The Mind-Body Problem

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Nature of the mind-body problem

Conscious experiencing subject

Possessor of mental states

- hearing
- seeing
- thinking
- remembering
- feeling
- pain
- wondering
What does it mean to have a mind?

Physical phenomena
- Well developed theories about the nature and behavior of physical bodies, processes and events – physics, chemistry, biology

Mental phenomena
- Without your mental life, as a person, you would not exist.

K. T. Maslin

What is going on in us when we solve a math problem or hurt our big toe? What is it that gives us the ability to think and experience a sensation?
What is the nature of the mind?

physical

mental

like photosynthesis

immaterial soul-like
A new field is born...

Understanding subjective states

| Purpose | How the distinct states come about? | Qualia |

“In most brain states are not directly associated with conscious sensations: We have almost no access to the structures that give rise to speech, to depth perception or color vision, to the rapid sequence of sensory-motor transformations necessary to play soccer, climb a rock wall, or return a tennis ball, let alone those influencing perspiration, heart rate, or the action of our immune systems. Unlike qualia, these proceed in blankness. Where is the difference between the two?”

The Inchoate Science of Consciousness, Koch (2005)
Brain to consciousness

Greatest unsolved question in science

Self consciousness
- The ability to examine one’s own desires and thoughts

Content of consciousness
- What are you actually conscious of at this moment?

Brain relationship?
- Which processes relate to consciousness and non-consciousness?
We still don’t understand enough -- but

First step

NCC
Neural Correlates of Consciousness

Brain activity that matches with specific conscious experiences

NCC are the minimal set of neuronal mechanisms or events jointly sufficient for a specific conscious percept or experience.
The concept

- Simple
  - Special set of neurons
  - Activity $\rightarrow$ Consciousness

- Physical
  - Consciousness would have a physical location

- But
  - Where to start?
  - Hint: start small!
Which neurons are needed to have any form of consciousness at all?

What are the smallest set of neurons responsible for a particular percept?

Enabling factors?
Minimal conditions needed for any consciousness

Specific factors?
Minimal conditions needed for a particular conscious percept

Continuous or discontinuous?
- Modulating the degree of consciousness?
- Is it as simple as on or off?
Enabling factors:

(what must be in place for consciousness to occur)

- Proper blood supply
- Functional brainstem MRF (mesencephalic reticular formation)
- Acetylcholine
- Non-specific thalamic activity
Projections of Norepinephrine-containing neurons
Major cholinergic projections

Nucleus basalis projects to neocortex.
Pedunculopontine nucleus (PPN) projects to the thalamus
Why might the cholinergic neurons be part of the nCC?

**Thalamus**
- Brainstem to thalamus
- Influence sensory information from the thalamus.
- Propitious location

**Cortex**
- All cortical regions
- Limbic system

**Sleep-Wake**
- Increased cholinergic activity is associated with wakefulness.

**Dementias**
- Alzheimer’s, Parkinson’s disease
- Loss of cholinergic pathway
Anatomically, the body of the thalamus is divided by a Y-shaped band of white matter (known as the internal medullary lamina) into three large cell groups: mediodorsal, anterior and lateral. Intralaminar nuclei are found within the lamina itself and a reticular nucleus surrounds the thalamus on the dorsal side.
Functionally, the nuclei of the thalamus can be divided into three categories: relay nuclei, association nuclei and non-specific nuclei. The **relay nuclei** include the geniculate bodies (hearing and vision) and the ventral nuclei which relay tactile and motor information to the cerebral cortex. The relay nuclei function to relay sensory and motor information to the cortex. These nuclei all have reciprocal connections with the cortex, which undoubtedly gives feedback-control on signals sent.
Visual Awareness and the Thalamic Intralaminar Nuclei

Christof Koch

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Pasadena, California 91125

We argue that the current known anatomy of connections between the intralaminar nuclei (ILN) of the thalamus and visual cortical areas makes it unlikely that neuronal activity in the ILN mediates visual awareness. © 1995 Academic Press, Inc.

