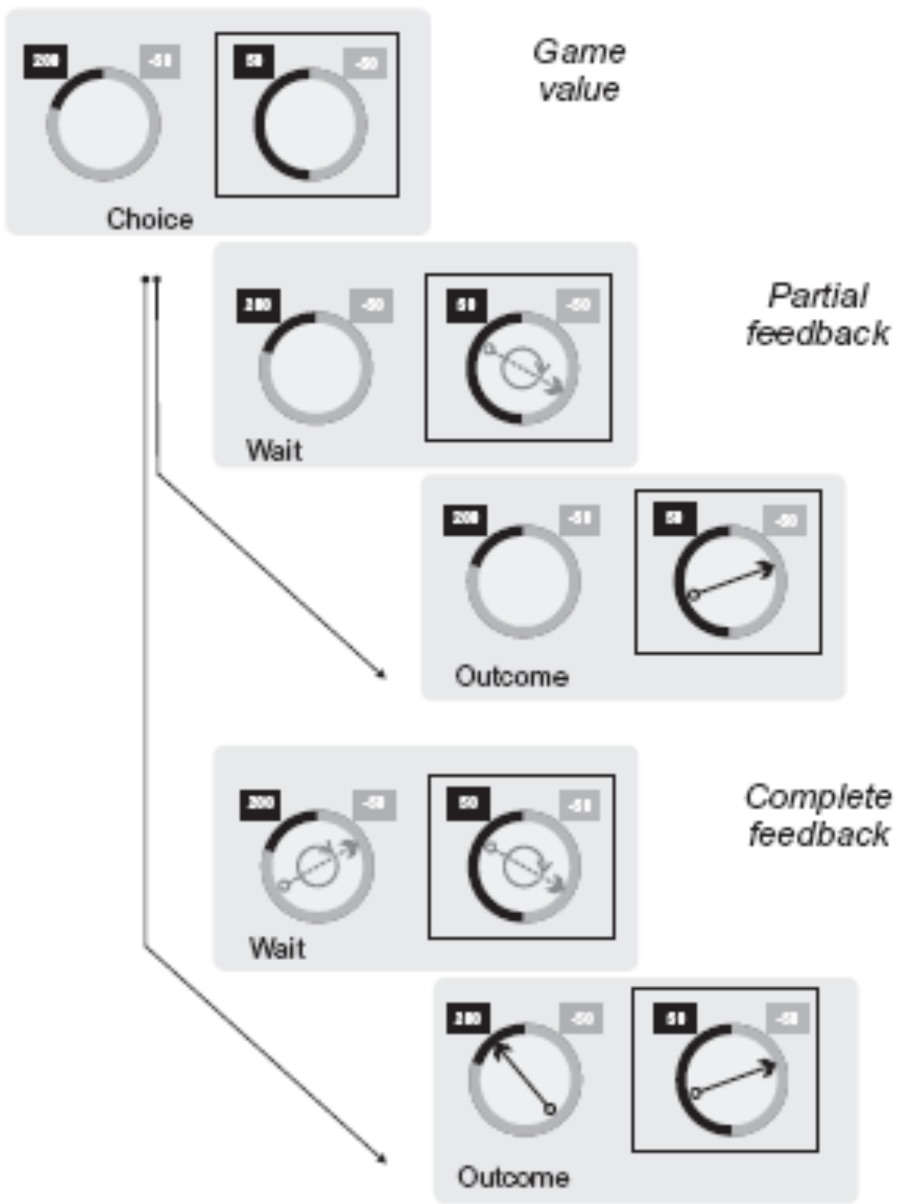
3. Le cerveau anticipe les conséquences de l’action et leurs assignent des valeurs

The Involvement of the Orbitofrontal Cortex in the Experience of Regret
Nathalie Camille, *et al.*
Science **304**, 1167 (2004);
DOI: 10.1126/science.1094550

The Involvement of the Orbitofrontal Cortex in the Experience of Regret

Nathalie Camille,[1*] Giorgio Coricelli,[1,2*] Jerome Sallet,[1]
Pascale Pradat-Diehl,[3] Jean-René Duhamel,[1] Angela Sirigu[1†]

Facing the consequence of a decision we made can trigger emotions like satisfaction, relief, or regret, which reflect our assessment of what was gained as compared to what would have been gained by making a different decision. These emotions are mediated by a cognitive process known as counterfactual thinking. By manipulating a simple gambling task, we characterized a subject's choices in terms of their anticipated and actual emotional impact. Normal subjects reported emotional responses consistent with counterfactual thinking; they chose to minimize future regret and learned from their emotional experience. Patients with orbitofrontal cortical lesions, however, did not report regret or anticipate negative consequences of their choices. The orbitofrontal cortex has a fundamental role in mediating the experience of regret.



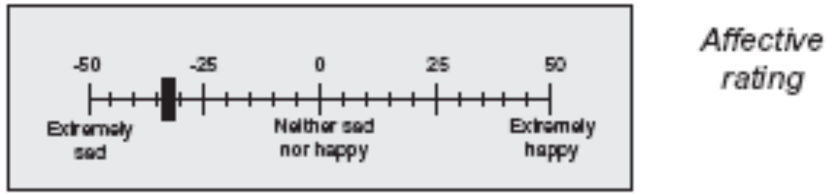


Fig. 1. Time course of a gambling trial. Two wheels appeared on a computer screen (gamble 1 and gamble 2). Each wheel had two sectors (black and light gray) associated with different value pairs. The size of each sector indicated the outcome probability. The two possible outcomes are formed by any pair of the following values: +50, –50, +200, –200 (units correspond to former French francs), associated with different outcome probabilities (0.8, 0.2, 0.5). The subject selected one of the two wheels by clicking a mouse. A rectangular box appeared around the selected wheel. In partial feedback blocks, a spinning arrow appeared only in the selected wheel, rotated for a variable duration, and stopped in one of the two sectors. Only the outcome of the selected wheel could be seen. In complete feedback blocks, a spinning arrow appeared in both the selected and the nonselected wheels. The arrows rotated and stopped, allowing the subject to view both outcomes. At the end of each trial, subjects rated their affective state using a rating scale from –50 (extremely sad) to +50 (extremely happy). SCR was also recorded.

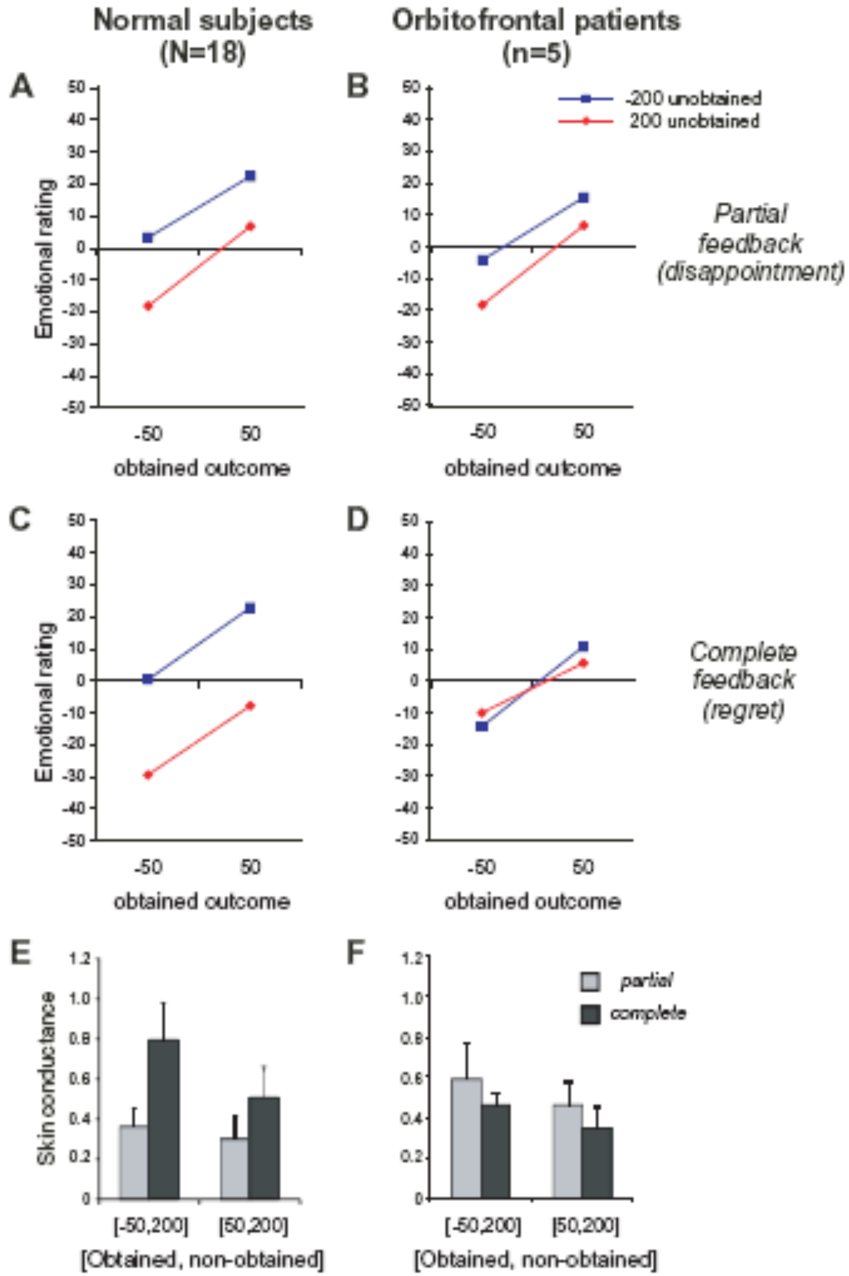


Fig. 2. Effect of the unobtained outcome of the gamble in partial and complete feedback. (**A** and **C**) Mean emotional ratings made by 18 normal control subjects for two obtained outcomes (–50 or 50) as a function of the unobtained outcome (blue line and symbols, –200; red line and symbols, 200) in the partial and complete feedback conditions, respectively. In the partial condition, the unobtained outcome corresponds to the unobtained value of the chosen gamble. In the complete condition, it corresponds to the obtained value of the nonchosen gamble. (**B** and **D**) Mean emotional ratings made by five orbitofrontal patients in the partial and complete feedback conditions, respectively. Conventions as in (A) and (C). (**E**) Mean skin conductance response (+ standard error) of normal subjects, measured at the end of arrow rotation, for the conditions in which the unobtained outcome is more advantageous than the obtained outcome (corresponding to the red curves in the graphs above). Gray bars (partial feedback) and black bars (complete feedback) are physiological markers of disappointment and regret, respectively. Regret is correlated with stronger emotional arousal. (**F**) Same data for orbitofrontal patients, showing no regret effect.

