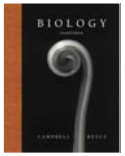
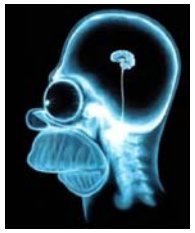
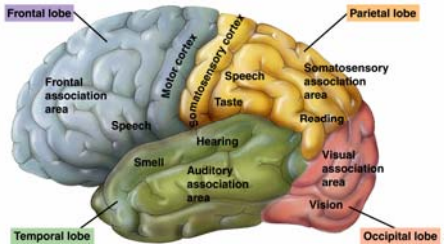
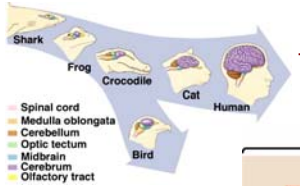


bs148h 25 October 2007
Read: Text ch 49

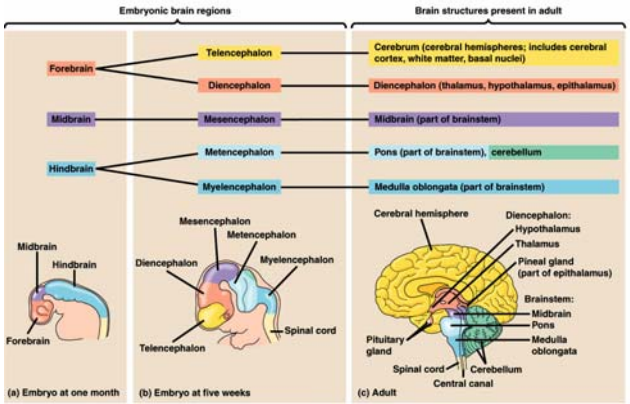
- the CNS - Brains
- cortical maps & fMRI
- sensation & perception
- limbic system
- selective attention
- "cortical control"
- placebo effect
- emotions & decisions
- vision - illusions
- split-brains: consciousness - Mind the Gap
- lateralization
- Theory of Other Minds
- empathy - Yawn!





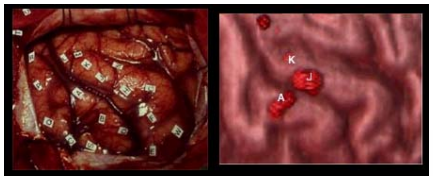


The Brain evolved & develops
as an elaboration of the dorsal hollow neural tube,
& the basic organization is apparent in fish

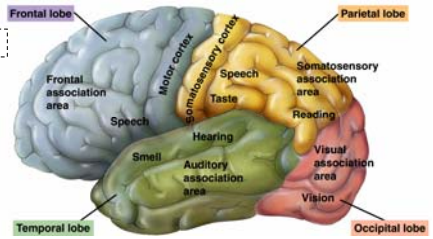


A **human brain consists of 100 billion neurons**
(more than all the stars in the Milky Way),
each connected to as many as 10,000 other neurons,
combining to produce **more possible states of mind**
than the estimated number of elementary particles in the universe.

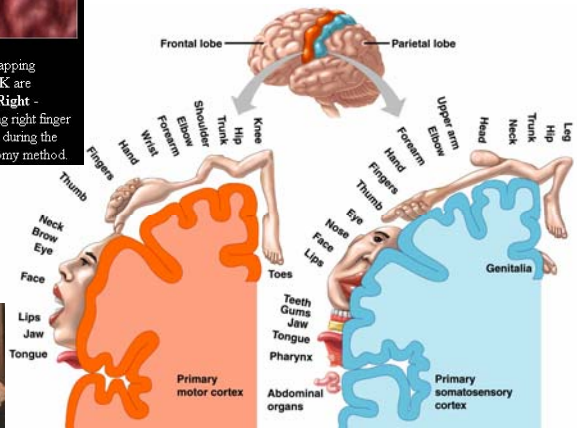
Motor and sensory body surfaces
are
onto the cerebral cortex
w/ 'association areas' nearby.



Pre-surgical Mapping. Left - pre-surgical craniotomy mapping several motor and sensory regions. Note regions **A**, **J** and **K** are mappings during right finger movement and sensory input. **Right** - surface rendered brain from a pre-surgical fMRI scan during right finger movement. The clusters observed in the fMRI (A,J and K) during the finger paradigm are in excellent agreement with the craniotomy method.



