

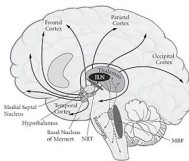
Consciousness I: Visual Awareness

Multiple Meaning of *Conscious*

- Being sentient: the organism responds to its environment
 - Contrast: does not respond to sensory inputs
- Being awake
 - Contrast: being asleep
- Self consciousness: aware of one's self (as an agent)
 - Contrast: a Zen state?
- Phenomenal awareness: "what it is like to be" or attending to one's experience
 - Contrast: Responding without awareness
- Being able to report on one's experience
 - Contrast: Mere processing information

Arousal

- A host of structures in the brainstem and thalamus have been found to play a role in regulating overall state of arousal
 - Reticular activating system
 - Release acetylcholine, noradrenaline/norepinephrine, serotonin, etc.
- Many project to the intralaminar nuclei (ILN)
 - Lesions result in loss of all awareness

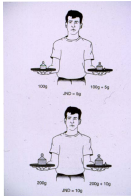


History of Consciousness

- The mind is Inherently conscious
 - "By the word 'thought' ('pensée') I understand all that of which we are conscious as operating in us." (Descartes, *Principles*)
 - "I do not say there is no soul in man because he is not sensible of it in his sleep. But I do say he can not think at any time, waking or sleeping, without being sensible of it. Our being sensible of it is not necessary to anything but our thoughts, and to them it is and to them it always will be necessary." (Locke, *Essay*)
- The emergence of a puzzle: Leibniz's thought experiment
 - Imagine yourself a very tiny person walking through a person's brain--where would you see conscious thought
 - The explanatory gap (Levine)

Psychophysics

- Starting with Weber in the late 19th century, researchers have tried to relate sensory stimuli to their subjective character
 - Weber focused on the minimal change in a stimulus that is detectable: just noticeable difference
 - Represented mathematically:
 $\Delta I/I = K$
 - Fechner extended the idea to a general relation between the intensity of a stimulus and intensity of sensation $\gamma = \lambda \log(I/b)$
 - Stevens proposed a competing power-law account in the 1950s



William James

- Characterizes mental life as conscious:
 - Is purposeful and willful
 - Exhibits intentionality
 - Is something of which we are aware
 - Is private, personal, and uniquely one's own
 - Is always changing--in flux
 - Is sensibly continuous--flows like a stream
 - Is selective, attentive, and interested; it is excited by some features of the world, not by others

What Good is Consciousness?

- Crick and Koch
 - "We have suggested (Crick and Koch, 1995a) that the biological usefulness of visual consciousness in humans is to **produce the best current interpretation of the visual scene** in the light of past experience, either of ourselves or of our ancestors (embodied in our genes), and to **make this interpretation directly available, for a sufficient time, to the parts of the brain that contemplate and plan voluntary motor output**, of one sort or another, including speech."
- Alternative suggestion: enables certain kinds of learning
 - Contrast conscious from automatic responses
 - Episodic memory and long-term planning

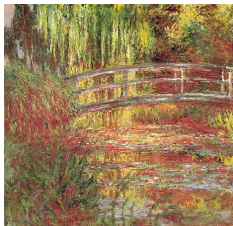
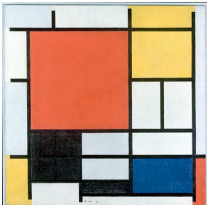
The Disappearance of Consciousness

- Behaviorism: Watson's exclusive focus on behavior
 - Rejected puzzling over consciousness (as introspectionists did) as a distraction for psychology
- The Cognitive Revolution (1950s)
 - The mind returns as an information processing device
 - Little interest in consciousness per se
 - But considerable interest in attention including debates over early versus late selection
 - Exogenous vs. endogenous attention



Phenomenal Consciousness

- There is something that it is like to have a visual, auditory, aromatic, etc., experience



Piet Mondrian - Komposition 244 großer roter Fleck, Gelb, Schwarz, Grau und Blau, 1917 © Fondation Hartmann Brecht, v/o M&K International, Warrington, VA

The Other Minds Problem

- We are aware of our own conscious states (first person perspective)
- But we don't have access to the consciousness of anyone or anything else (third person perspective)
- So how do I know
 - That you are conscious?
 - What your consciousness is like?
 - Whether chimpanzees, dogs, fish, insects, plants, or rocks are conscious?
 - Whether consciousness makes any difference to our life?

Temptations to Dualism

- The conscious states of an organism radically different from us are inaccessible (Nagel: we cannot know what experience is like for a bat)
- Qualitative character (*qualia*) as epiphenomenal
 - The inverted qualia hypothesis
 - The absent qualia hypothesis
- What Mary, Jackson's super-neuroscientist, doesn't and cannot know
 - Living in a black and white world,
Mary becomes the top vision neuroscientist in the world—she wins a Nobel Prize for her work on color vision
 - But she has never seen red
 - When released into the real world, she learns something new—what it is like to experience red



The Zombie Problem

- Chalmers' zombies are creatures that are supposed to process inputs and act just like you, but without consciousness
- Is this a possibility?
 - We do know that information is processed and even responded to without being conscious
 - And blind-sight provides clear evidence that even information we are normally conscious of can affect behavior without being conscious
- The zombie problem presumes that consciousness has no function
 - That we can behave the same whether conscious or not

Clicker Question

On Chalmers's portrayal of a zombie, how could you tell whether a person you are romantically involved with is a zombie?