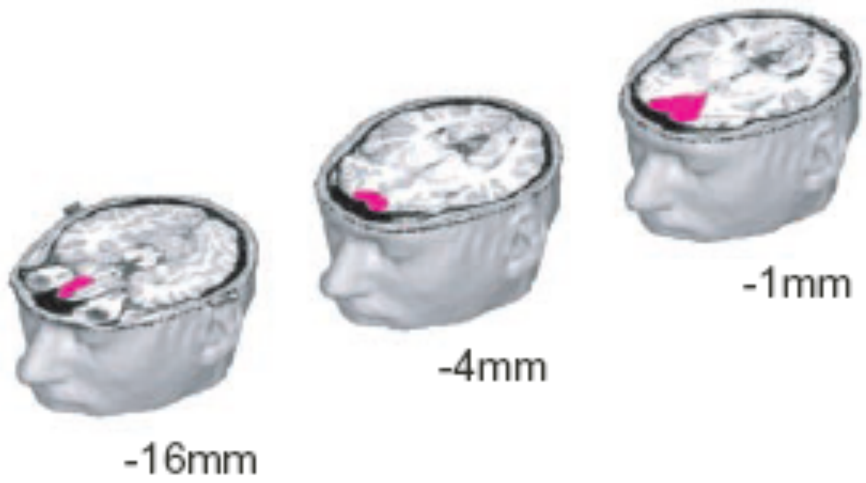


Fig. 3. Lesion overlap in the orbitofrontal cortex for the five patients. Lesion locations were reconstructed from individual magnetic resonance imaging scans. The three slice levels (in Talairach coordinates) show the region of common cortical damage, which is located in the basal and ventromedial sector of the prefrontal cortex and which includes Brodmann's areas 10, 11, 32, 24, and 47.

The Neural Basis of Economic Decision-Making in the Ultimatum Game

Alan G. Sanfey,[1,3*] James K. Rilling,[1*] Jessica A. Aronson,[2]
Leigh E. Nystrom,[1,2] Jonathan D. Cohen[1,2,4]

The nascent field of neuroeconomics seeks to ground economic decision-making in the biological substrate of the brain. We used functional magnetic resonance imaging of Ultimatum Game players to investigate neural substrates of cognitive and emotional processes involved in economic decision-making. In this game, two players split a sum of money; one player proposes a division and the other can accept or reject this. We scanned players as they responded to fair and unfair proposals. Unfair offers elicited activity in brain areas related to both emotion (anterior insula) and cognition (dorsolateral prefrontal cortex). Further, significantly heightened activity in anterior insula for rejected unfair offers suggests an important role for emotions in decision-making.

Sens de la justice et sensation de dégoût

- **Le jeu de l'ultimatum**
  - Vous venez de recevoir 10 euros
    - Pour les garder, il faut partager (9/1 ; 8/2…, 5/5) avec un autre joueur, **qui doit accepter votre proposition**… Si l'autre joueur refuse la proposition la somme est perdue pour les 2 .
    - Décision rationnelle 9/1

Sanfey, A et al. ***Science****, 2003*

Sens de la justice et sensation de dégoût

- L'insula s'active d'autant plus que les offres proposées sont perçues comme plus injustes (sensible au degré d'injustice), par exemple 9/1 > 7/3
  - Or l'insula est connue pour son rôle dans les états émotionnels négatifs, notamment **le dégoût**

Sanfey, A et al. Science, 2003

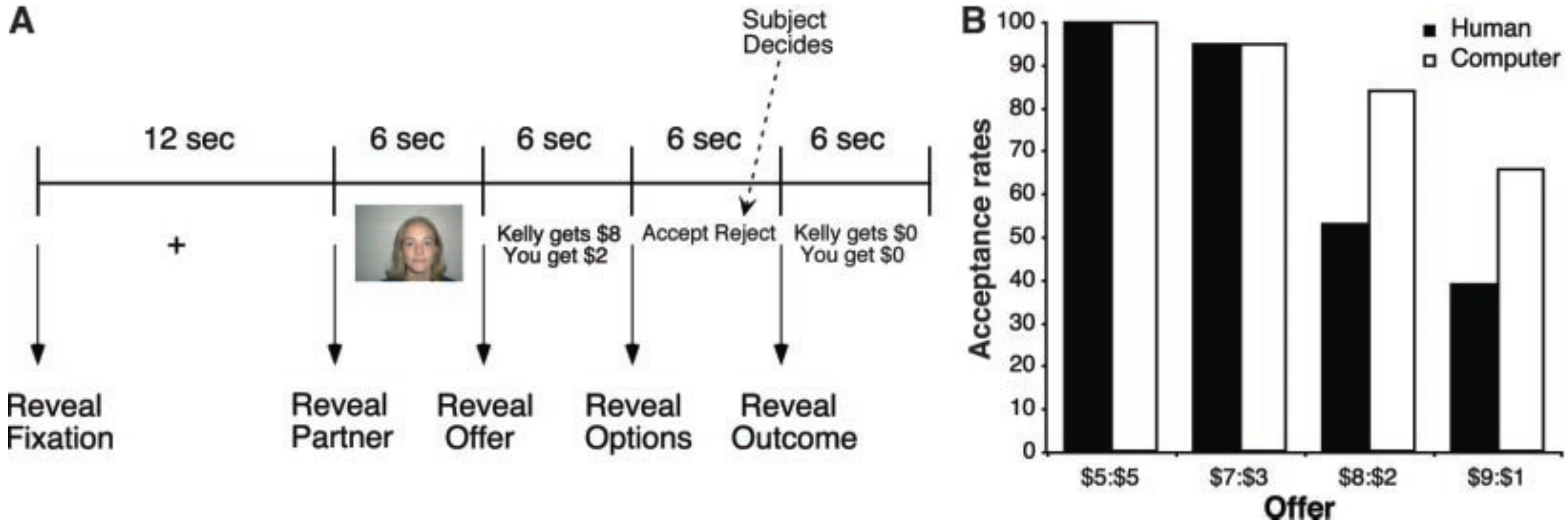


Fig.1. **(A) Time line for a single round of the Ultimatum Game. Each round lasted 36 s. Each round began with a 12-s preparation interval. The participant then saw the photograph and name of their partner in that trial for 6 seconds. A picture of a computer was shown if it was a computer trial, or a roulette wheel if it was a control trial. Next, participants saw the offer proposed by the partner for a further 6 s, after which they indicated whether they accepted or rejected the offer by pressing one of two buttons on a button box. (B) Behavioral results from the Ultimatum Game. These are the offer acceptance rates averaged over all trials. Each of 19 participants saw five $5:$5 offers, one $7:$3 offer, two $8:$2 offers, and two $9:$1 offers from both human and computer partners (20 offers in total).**

Deux études sur les attitudes politiques

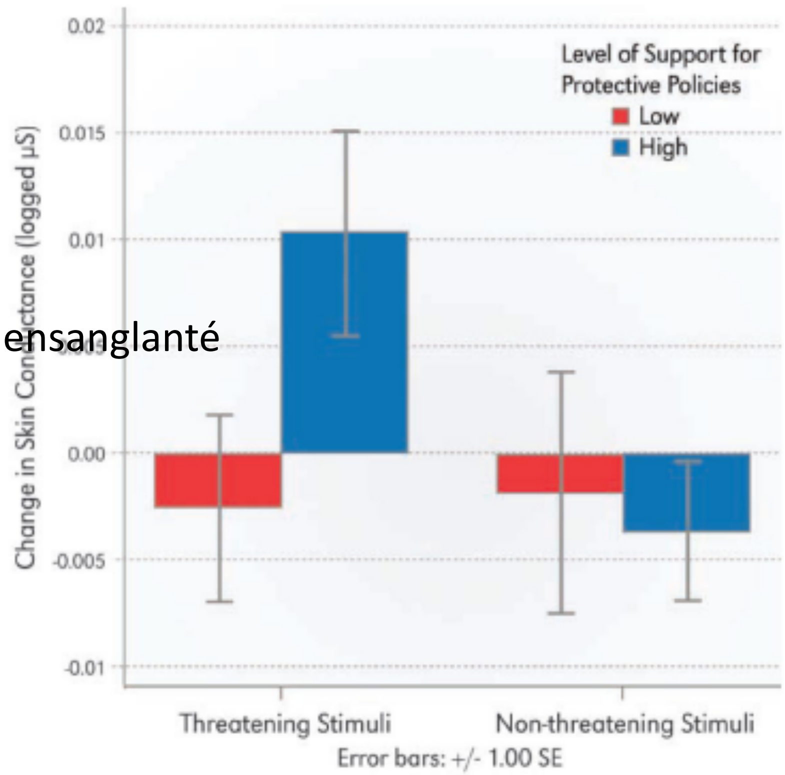
Political Attitudes Vary with Physiological Traits

Douglas R. Oxley,[1] Kevin B. Smith,[1] John R. Alford,[2] Matthew V. Hibbing,[3] Jennifer L. Miller,[1] Mario Scalora,[4] Peter K. Hatemi,[5] John R. Hibbing[1]

Science **321**:5896 (September 19, 2008), pp. 1667–1670

46 participants

Stimuli :
 3 images mélangées à une séquence de 33 images
- une plaie ouverte avec des asticots
- une personne étourdie au visage ensanglanté
- une araignée géante sur le point d'atteindre une personne



Le degré de réactivité à des stimuli menaçants est corrélé au degré de soutien aux politiques de protection de la structure sociale existante contre les menaces extérieures et intérieures (individus qui violent les normes)

Political Attitudes Vary with Physiological Traits, ***Science 2008***

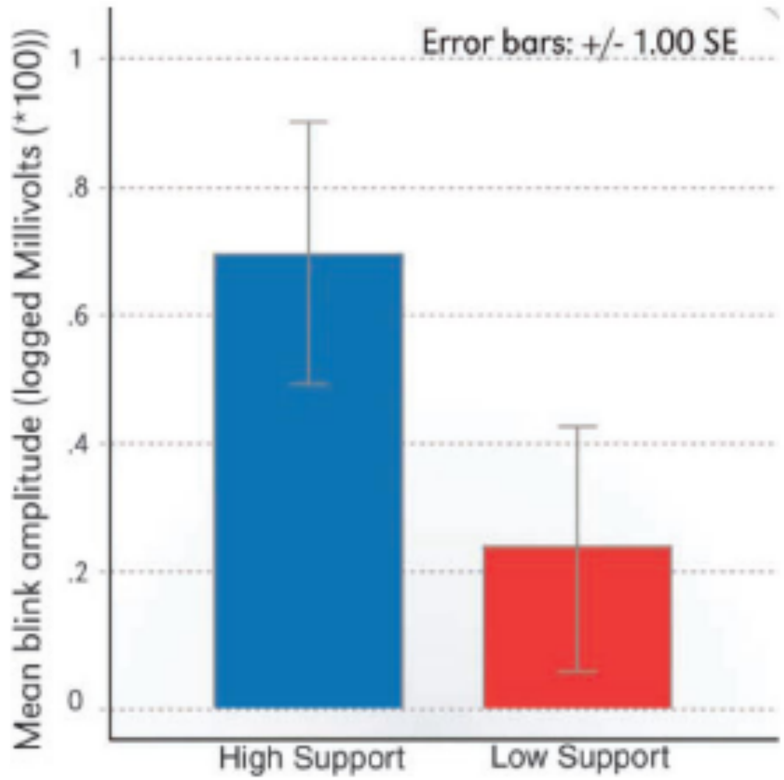


Figure 3. Mean blink amplitude in response to all seven startling noises for high supporters and low supporters of socially protective politics. Bars are mean blink amplitudes (in millivolts). Difference of means tests for overall means: $t = 1.64$, $P = 0.10$. Support for policies is as described in Figure 1.

nature neuroscience

Neurocognitive correlates of liberalism and conservatism

David M Amodio[1], John T Jost[1], Sarah L Master[2] & Cindy M Yee[2]

Political scientists and psychologists have noted that, on average, conservatives show more structured and persistent cognitive styles, whereas liberals are more responsive to informational complexity, ambiguity and novelty. We tested the hypothesis that these profiles relate to differences in general neurocognitive functioning using event-related potentials, and found that greater liberalism was associated with stronger conflict-related anterior cingulate activity, suggesting greater neurocognitive sensitivity to cues for altering a habitual response pattern.