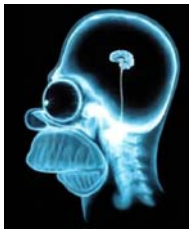
These mappings are
variable across people,
and 'plastic' within people
(some reorganization after injury)



MSKCC fMRI

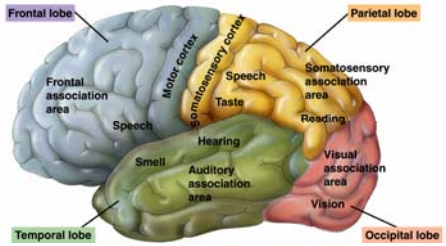
About functional MRI(General)

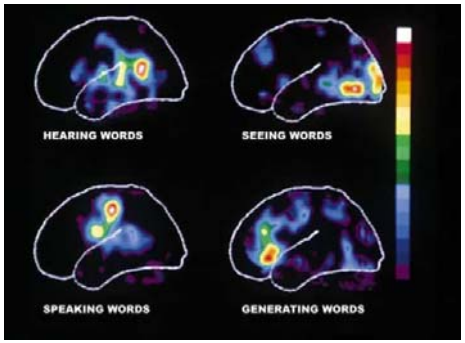
THE LABORATORY OF FUNCTIONAL MRI Memorial Sloan-Kettering Cancer Center



... a new technique called
functional magnetic resonance imaging, fMRI:
provides high resolution, noninvasive reports
of neural activity detected by
a blood oxygen level dependent signal ...

... maps of human brain function.





fMRI & other brain scanning techniques
have allowed new advances ...

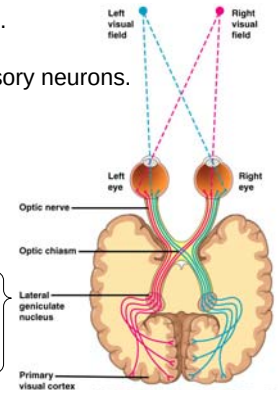
Language Acquisition and Brain Development
Kuniyoshi L. Sakai
Science 4 November 2005: 815-819. [Full Text]

Sex Differences in the Brain: Implications for Explaining Autism
Simon Baron-Cohen et al.
Science 4 November 2005: 819-823. [Full Text]

Patterning and Plasticity of the Cerebral Cortex
Mriganka Sur and John L. R. Rubenstein
Science 4 November 2005: 805-810. [Full Text]

Map Plasticity in Somatosensory Cortex
Daniel E. Feldman and Michael Brecht
Science 4 November 2005: 810-815. [Full Text]

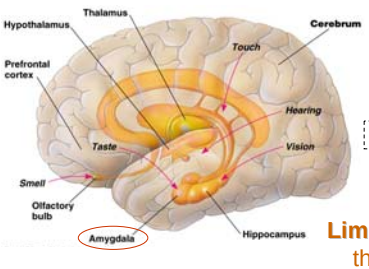
Sensations & **perceptions**
begin with the detection of a stimulus by **sensory receptors** .
... specialized neurons or epithelial cells
Sensations are action potentials that reach the brain via sensory neurons.
The brain interprets them, giving the perception of stimuli.
Perceptions - such as colors, smells, sounds, and tastes -
are constructions formed in the brain
and do not exist outside it. *{color?}*
The perception depends on where action potentials go,
not what triggers them. *{consider cochlear implants}*



In vertebrates, sensory signals
generally go first to the
the gateway to the cerebral cortex.

This gateway is influenced by instructions
{there is active 'top down' control of sensory input}
The information is then sent on to the many parts of the brain
that contribute to forming our perceptions.

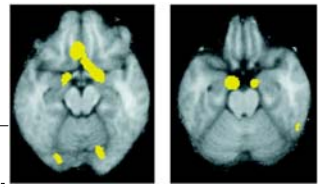
Our memories and expectations can strongly influence our perceptions,
... **we perceive what we expect to hear or see** …
{perception involves selective attention – the cocktail party effect -
& active interpretation → illusions; when we listen to sentences,
we constantly guess what's coming next & are surprised by unanticipated endings}



The **hippocampus**, **amygdala**,
some inner portions of the cortex's lobes and
sections of the **thalamus** and **hypothalamus**,
form a ring around the brainstem called
- interacts with neocortex & generates **emotions**.