In the lead article, Bogen (1995) argues that the collection of thalamic nuclei, collectively known as the intralaminar nuclei (ILN), subserves the neuronal mechanism(s) underlying the subjective experience of consciousness (what is sometimes called the Neural Correlate of Consciousness). In his view, neuronal activity in the ILN does not mediate the content of conscious experience—this is the domain of cortex—but the subjective aspects. As Bogen points out, this is not a new proposal, having been advocated already in a related form by Jaspers and Penfield.
Why is vision special?

- Vision is vital
- Information
- Object Localization
- Dominant sense
- 30% of cortex
Perception is analytic – some processes represent shape, others color, others movement...
We perceive objects as unified wholes – but how?

FEATURE-EXTRACTION HYPOTHESIS
What you see is not always what you perceive
Visual receptive fields
Primary visual cortex (V1)
Hemianopia  Visual Field Loss
Quadrantanopia   Visual Field Loss
Fig. 1. Lateral view of the left hemisphere of a rhesus monkey. The shaded area defines the cortical visual tissue in the occipital, temporal and parietal lobes. Arrows schematize two cortical visual pathways, each beginning in primary visual cortex (area OC), diverging within prestriate cortex (areas OB and OA), and then coursing either ventrally into the inferior temporal cortex (areas TEO and TE) or dorsally into the inferior parietal cortex (area PG). Both cortical visual pathways are crucial for higher visual function, the ventral pathway for object vision and the dorsal pathway for spatial vision.

Ungerleider and Mishkin (1982)
Monkey Lesion Data

- Two types of Delayed Response Task
- Monkeys trained to criterion on one of these tasks
- Then task was reversed
- After learning, either temporal or parietal lobe lesioned

Landmark Discrimination Task

Object Discrimination Task
Effects of Lesion on Landmark Task

- Unoperated monkeys show no impairment
- Temporal-lobe lesion monkeys show minimal impairment
- Parietal-lobe lesion monkeys show much impairment
Effects of Lesion on Object Task

- Temporal-lobe lesion monkeys show much impairment
- Parietal-lobe lesion monkeys show minimal impairment
Physiological properties of parietal cells

Both P&M large receptive fields, but parietal non-selective

Single cell recordings from neuron in monkey posterior parietal cortex (PPC). The cell responds to both small and large stimulus, but the magnitude of activity is correlated with the size of the stimulus. Many exclude fovea and cover periphery.
Physiological properties of temporal cells

SCRs from neuron in monkey inferior temporal cortex (ITC). Cells here rarely respond to simple stimuli e.g. lines/spots of light but sensitive to complex objects such as hand drawings. Weak response to mitten – activity not related to general hand shape – neither responsive to comblike objects (despite similar features).
Recall: Is There a unique ncc for...?

seeing a red patch

seeing one's grandmother

feeling angry

Human single-neuron responses at the threshold of conscious recognition

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Raster plots and peristimulus time histograms (PSTH) (100-ms bin size) of a single neuron in the right hippocampus that responded selectively to a picture.

R. Quian Quiroga, et al. (2008)

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Visual Streams – what/how

Milner and Goodale 1991

- Worked with a patient, D.F. with extensive bilateral ventral-stream lesions since 1991.
- D.F. has profound visual form agnosia

It’s the need to act on the stimulus that allows her to perform. She still doesn’t know what it is or (maybe) where it but knows how to post something into it.
Patient DF suggests processing systems make use of different sources of perceptual information. Dorsal system used to locate and guide actions.
Koch’s – Basic assumption

**Coalition of activity**
- Thalamus & cortex

**Duration**
- How long do the neurons need to fire to produce a percept?

**Effects**
- Conscious perception
- If activity is blocked, is the percept disabled?
- Potential for anesthetic?
sufficient activity for conscious percepts

- information is broadcast to many areas in the cortical system

competition

- One coalition of neuronal activity survives while the other coalitions are inhibited or suppressed
Right parietal TMS shortens dominance durations in binocular rivalry.