500ms

M----------------- Go, 80%

W----------------No Go 20%

500 essais

NoGo, erreurs 39%

Go erreur 0.01%

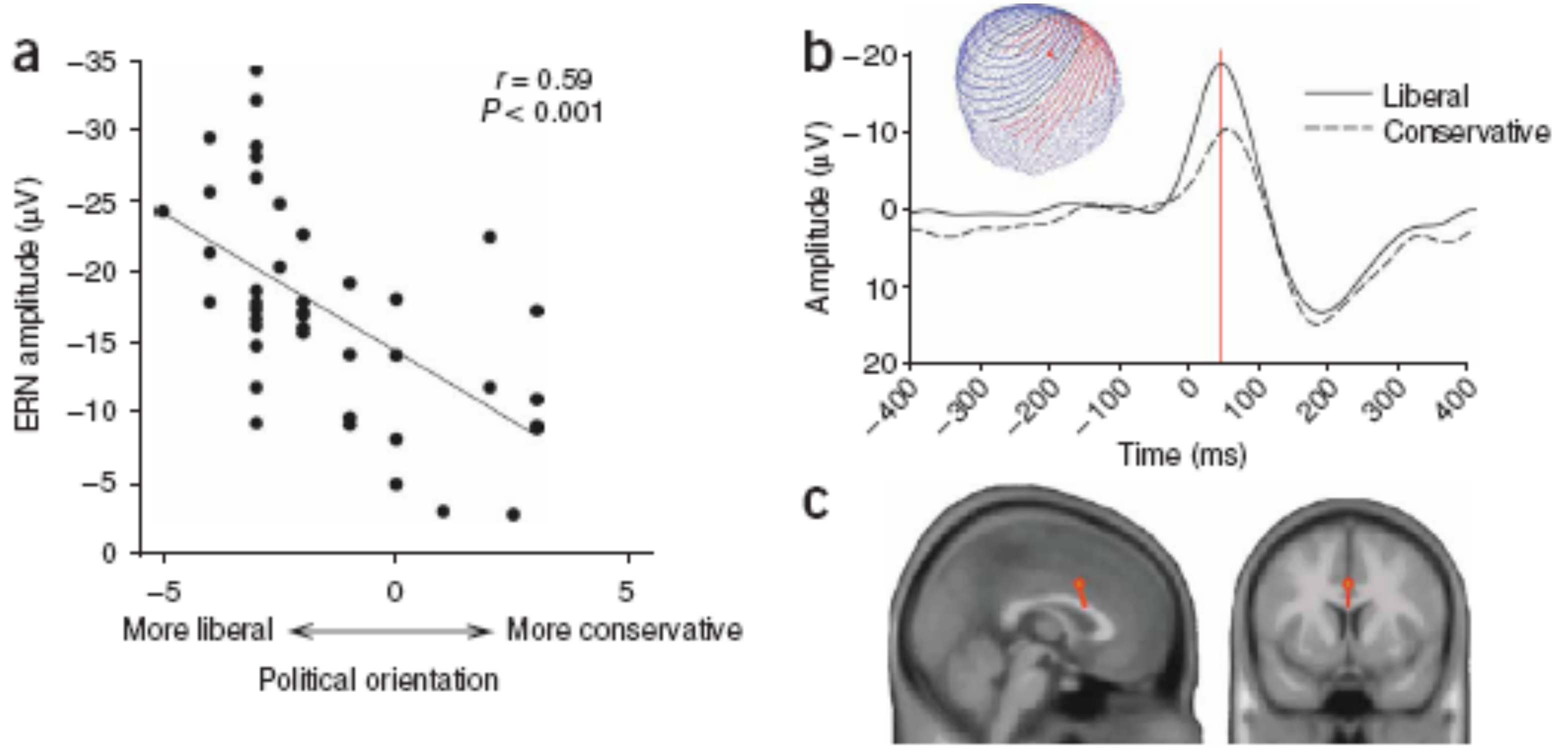


Figure 1 The relation between political orientation and a neurocognitive index of conflict monitoring. (a) Political liberalism was associated with larger No-Go error-related negativity (ERN) amplitudes, as indicated by more negative scores, suggesting greater neurocognitive sensitivity to response conflict. (b) ERP waveforms corresponding to No-Go errors, with the waveform for correct Go responses subtracted, are shown for both liberal and conservative participants (response made at 0 ms; ERN peaked at 44 ms postresponse), with the inset showing the voltage map of the scalp distribution of the ERN. (c) Source localization indicates a dorsal anterior cingulate generator for the ERN, computed at peak amplitude (red line in panel b)

Subliminal exposure to national flags affects political thought and behavior

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Edited by Edward E. Smith, Columbia University, New York, NY, and approved October 29, 2007 (received for review May 20, 2007)

Political thought and behavior play an important role in our lives, from ethnic tensions in Europe, to the war in Iraq and the Middle Eastern conflict, to parliamentary and presidential elections. However, little is known about how the individual's political attitudes and decisions are shaped by subtle national cues that are so prevalent in our environment. We report a series of experiments that show that subliminal exposure to one's national flag influences political attitudes, intentions, and decisions, both in laboratory settings and in "real-life" behavior. Furthermore, this manipulation consistently narrowed the gap between those who score high vs. low on a scale of identification with Israeli nationalism. The first two experiments examined participants' stance toward the Israeli–Palestinian conflict and the Jewish settlers in the West Bank. Experiment 3 examined voting intentions and actual voting in Israel's recently held general elections. The results portray a consistent picture: subtle reminders of one's nationality significantly influence political thought and overt political behavior.

The experiments in this article examine the effects of national symbols, in this case one's national flag, on various political issues of the type presented above and on significant "real-life" political behavior. The national flag of any country is one of the most pervasive cultural and ideological images, and as such it has the potential of exerting significant influence over our behavior. Symbols of this sort are known to have two functions. First, they communicate certain ideas, beliefs, and goals. Second, they bring about thoughts and behaviors that are concomitant with these ideas (17–20). Hence, given that flags are often used to express unity and patriotism (21), they are likely to be able to bring about unity (22, 23). Given the vast research on nonconscious processes succinctly described above, we argue that this effect of national flags may occur outside of conscious awareness (22).

The constant changes in the degrees of citizens' unity and partiality concerning national issues are central to the life of a nation, and understanding these dynamics has long occupied

Neurosciences du consommateur

Neurosciences du consommateur

– Neuromarketing

vs

– Prévention en santé publique

PSYCHOLOGICAL SCIENCE

Research Article

Try It, You'll Like It

The Influence of Expectation, Consumption, and Revelation on Preferences for Beer

Leonard Lee,[1] Shane Frederick,[2] and Dan Ariely[2]

[1]*Columbia Business School, Columbia University, and* [2]*Sloan School of Management, Massachusetts Institute of Technology*

ABSTRACT—*Patrons of a pub evaluated regular beer and "MIT brew" (regular beer plus a few drops of balsamic vinegar) in one of three conditions. One group tasted the samples blind (the secret ingredient was never disclosed). A second group was informed of the contents before tasting. A third group learned of the secret ingredient immediately after tasting, but prior to indicating their preference. Not surprisingly, preference for the MIT brew was higher in the blind condition than in either of the two disclosure conditions. However, the timing of the information mattered substantially. Disclosure of the secret ingredient significantly reduced preference only when the disclosure preceded tasting, suggesting that disclosure affected preferences by influencing the experience itself, rather than by acting as an independent negative input or by modifying retrospective interpretation of the experience.*

388 participants

- 90 exp 1
- 139 exp 2
- 159 exp 3

Our first three experiments were conducted at two local pubs: The Muddy Charles and The Thirsty Ear. Patrons were approached and asked to participate in a short study involving free beer. Those who agreed (nearly everyone) tasted two 2-oz. samples of beer: "regular" beer (Budweiser or Samuel Adams) and the MIT brew, which included several drops of balsamic vinegar.[2]

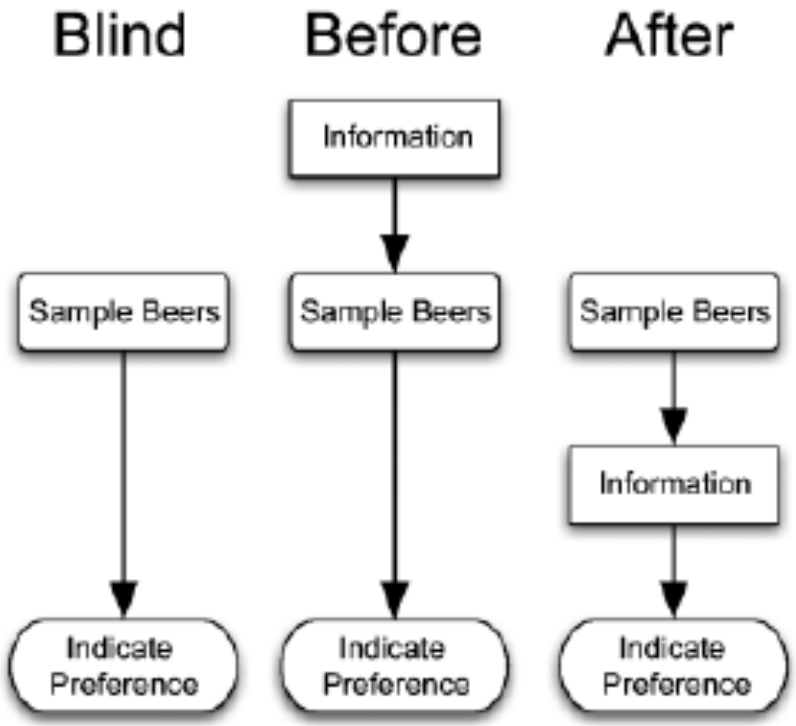


Fig. 1. Illustration of the three experimental conditions, in which we manipulated whether information about the presence of balsamic vinegar in one of the samples was disclosed and if so, when it was disclosed relative to tasting and evaluation.