Limbic regions *{emotions}* are central in determining
the importance of the sensory input to the organism.

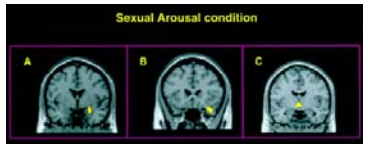
Amygdala activity related to enhanced memory
for pleasant and aversive stimuli
Hamann et al. 1999 Nature Neurosci 2, 289-293.
Pleasant or aversive events
are
Using positron emission tomography, we show that
bilateral amygdala activity during memory encoding
is correlated with enhanced episodic recognition memory …
The amygdala seems to modulate the strength of memory for events
according to emotional importance …



Maps of pixels in which individual subject
rCBF *{regional cortical blood flow}*
was significantly correlated with
individual-subject episodic-memory enhancement

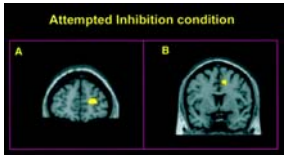
Neural correlates of conscious self-regulation of emotion.
Beauregard et al. 2001. Journal if Neuroscience 21 (18):U11-U16.

Abstract:
… brain activation was measured *{fMRI}* in normal male subjects while they
either responded in a normal manner to erotic film excerpts *{ ?! }*
or voluntarily attempted to inhibit the sexual arousal induced by erotic stimuli.



… the sexual **arousal** experienced
in response to the erotic film excerpts,
was associated with activation in limbic
and paralimbic structures, such as
the *{A}*, right anterior temporal pole *{B}*, and **hypothalamus** *{C}*.

… the attempted **inhibition** of the sexual arousal
… was associated with activation of
the right superior
and right anterior
… reinforce the view that **emotional self-regulation**
is normally **implemented by**
… various

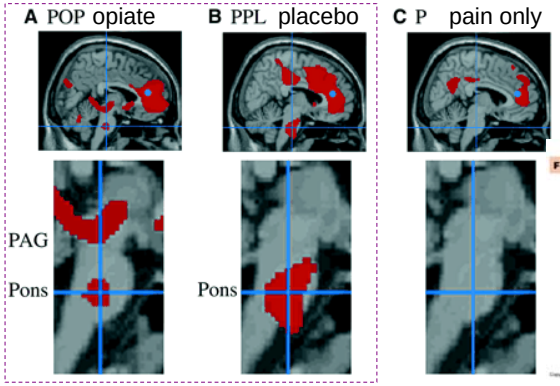


… humans have the capacity
to influence the electrochemical dynamics of their brains,
by voluntarily changing the nature of the mind
processes unfolding in the psychological space.

Placebo and opioid analgesia - Imaging a shared neuronal network.
Petrovic Pet al. SCIENCE 295 (5560): 1737-1740 MAR 1 2002

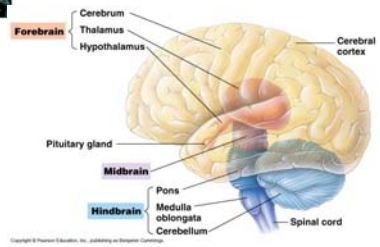
We compared the analgesic effects of a placebo treatment (PPL)
and a rapidly acting opioid (POP) ... in a standard pain-stimulus paradigm.

Covariation between rACC and the brainstem



Red: correlated changes in blood flow

- rACC (rostral Anterior Cingulate Cortex)



Higher cortical systems *{rACC}* may [ ]
[ ]
not only during opioid analgesia *{POP}* but also during placebo analgesia *{PPL}*

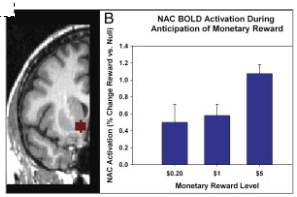
{ The larger the anticipated benefit from a drug or a procedure, the greater is the actual health improvement observed ([de Craen et al., 2000] and [Moseley et al., 2002]). }

news@nature.com
The best in science journalism

NEWS Published online: 18 July 2007;
Michael Hopkin

Revealed: **how the mind processes placebo effect**
Expecting a big reward helps the reward to come true.