David Carmel, Vincent Walsh, Nilli Lavie, and Geraint Rees

Current Biology Vol 20 No 18 2010
Define the term Microconsciousness – “to emphasize that the NCC at an essential node for one particular attribute, say color, can be independent of the NCC at another essential node for a different attribute, say motion.”

Koch, 2004
...but I'm blind, I can't see any stripes.

Well just have a guess.

Um... then I guess horizontal red stripes.
Seeing without Seeing? Degraded Conscious Vision in a Blindsight Patient

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Abstract

Blindsight patients, whose primary visual cortex is lesioned, exhibit preserved ability to discriminate visual stimuli presented in their “blind” field, yet report no visual awareness thereof. Blindsight is generally studied in experimental investigations of single patients, as very few patients have been given this “diagnosis”. In our single case study of patient GR, we ask whether blindsight is best described as unconscious vision, or rather as conscious, yet severely degraded vision. In experiment 1 and 2, we successfully replicate the typical findings of previous studies on blindsight. The third experiment, however, suggests that GR’s ability to discriminate amongst visual stimuli does not reflect unconscious vision, but rather degraded, yet conscious vision. As our findings result from using a method for obtaining subjective reports that has not previously used in blindsight studies (but validated in studies of healthy subjects and other patients with brain injury), our results call for a reconsideration of blindsight, and, arguably also of many previous studies of unconscious perception in healthy subjects.


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New pathway

- Retina
- Thalamus (LGN)
- Visual cortex (V1)
- Dorsal (how) pathway
  - Parietal lobes
- Ventral (what) pathway
  - Temporal lobes
OLD pathway

- retina
- Superior Colliculus
- Blind sight
- PARIETAL lobes
Inducing conscious perception of colour in blindsight

Juha Silvanto, Alan Cowey and Vincent Walsh

Current Biology, Vol 18
classic reads, , ,

EYE, BRAIN, AND VISION.
DAVID H. HUBEL.
Scientific American Library
THE REDISCOVERY OF THE MIND.
John R. Searle.
BRIGHT AIR, BRILLIANT FIRE: ON THE MATTER OF THE MIND.
Gerald M. Edelman.
THE FEELING OF WHAT HAPPENS:
BODY AND EMOTION IN THE MAKING
OF CONSCIOUSNESS.
Antonio R. Damasio.
“Mr. Osborne, may I be excused? My brain is full.”
Spatial Neglect: a failure of attention

Copying:

Spontaneous drawing:

Line bisection:

Healthy control

Neglect patient

Ignored portion of space -
These letters are big and easy to read. Is it time for a quick snack yet?
Attention Metaphors

- Spotlight
  - Movable
  - Limited
  - Indivisible
- Zoom lens
  - Change width
  - Change resolution
- Glue
  - Keeps multiple things together
Attention

○ Selective attention
  ○ Ability to focus on one message and ignore all others

○ Divided attention
  ○ Ability to attend to more than one thing at a time

○ Visual attention
  ○ Ability to pick out visual objects or parts of a visual scene
Selective Attention

- Ability to focus on one message and ignore all others
Stroop Effect

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Stroop Effect

Red  Blue  Green  Yellow
Yellow  Red  Blue  Green
Blue  Yellow  Green
Red
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Automatic vs. controlled processes

- **Automatic**
  - Do not require attentional resources
  - Not conscious
  - Well-practiced
  - Fast

- **Controlled**
  - Require attentional resources
  - Conscious
  - Not well-practiced
  - Slow
Visual attention

- **Bottom up**
  - Stimulus salience
    - E.g., color, contrast
  - Saliency map

- **Top down**
  - Scene schema
    - Knowledge
Change Blindness