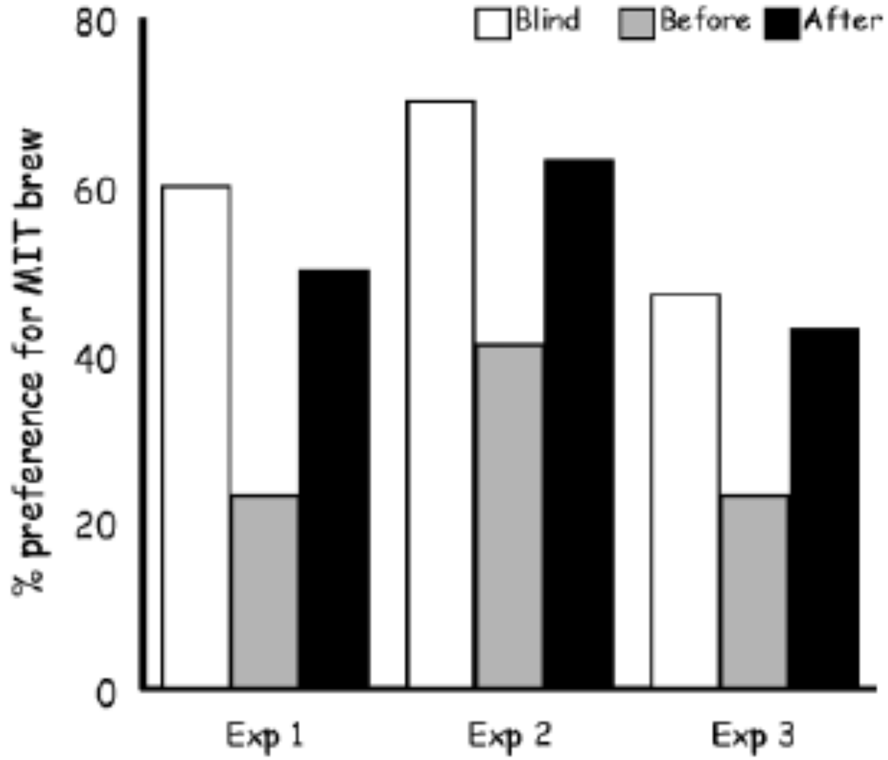


Fig. 2. Percentage of respondents preferring the MIT brew across the three conditions in Experiments 1 through 3.

Try It, You'll Like It. The Influence of Expectation, Consumption, and Revelation on Preferences for Beer, ***Psychological Science***


100% BEER
Skinny
BLONDE
5.2% ALC/VOL
100% AUSSIE OWNED & BREWED
www.skinnyblonde.com.au
londe sixpack
Staring competition
About the beer


Domestic
More Fun
Better Beer
Imported


TASTE
PREFERENCE
Carlo Rossi

Marketing actions can modulate neural representations of experienced pleasantness

Hilke Plassmann*, John O'Doherty*, Baba Shiv[†], and Antonio Rangel*[‡]

*Division of the Humanities and Social Sciences, California Institute of Technology, MC 228-77, Pasadena, CA 91125; and [†]Stanford Graduate School of Business, Stanford University, 518 Memorial Way, Littlefield L383, Stanford, CA94305

Edited by Leslie G. Ungerleider, National Institutes of Health, Bethesda, MD, and approved December 3, 2007 (received for review July 24, 2007)

Despite the importance and pervasiveness of marketing, almost nothing is known about the neural mechanisms through which it affects decisions made by individuals. We propose that marketing actions, such as changes in the price of a product, can affect neural representations of experienced pleasantness. We tested this hypothesis by scanning human subjects using functional MRI while they tasted wines that, contrary to reality, they believed to be different and sold at different prices. Our results show that increasing the price of a wine increases subjective reports of flavor pleasantness as well as blood-oxygen-level-dependent activity in medial orbitofrontal cortex, an area that is widely thought to encode for experienced pleasantness during experiential tasks. The paper provides evidence for the ability of marketing actions to modulate neural correlates of experienced pleasantness and for the mechanisms through which the effect operates.

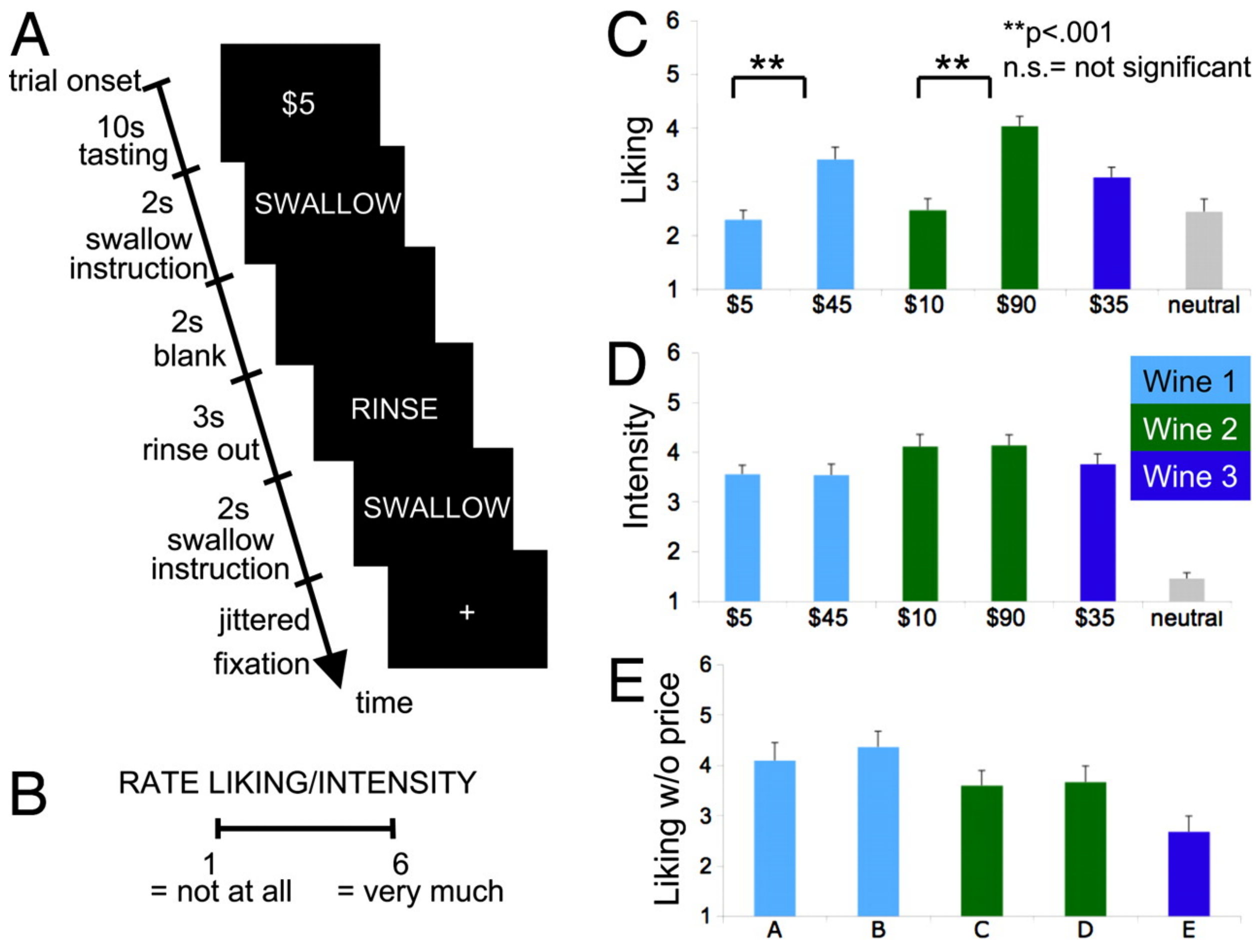
orbitofrontal cortex | modulation by marketing actions | neuroeconomics | taste

experiences and, through this, the actual quality of experiences (2, 7, 8). Consider, for example, the experience of an individual sampling a wine for which he or she has information about its retail price. Because perceptions of quality are known to be positively correlated with price (9), the individual is likely to believe that a more expensive wine will probably taste better. Our hypothesis goes beyond this by stipulating that higher taste expectations would lead to higher activity in the medial orbitofrontal cortex (mOFC), an area of the brain that is widely thought to encode for actual experienced pleasantness (6, 10–16). The results described below are consistent with this hypothesis. We found that the reported price of wines markedly affected reported EP and, more importantly, also modulated the blood-oxygen-level-dependent (BOLD) signal in mOFC.