Think about it: **expecting pain relief can trigger the brain to make it happen.**
Neuroscientists have found that
people who experience a strong dose of pleasure
at the thought of an upcoming reward *{$$$}*
are [ ]
{measured by activity of limbic dopamine cells during reward anticipation }
The research shows how **the placebo effect**,
in which patients perceive a benefit from a medical treatment
despite it having no genuine therapeutic activity,
hinges on the brain's 'reward centre' —
a region that predicts our future expectations of positive experiences,
and which is also implicated in [ ]
{people who anticipate greater pleasure from a win or a "high"
[ ]
Greater activity in this brain region,
called the nucleus accumbens,
{"reward center" in forebrain}
is linked to a stronger placebo effect ...



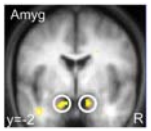
Scott, D. J. *et al*. *Neuron* **55**, 325-336 (2007).

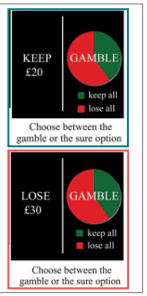
Science AAAS News of the Week Greg Miller
The Emotional Brain Weighs Its Options

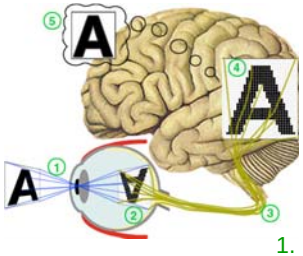
Theories of economic decision-making traditionally assume that
humans are fundamentally rational creatures.
However, **humans are reproducibly irrational** in characteristic ways.
Faced with a decision between two packages of ground beef,
one labeled "80% lean," the other "20% fat," which would you choose?
The meat is exactly the same, but **most people would pick** [ ]

The language used to describe options often influences what people choose,
a phenomenon behavioral economists call **the** [ ]
De Martino *et al.* (p. 684) identify the integration of
emotional biases arising from an [ ] **decision-making system**
as the underlying cause of the framing effect.

Frames, Biases, and Rational Decision-Making in the Human Brain
B De Martino et al. *Science* 4 August 2006: 684-687. Full Text »
Subjects had to choose between
a **"sure" option** framed as
("**Gain**;" keep £20 of £50) or ("**Loss**;" lose £30 of £50).
and an identical **"gamble"** presented as a pie chart
... [ ] was significantly greater
when subjects decided to choose
the sure option in the Gain frame *{57.1% of KEEP 20 trails}* and
the gamble option in the Loss frame *{61.6% of LOSE 30 trails}*

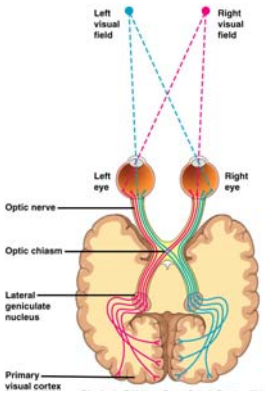






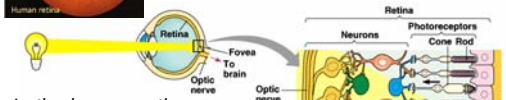
Let's look at the basic nuts & bolts picture
of a **sensory system - vision**

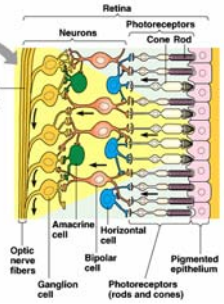
http://www.chemistry.wustl.edu/EduDev/LabTutorials/Vision/Vision.html

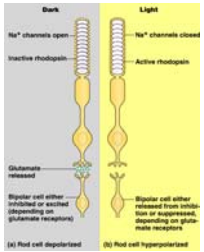


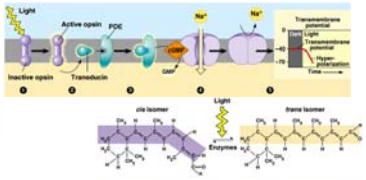
1. Rays of light (blue) reflected off of an image *{3D}*
   are focused through the lens onto the back of the eye,
   forming an upside-down image *{2D}* on the retina.
2. … we can think of the image as a *{2D}* pixellate map
   of activated and nonactivated photocells on the retina.
3. *{After much processing in retina by horizontal, amacrine & bipolar cells}* A nerve from each *{ganglion cell}*
   connects to a particular location in the visual cortex
   of the brain. *{via lateral geniculate nucleus of thalamus}*
4. **The brain** … reconstructs the pixellate map.
5. then **interprets** *{or misinterprets}* **the** *{2D}* **map**
   as an *{3D}* **image** *{made up of "sensible" objects}.*

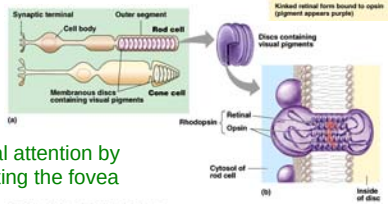
Amacrine & Horizontal cells:
lateral inhibition
enhances edges & contrast









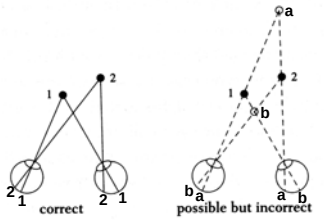


In the human retina,
rods absent from the **fovea**.
You cannot see a dim star at night by looking at it directly; you can see it at an angle by focusing the starlight onto the periphery & rods.
You achieve your sharpest daylight vision by looking straight at the object of interest because **cones** are most dense at the **fovea**, (about 150,000 per mm^2).

We allocate visual attention by sequentially pointing the fovea (saccades)

Edge enhancement from lateral inhibition by amacrine & horizontal cells in retina creates **Mach bands**

When the 3D world is projected onto the 2D retina,
the image is 'underdetermined:'
different hypothetical 'real 3D worlds'
could have created the same 2D image.



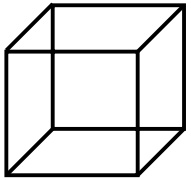
the correspondence problem
{consider clues … }

From phylogeny and ontogeny,
the mind has

about how the real world works,
things like:
every mark is in only one place at a time
a dot on one retina corresponds to only one dot on the other,
matter is smooth and cohesive, etc *{"folk physics"}*

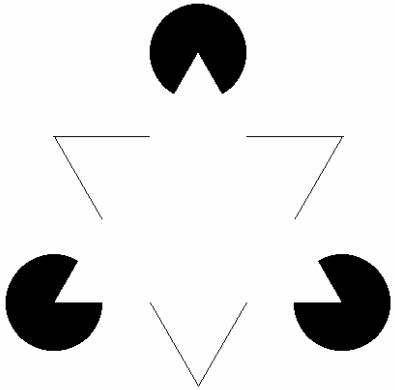
We are constantly testing alternative hypotheses
against sensory data in "the mind's eye."

Necker cube



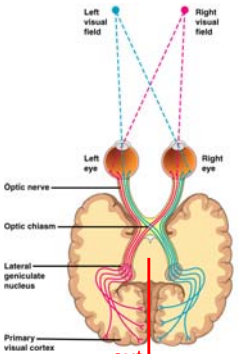
http://www.illusionworks.com/html/jump_page.html

"Whilst part of what we perceive comes through our senses from the object before us, another part (and it may be the larger part) always comes out of our own mind."
William James

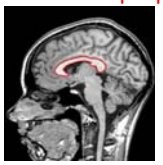


Kanizsa's triangle

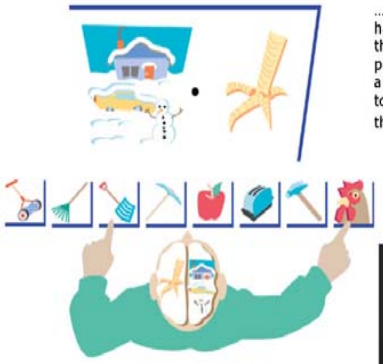
The body-surface to cortical-surface mapping crosses over, unless ...



cut corpus callosum to control epilepsy



By using a tachitoscope, which displays visual stimuli for very brief intervals of time on each half of the screen in front of the patient, information presented on the left is exclusively perceived by the right hemisphere, and vice versa. If we ask the patient to identify what is seen, the right hand (controlled by the left hemisphere) will point toward a chicken...



... whereas the left hand (operated by the right hemisphere) will choose a shovel (needed to remove snow in the scene).