To investigate the impact of price on the neural computations associated with EP, we scanned human subjects ($n = 20$) using fMRI while they sampled different wines and an affectively neutral control solution, which consisted of the main ionic components of human saliva (17). We chose wine as a stimulus because it is

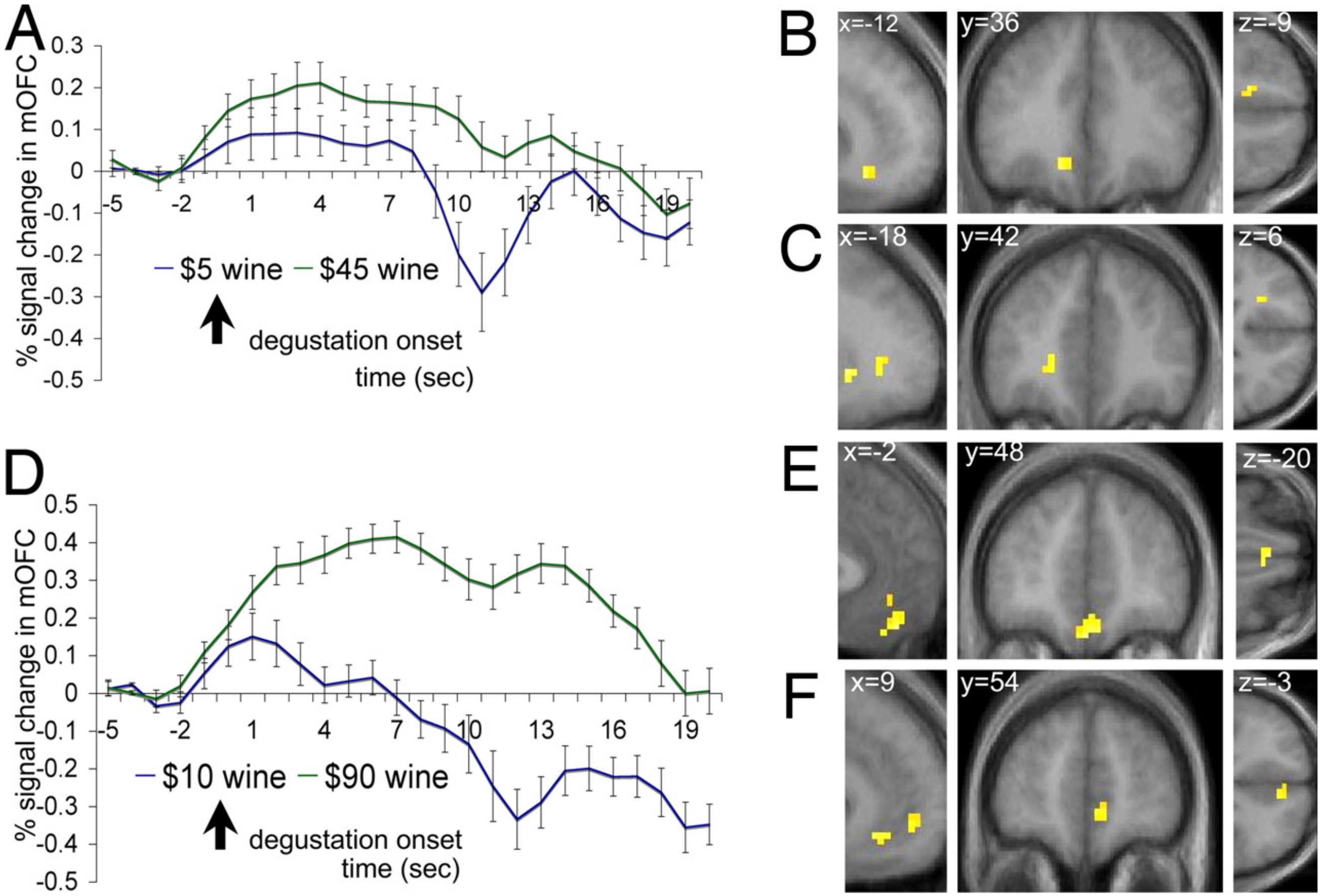
Plassmann H et al. PNAS 2008;105:1050-1054

Experimental design and behavioral results.



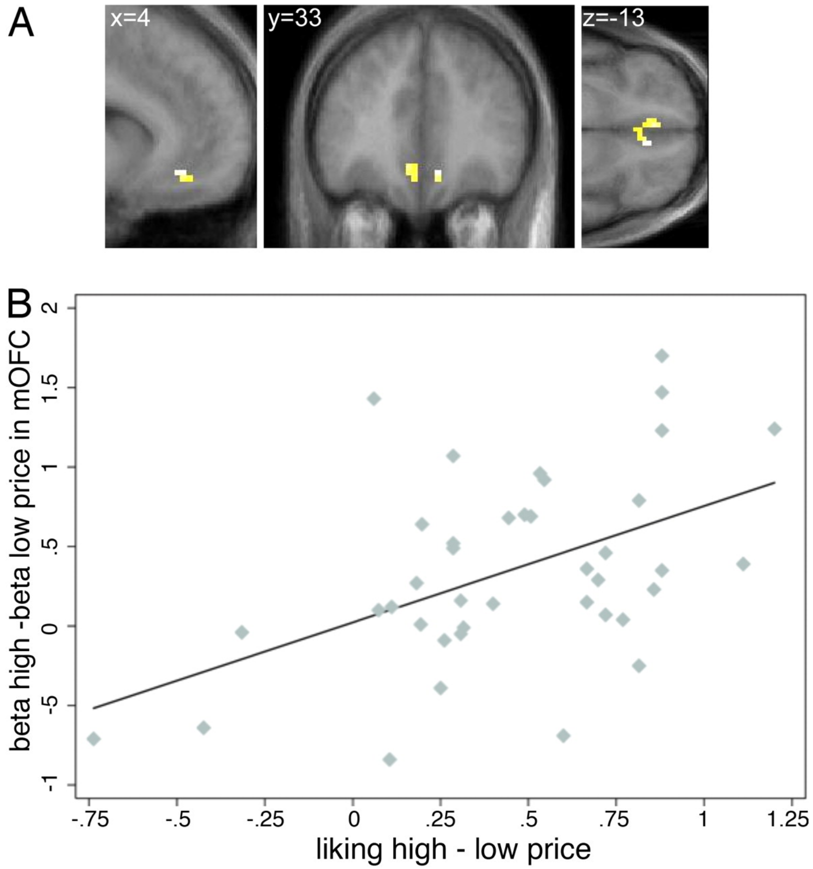
Experimental design and behavioral results. (A) Time course for a typical trial. (B) Reported pleasantness and intensity rating scales. (C) Reported pleasantness for the wines during the cued price trials. (D) Taste intensity ratings for the wines during the cued price trials. (E) Reported pleasantness for the wines obtained during a postexperimental session without price cues.

The effect of price on each wine.



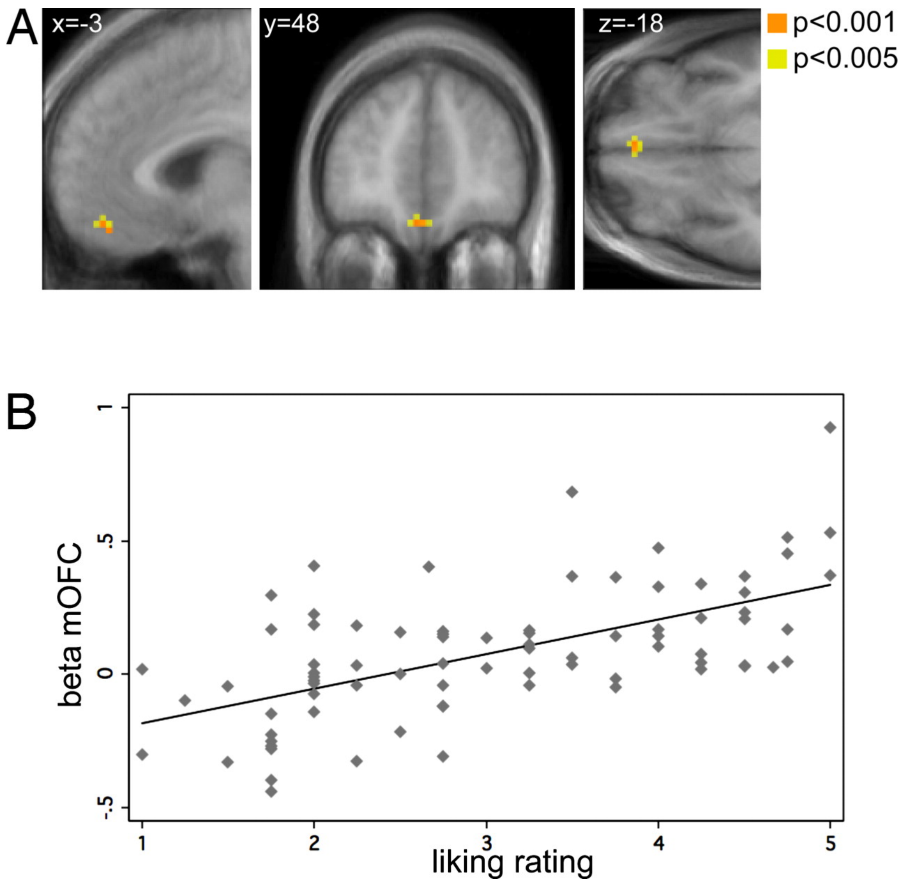
The effect of price on each wine. (A) Wine 1: averaged time courses in the medial OFC voxels shown in B (error bars denote standard errors). (B) Wine 1: activity in the mOFC was higher for the high- ($45) than the low-price condition ($5). Activation maps are shown at a threshold of P < 0.001 uncorrected and with an extend threshold of five voxels. (C) Wine 1: activity in the vmPFC was also selected by the same contrast. (D) Wine 2: averaged time courses in the medial OFC voxels shown in E. (E) Wine 2: activity in the mOFC was higher for the high- ($90) than for the low-price condition ($10). (F) Wine 2: activity in the vmPFC was higher for the same contrast.

The effect of price on both wines



The effect of price on both wines. (A) Conjunction analysis. Activity in the mOFC/rACC was higher in the high- than in the low-price condition for both wines 1 and 2. (B) Correlation of behavioral and BOLD responses ($r = 0.49$, $P < 0.001$). Each point denotes an individual wine pair. The horizontal axis measures the change in reported pleasantness between the high- and low-price conditions. The vertical axis computes an analogous measure using the betas from the general linear model in a 5-mm spherical volume surrounding the area depicted in A.

Neural correlates of liking ratings



Neural correlates of liking ratings. (A) Activity in the mOFC and the midbrain correlated with the reported pleasantness of the six liquids at degustation time. For illustration purposes, the contrast is shown both at P < 0.001 and P < 0.005 uncorrected and with an extend threshold of five voxels. (B) Correlation of pleasantness ratings and BOLD responses (r = 0.593, P < 0.000). Each point denotes a subject-price pair. The horizontal axis measures the reported pleasantness. The vertical axis computes the betas from the general linear model in a 5-mm spherical volume surrounding the area depicted in A.

How Cognition Modulates Affective Responses to Taste and Flavor: Top-down Influences on the Orbitofrontal and Pregenual Cingulate Cortices, Cerebral Cortex, 2007

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How Cognition Modulates Affective Responses to Taste and Flavor: Top-down Influences on the Orbitofrontal and Pregenual Cingulate Cortices

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How cognition influences the affective brain representations of the taste and flavor of a food is important not only for understanding top-down influences in the brain, but also in relation to the topical issues of appetite control and obesity. We found using functional magnetic resonance imaging that activations related to the affective value of umami taste and flavor (as shown by correlations with pleasantness ratings) in the orbitofrontal cortex were modulated by word-level descriptors. Affect-related activations to taste were modulated in a region that receives from the orbitofrontal cortex, the pregenual cingulate cortex, and to taste and flavor in another region that receives from the orbitofrontal cortex, the ventral striatum. Affect-related cognitive modulations were not found in the insular taste cortex, where the intensity but not the pleasantness of the taste was represented. We conclude that top-down language-level cognitive effects reach far down into the earliest cortical areas that represent the appetitive value of taste and flavor. This is an important way in which cognition influences the neural mechanisms that control appetite.