Figure 1. Lateralized presentation of information in a split-brain patient

Researcher Roger Sperry

Gazzaniga's 'left-brain interpreter' (from Massimo Pigliucci)
if asked to explain ... the left hemisphere acted as an interpreter ... and _____ **to fit all the available data!**

The Blind Decision-Maker

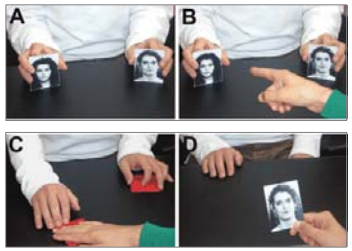
What is the relation between intention, choice, and introspection?

Johansson *et al.* (p. 116) used a card trick in a simple decision task to identify a dissociation between awareness of the initial choice and the outcome when this has been surreptitiously altered.

Participants were given a choice to make in the attractiveness of two female faces shown on two cards, and then asked to justify their choice as they examined the card with the alternative they had allegedly chosen.

In some trials, the experimenters covertly switched the cards.

In the majority of such trials, **participants failed to recognize the switch, and proceeded to** _____ **of the card they were handed,** although it was not the one they had selected.

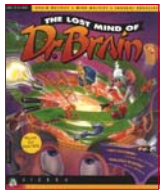


... **participants may produce confabulatory reports when asked to describe the reasons behind their choices.**
{post hoc rationalization}

Our consciousness may be primarily _____ from moment to moment, about what we did and why we did it. It is a thin, often inaccurate **veneer rationalizing a mountain of unconscious processing**.

Hans Moravec, 1998

Reductionist efforts are getting us to the **neural correlates of brain function**,



but we still haven't found 'the **mind**.'

http://www.sci-con.org/reviews/20031101.html

The split-brain phenomenon gave rise to a host of conflicting propositions about **the neuroanatomical localization of the self**.
Where is the self in the split brain?
In the left hemisphere? In the right hemisphere? In both?

With fMRI we can now distinguish what specific areas of the brain are active when people think, feel, imagine, perceive, and so on.
Researchers are starting to apply this technology to find the self in the brain.

Mirror self-recognition (MSR) and _____
seem to be associated with _____
{but explaining verbally is localized on left}

During an infant's or child's brain development, typically …

The **right** hemisphere is stronger at _____ spatial relations, music …

{the 'holostic hemisphere'}

The **left** is most adept at _____ fine visual and auditory details …

{the 'reductionist hemisphere'}

nature

18 January 2001

brief communications

home

Nature **409**, 305 (2001); doi:10.1038/35053167

Neurology: **Self-recognition and the** _____ **hemisphere.** JULIAN PAUL KEENAN et al.

Here we show that **in humans the** _____ **hemisphere of the brain seems to be preferentially involved in self-face recognition.**

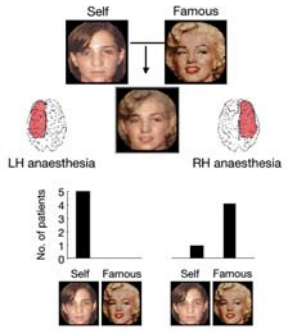


Figure 1 Five patients were presented with a picture showing a morph of a face that was composed of their own face and a famous face during the time when either the right or the left hemisphere of their brain was anaesthetized.

Following anaesthesia of the left hemisphere (LH), patients selected the 'self ' face as having been shown to them (5/5);

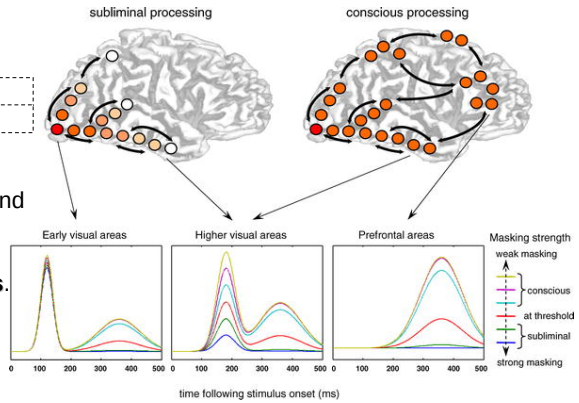
after anaesthesia of the right hemisphere (RH), patients selected the famous face as the one they had viewed (4/5).

An optical illusion can help define
which parts of the brain are responsible for human consciousness.
People cannot consciously perceive a number flashed on a screen for 16 ms
if it is quickly followed by another stimulus in the same area. *{a "mask"}*
As the time between the two stimuli increases, the first stimulus becomes visible;
that is, it is accessible to the person's consciousness. *{can report seeing it}*

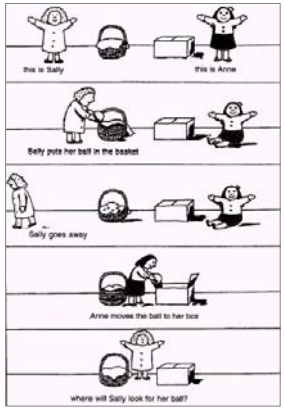
Brain Dynamics Underlying the Nonlinear Threshold for Access to **Consciousness**
Antoine Del Cul et al. 2007. PLoS

... Conscious perception
of masked stimuli
corresponded to activity
in a

... this late stage
... clearly separated
from subliminal processing and
mask-target interactions,
can be regarded as
a marker of consciousness.



http://pubpages.unh.edu/~jel/seminar/Frith_mind.pdf



SCIENCE'S COMPASS • REVIEW
REVIEW: COGNITIVE PSYCHOLOGY

Interacting Minds—A Biological Basis

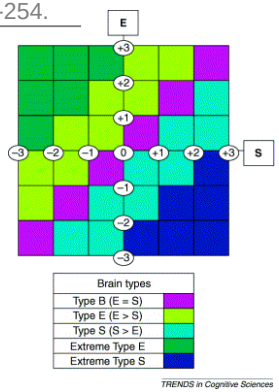
Chris D. Frith[1*] and Uta Frith[2]

Baron-Cohen et al.'s(1996) **false belief test**
is presented as a simple story.
1. There are two puppets, Sally and Anne.
Sally has a marble, which she keeps in a basket.
2. Then Sally leaves the room, and while she is away
3. Anne takes the marble out of the basket
and hides it in the box.
4. Sally comes back into the room.
The child subject is then asked the question:
"Where will Sally look for her marble?"

Older children say that she will look
because they know that Sally doesn't know it has been moved from the basket,
and they can distinguish Sally's (false) belief from their own (true) belief.
Younger children, and autistic children,
simply **say that Sally will look**
The false belief test, therefore, explores the change that happens
as common-sense psychology develops. *{a Theory of Other Minds}*

The extreme male brain theory of autism
Baron-Cohen S 2002 Trends in Cognitive Sciences 6: 248-254.

'**Empathising**' is the drive to identify another person's
emotions and thoughts & to respond appropriately.
... allows you to **predict a person's behaviour**.
I review evidence that on average,
females spontaneously empathise
to a greater degree than do males.
'**Systemising**' is the drive to analyse a system,
to derive the underlying rules
that govern the behaviour of a system.
... allows you to **predict the behaviour of a *system***.
I review evidence that, on average,
males spontaneously systemise more than do females



... **autism can be considered as**
{this is highly controversial, of course!}

... **males tend to have**
{associated w/ higher levels of testosterone in uterus}
people with autism show this trait in a magnified form

2nd to 4th digit ratios, fetal testosterone and estradiol.
Lutchmaya S et al. 2004 Early Human Development 77:23-28.

news@nature.com
The best science journalism on the web
Kind people catch yawns.

Contagious yawning:
the role of self-awareness and mental state attribution
Platek SM et al. 2003 Cognitive Brain Research 17: 223-227.

We hypothesized that **contagious yawning**
is part of a more general phenomenon known **as mental state attribution**
(i.e. the ability to inferentially model the mental states of others).

... we compared **susceptibility to contagiously yawn**
{response to video clips of neutral, laughing or yawning people}
with performance on a **self-face recognition task** *{left-right hand response time}*,
several **theory of mind stories**, *{about false beliefs & social faux pas}*
and on a measure of **schizotypal personality traits**. *{the SPQ test}*
with the hypothesis, **susceptibility to contagiously yawn**
was related to performance on **self-face recognition**
& **faux pas stories**,
and related to **schizotypal personality traits**.

If autistic people are poor at mental state attribution (TOM)
what does this imply about contagious yawning?

Senju, A. *et al*. Biology Letters (2007)
... yawning faces triggered more than twice as many yawns in non-autistic children
than in their autistic counterparts ...