Table 1
Stimuli and abbreviations

MSGrich	0.1 M MSG + 0.005 M inosine 5′-monophosphate	"Rich and delicious taste"
MSGbasic	0.1 M MSG + 0.005 M inosine 5′-monophosphate	"Monosodium glutamate"
MSGVrich	0.1 M MSG + 0.005 M inosine 5′-monophosphate + 0.4% vegetable odor	"Rich and delicious flavor"
MSGVbasic	0.1 M MSG + 0.005 M inosine 5′-monophosphate + 0.4% vegetable odor	"Boiled vegetable water"
MSG2	0.4 M MSG + 0.020 M inosine 5′-monophosphate	"Monosodium glutamate"

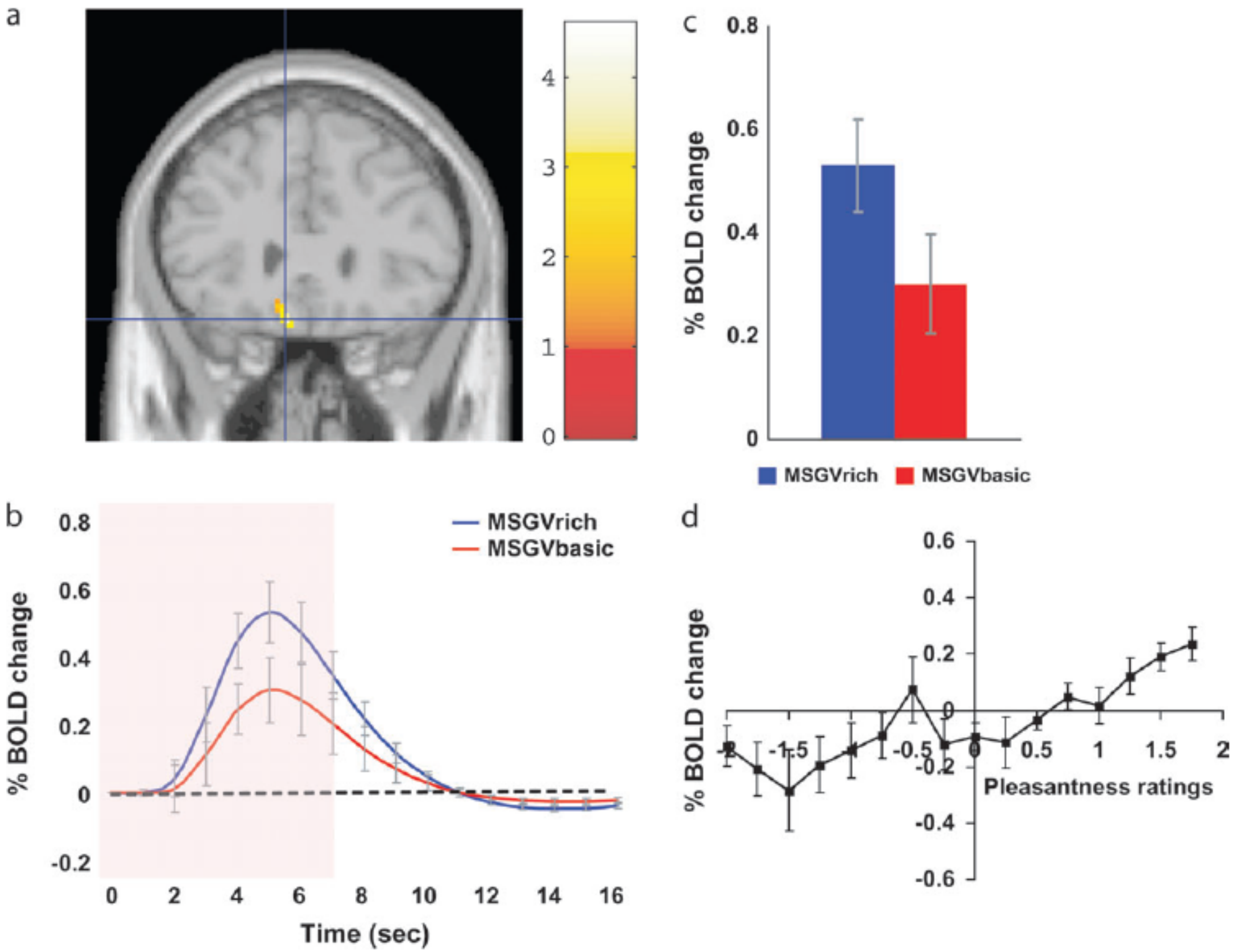

Figure 3. (*a*) The medial orbitofrontal cortex was more strongly activated when the flavor stimulus was labeled "rich and delicious flavor" (MSGVrich) than when it was labeled "boiled vegetable water" (MSGVbasic) ([−8 28 −20]). (*b*) The time course of the BOLD signals for the 2 conditions. (*c*) The peak values of the BOLD signal (mean across subjects ± SEM) were significantly different ($t = 3.06$, df = 11, $P = 0.01$). (*d*) The BOLD signal in the medial orbitofrontal cortex was correlated with the subjective pleasantness ratings of taste and flavor, as shown by the SPM analysis (Table 2), and as illustrated in (*d*) (mean across subjects ± SEM, $r = 0.86$, $P < 0.001$).

« Saveur délicieuse » *vs* « Bouillon de légumes »

Encadré 1 : Plaisir de manger, le poids des mots

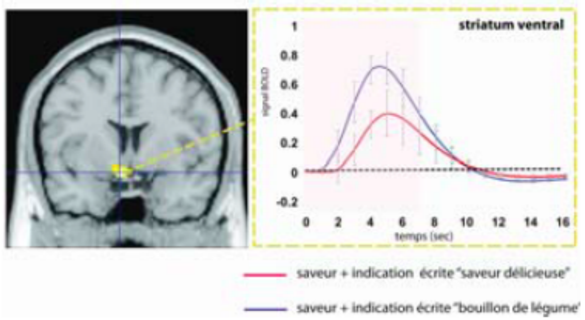

Figure 2 : Modulation de l'activité cérébrale lors de l'ingestion de nourriture en fonction de sa description. (Oxford Press©)

Dans le cadre d'une campagne de sensibilisation, comme dans toute entreprise de communication, le choix des mots est primordial. Une expérience récemment publiée pourrait suggérer de nouvelles pistes quant à la façon de communiquer et de promouvoir une alimentation équilibrée. Des chercheurs de l'université d'Oxford[18] ont montré que lors de l'ingestion de nourriture, l'activité dans les aires cérébrales contribuant au plaisir de manger était plus élevée si la prise alimentaire était accompagnée d'une mention positive. Ainsi, présenter l'aliment comme ayant une « saveur délicieuse » stimule dans le *striatum* ventral une activité significativement plus élevée que lorsqu'il est décrit par la simple mention « bouillon de légumes » (*voir figure 2*). L'apport de tels résultats est double. Ils peuvent servir à imposer une présentation publicitaire « neutre » pour les aliments les plus caloriques. Ils suggèrent également que parler en termes appétissants des fruits et légumes serait sûrement plus efficace pour convaincre les consommateurs d'en manger cinq par jour.

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Neural predictors of purchases

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Abstract

Microeconomic theory maintains that purchases are driven by a combination of consumer preference and price. Using event-related FMRI, we investigated how people weigh these factors to make purchasing decisions. Consistent with neuroimaging evidence suggesting that distinct circuits anticipate gain and loss, product preference activated the nucleus accumbens (NAcc), while excessive prices activated the insula and deactivated the mesial prefrontal cortex (MPFC) prior to the purchase decision. Activity from each of these regions independently predicted immediately subsequent purchases above and beyond self-report variables. These findings suggest that activation of distinct neural circuits related to anticipatory affect precedes and supports consumers' purchasing decisions.

NIH-PA Autho

Neural Predictors of Purchases, ***Neuron 2007***

Figure 1. SHOP Task Trial Structure and Regressors

For task structure, subjects saw a labeled product (product period; 4 s), saw the product's price (price period; 4 s), and then chose either to purchase the product or not (by selecting either "yes" or "no" presented randomly on the right or left side of the screen; choice period; 4 s), before fixating on a crosshair (2 s) prior to the onset of the next trial. In regression models, preference was correlated with brain activation during the product and price periods, price differential was correlated with brain activation during the price period, and purchasing was correlated with brain activation during the choice period.

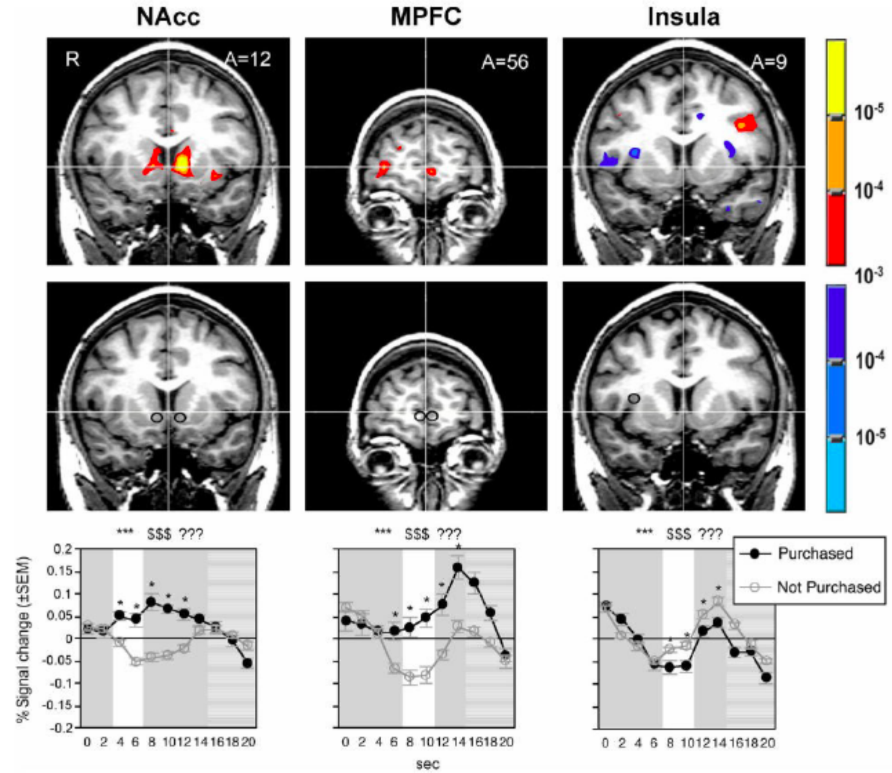

Figure 2.

Correlated activation, volumes of interest, and corresponding activation time-courses. Top row (L-R): Conjoined correlations of NAcc activation with preference during product and price periods; MPFC activation with price differential during the price period; and insula activation with decision not to purchase during the choice period (n=26). Middle row (L-R): Volumes of interest superimposed on structural images of the bilateral NAcc, bilateral MPFC, and right insula. Bottom row (L-R): Bilateral NAcc activation time-courses for trials in which products were subsequently purchased versus not; bilateral MPFC activation time-courses; right insula activation time-courses (white=predicted divergence, ***=product period, $$$=price period, ???=choice period, all lagged / shifted right by 4 s; n=26, *p<.05).

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Neural Correlates of Behavioral Preference for Culturally Familiar Drinks

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Summary

Coca-Cola® (Coke®) and Pepsi® are nearly identical in chemical composition, yet humans routinely display strong subjective preferences for one or the other. This simple observation raises the important question of how cultural messages combine with content to shape our perceptions; even to the point of modifying behavioral preferences for a primary reward like a sugared drink. We delivered Coke and Pepsi to human subjects in behavioral taste tests and also in passive experiments carried out during functional magnetic resonance imaging (fMRI). Two conditions were examined: (1) anonymous delivery of Coke and Pepsi and (2) brand-cued delivery of Coke and Pepsi. For the anonymous task, we report a consistent neural response in the ventromedial prefrontal cortex that correlated with subjects' behavioral preferences for these beverages. In the brand-cued experiment, brand knowledge for one of the drinks had a dramatic influence on expressed behavioral preferences and on the measured brain responses.

neural responses, and the modulation of both by nonodor or nonflavor stimuli—that is, the sensory problem. Ultimately, such sensory discriminations and the variables that influence them serve to influence expressed behavioral preferences. Hence, there is another large piece of the problem to understand. For modern humans, behavioral preferences for food and beverages are potentially modulated by an enormous number of sensory variables, hedonic states, expectations, semantic priming, and social context. This assertion can be illustrated with a quote from Anderson and Sobel (2003) profiling the work of Small et al. (2003) on taste intensity and pleasantness processing:

> "A salad of perfectly grilled woodsy-flavored calamari paired with subtly bitter pale green leaves of curly endive and succulent petals of tomato flesh in a deep, rich balsamic dressing. Delicate slices of pan-roasted duck breast saturated with an assertive, tart-sweet tamarind-infused marinade."

The text goes on further, but note that the sheer lushness of the description adds somehow to the appeal of the food described. Also notice one implicit point of the description: many levels of social, cognitive, and cultural influences combine to produce behavioral preferences for food and drink. The above description likely would not appeal to a strict vegan or an owner of a pet duck. Anderson and Sobel point out that the preferences indexed by their prose originated from the economic demands on our early forebears and were unlikely to have been strictly about aesthetic responses to food and drink.

However, the modern problem is different. Cultural influences on our behavioral preferences for food and

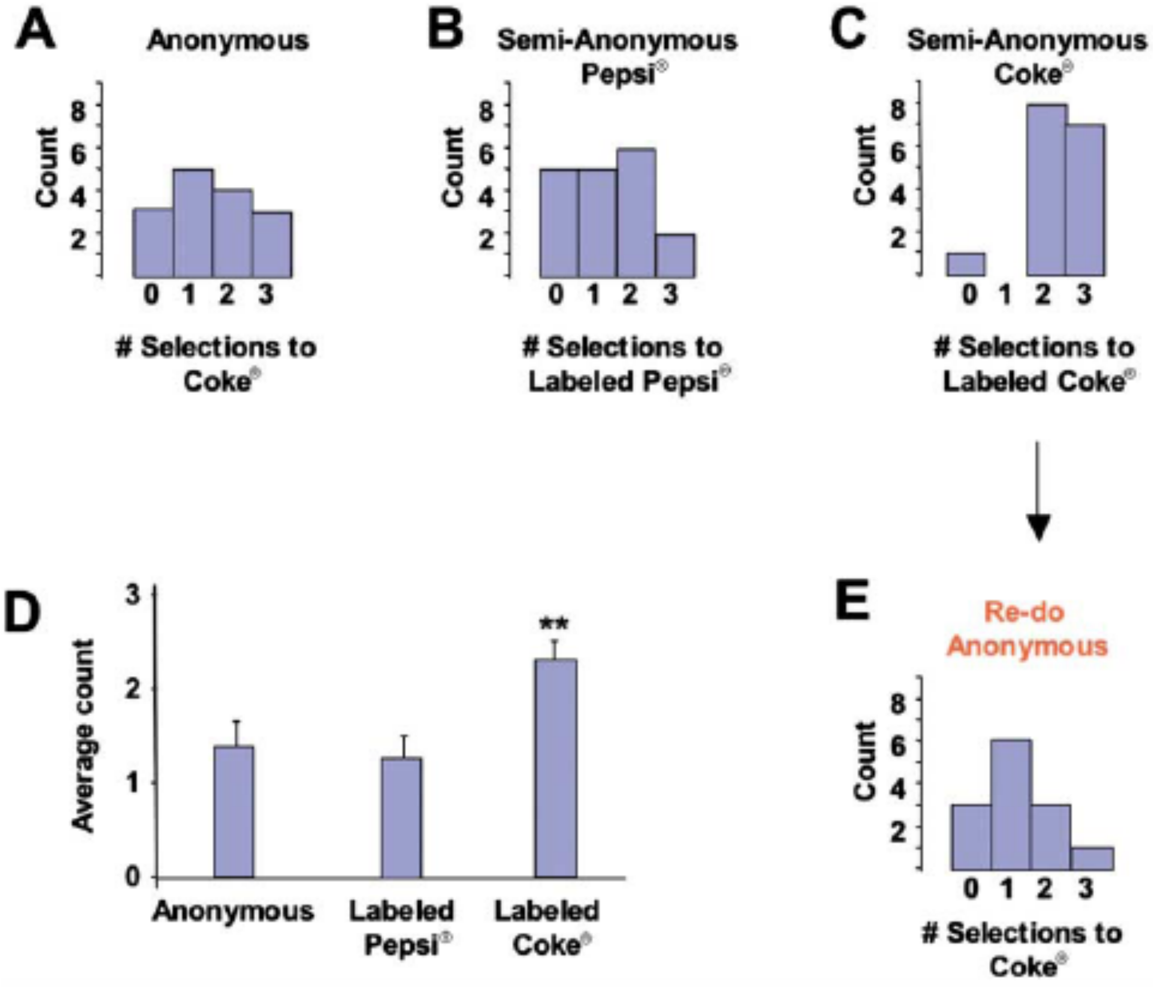

Figure 3. Effect of Brand Knowledge on Behavioral Preferences

(A) Histogram of subjects' preference in double anonymous task. The x axis indicates the number of selections made to Coke (maximum of three). Subjects showed no bias for either Coke or Pepsi.

(B) Histogram of subjects' behavior preference in semianonymous Pepsi task. The x axis indicates the number of selections to the Pepsi-labeled cup. Subjects showed no bias for either the labeled or unlabeled drink.

(C) Histogram of subjects' behavior preference in the semianonymous Coke task. The x axis indicates the number of selections to the labeled Coke. This preference distribution is different from the double anonymous task (Mann-Whitney U task, $n_1 = 16$, $n_2 = 16$, $U = 191.5$, $p < 0.05$) and semianonymous Pepsi task ($n_1 = 18$, $n_2 = 18$, $U = 225.5$, $p < 0.005$), with subjects demonstrating a strong bias in favor of the labeled drink.

(D) Average scores of subjects' preference (number of selections to Coke, labeled Pepsi, and labeled Coke, respectively) in the three behavioral tasks (A–C). Subjects tended to prefer the labeled Coke drink over anonymous Coke (one-way Student's t test, $p < 0.01$). The Coke label had a bigger effect in biasing subjects' preferences than the Pepsi label (one-way Student's t test, $p < 0.005$).

(E) Subjects who participated in the semianonymous Coke task later completed the anonymous taste test. The distribution of people's preference is significantly different from the Coke-labeled task (Mann-Whitney U test, $n_1 = 16$, $n_2 = 13$, $U = 142.5$, $p < 0.01$) but no different from the results in (A).

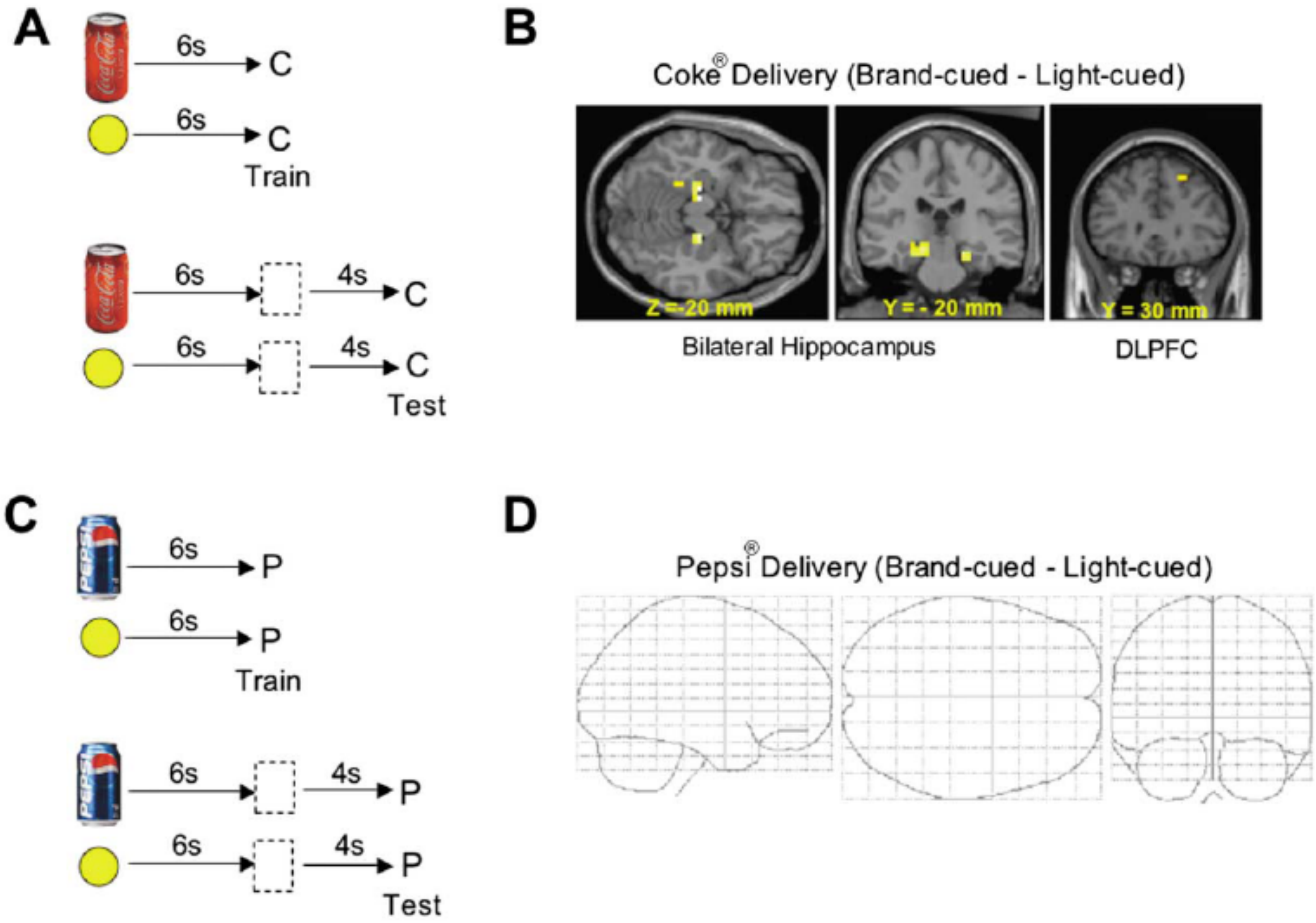

Figure 4. Effect of Brand Knowledge on Brain Responses in Semianonymous Tasks

(A) An image of a Coke can was used to cue the occurrence of Coke. A red or yellow circle (randomized across subjects) predicted the other. Both sodas delivered were Coke.

(B) Coke delivered following an image of a Coke can evoked significantly greater activity in several regions when contrasted against Coke delivered following a neutral flash of light. Significant activations ($p < 0.001$, uncorrected) were found bilaterally in the hippocampus (MNI coordinates [−24, −24, −20] and [20, −20, −16]), in the left parahippocampal cortex (MNI coordinates [−20, −32, −8]), midbrain (MNI coordinates [−12, −20, −16]), and dorsolateral prefrontal cortex (MNI coordinates [20, 30, 48]). See Table 1 for details.

(C) In the scanner, an image of a Pepsi can was used to cue the occurrence of Pepsi. A red or yellow circle predicted the other soda, and both sodas delivered were Pepsi.

(D) No voxels survive $p < 0.001$ threshold (uncorrected) for the equivalent contrast in the semianonymous Pepsi experiment.

The effects of brand knowledge for Pepsi and Coke were reflected in the imaging experiments as well. When an image of a Coke can preceded Coke delivery, significantly greater brain activity was observed in the DLPFC, hippocampus, and midbrain relative to Coke delivery preceded by a circle of light. As with the taste test, equivalent knowledge about Pepsi delivery had no such effect; indeed, no brain areas showed a significant difference to Pepsi delivered with versus without brand knowledge. The hippocampus and DLPFC have both been previously implicated in modifying behavior based on emotion and affect. The DLPFC is commonly implicated in aspects of cognitive control, including working memory (e.g., Watanabe, 1996). Lesions to the DLPFC are also known to result in depression (Davidson, 2002), which is hypothesized to result from a decreased ability to use positive affect to modify behavior (Mineka et al., 1998). It has been proposed that the DLPFC is necessary for employing affective information in biasing behavior (Watanabe, 1996; Davidson and Irwin, 1999). This is consistent with our findings: labeling Coke in taste and imaging tasks both biases behavior and recruits DLPFC activity. Furthermore, both of these effects are lost when compared with the semianonymous Pepsi tasks.

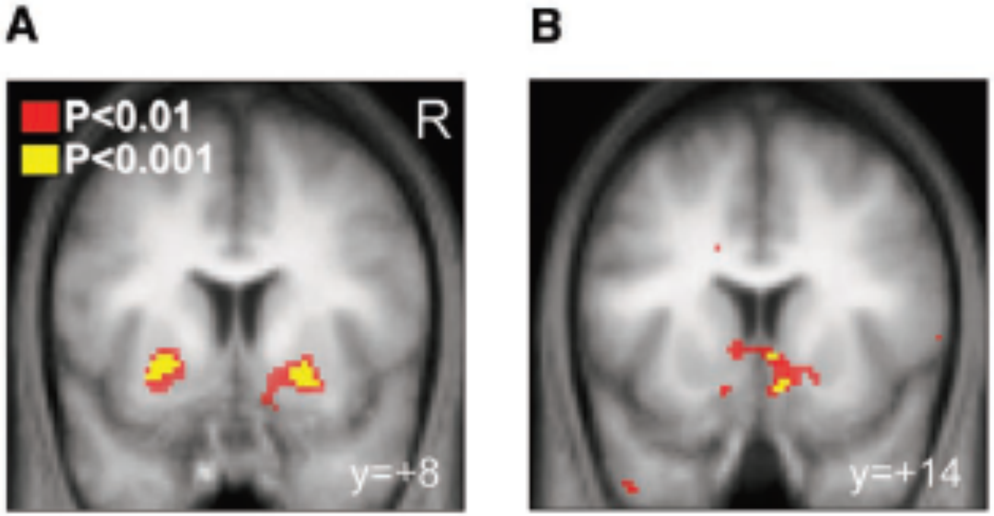

Fig. 2. Ventral striatum correlating with prediction error signal during Pavlovian and instrumental conditioning. (**A**) Reward prediction error responses in bilateral ventral striatum (ventral putamen) during Pavlovian conditioning in reward compared to neutral trials (left hemisphere coordinates: −26, 8, −4 mm; peak z-score = 3.98; right hemisphere coordinates: 26, 6, −8 mm; z = 4.167). Effects significant at $P < 0.001$ are shown in yellow, and effects significant at $P < 0.01$ are shown in red to illustrate the full extent of the activation. R, right. (**B**) Reward prediction error responses in ventral striatum (nucleus accumbens) during instrumental conditioning (right hemisphere coordinates: 6, 14, −2 mm; z = 3.43). (**C**) Results are shown for the conjunction of the prediction error signal for both types of conditioning. Significant effects were found in bilateral ventral striatum [in the bilateral ventral putamen (left hemisphere coordinates: −28, 8, −6 mm; z = 3.73; right hemisphere coordinates: 20, 12, −8 mm; z = 3.54) and in the right nucleus accumbens (14, 10, −10 mm; z = 3.21)] at $P < 0.001$. Images in (A), (B), and the left and middle panels of (C) show coronal slices through different sections of ventral striatum (at y = 8 mm, y = 14 mm, y = 8 mm, y = 10 mm, respectively). A plot of the contrast estimates is also shown (bar chart, right) for the peak voxel in the conjunction analysis with prediction error (PE) effects at the time of presentation of the cue or conditioned stimulus (cs) and at the time of presentation of the reward or unconditioned stimulus (ucs), plotted separately for each type of conditioning.

Behavioral/Systems/Cognitive

Brain Hemispheres Selectively Track the Expected Value of Contralateral Options

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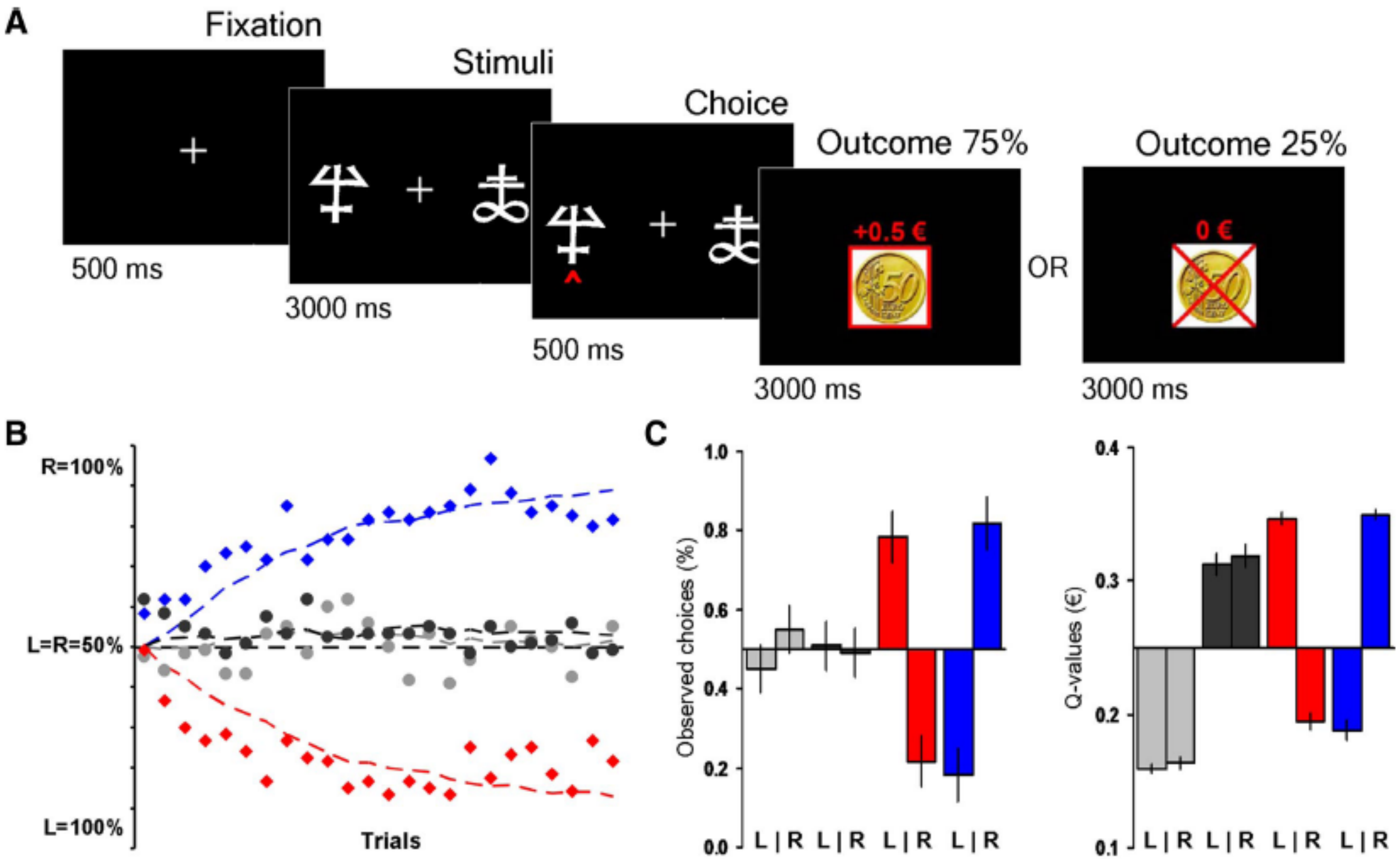
A
Fixation
500 ms
Stimuli
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OR
Outcome 25%
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Trials
C
Observed choices (%)
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L | R L | R L | R L | R
Q-values (€)
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0.3
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