- Throw water in their face and see how they respond
- Engage them in a detailed discussion about their feelings towards you
- Tell a joke and see whether they understand it
- You can't

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The Search for Neural Correlates

- Crick and Koch defined the project of identifying neural processes that *correlate* with conscious experience (NCC)
 - Quite deliberately they are not setting as the goal to find out what brain process is conscious experience
- Focus on brain processes whose information processing correlates with contents of which we are actually conscious
 - Correlation does require that, whenever the activity with which consciousness correlates occurs, we have a conscious experience
- In part, the goal is to use the brain to figure out what consciousness is
- Because we know more about it, they and others have focused on visual experience

Clicker Question

Crick and Koch set out "that to be aware of an object or event, the brain has to construct a multilevel, explicit, symbolic interpretation of part of the visual scene." They use a face as an example. What is the import of requiring the representation be "explicit"?

- That the interpretation must be communicable to other people
- That the activity of neurons represent something as a face
- It is sufficient that there be activity representing the eyes, nose, and mouth, etc.
- There must be distinct neural activity for each feature—for the eyes, the nose, the mouth, etc.

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How to Identify NCC

- Need some way to assess whether some neural activity is conscious
 - Behavioral measures, including verbal reports
- Block distinguishes
 - Access consciousness--what one can report on verbally
 - Phenomenal consciousness--experiences with a qualitative character
- These can come apart
 - Split brain patients cannot verbally report what is only presented to their left visual field
 - But can perform tasks on such objects with their left hands

Clicker Question

Crick and Koch make extensive use of Milner and Goodale's characterization of the two visual systems. What is important about these two pathways?

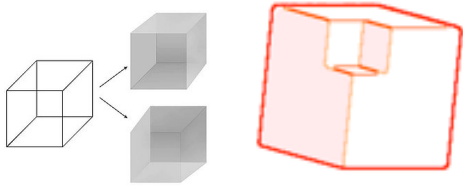
- They involve different types of consciousness—object consciousness and location consciousness
- Only the on-line action system involves conscious awareness
- Only the off-line object system involves conscious awareness
- We are aware only when the two systems are integrated

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What Part of Visual Processing is Conscious

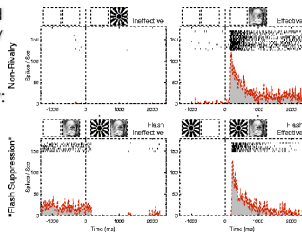
- Following Milner and Goodale, Crick and Koch argue that the system for action is not conscious but that the system for seeing objects--the ventral stream--is
- Only that part of the stream at which representation of a feature of the visual scene is *explicit*
- V1 activity is not conscious
 - The features processed there are not the ones we are aware of
 - V1 does not project to motor areas directly

Use of Bistable Percepts



Clues from Binocular Rivalry

- When different stimuli are presented to the two eyes, only one is consciously perceived
- Logothetis's strategy: identify which neurons follow the changing perception
 - Inferior temporal cortex a likely NCC



Clicker Question

Which of the following constitute Prinz's reasons for rejecting the claim that inferior temporal cortex (ITC) is part of the neural correlate of visual consciousness

Logothetis' evidence is compatible with ITC being an output of conscious stages, not the correlate of the states themselves

Patients with ITC lesions remain visually conscious of what they see—they just cannot categorize what they see

ITC cells respond to objects independently of perspective and location, whereas we are conscious of the orientation and perspective of what is presented

All of the above

Prinz's Alternative Hypothesis

- Frontal cortex:
 - For consciousness to affect action planning, frontal areas do not themselves need to be conscious
 - Much of the control of action is itself not conscious
- Inferotemporal Cortex (IT)
 - Cells represent objects independently of perspective
 - But conscious experience is perspective specific
 - Visual agnosics retain conscious experience but lack knowledge of what they experience
 - The Logothetis evidence is compatible with IT being an output from (and input to) conscious experience

Clicker Question

What, for Prinz, distinguishes extra striate processing that is conscious from that which remains unconsciousness

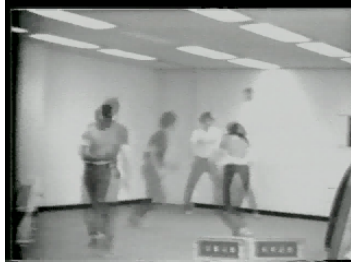
- Binding of features together through synchronized firing
- The strength of the sensory stimulus
- The frequency of the neural activity
- Attentional mechanisms

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Role of Attention in Perceptual Consciousness

- Prinz, in opposition to Crick and Koch, contends that attention is essential to consciousness
 - We don't consciously experience what we don't attend to
 - Mack and Rock--inattentional blindness

Inattention Blindness



Inattention Blindness



Prinz's AIR Theory

- Prinz proposes that attended intermediate representations (V4, MT) are conscious

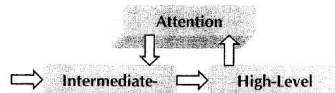
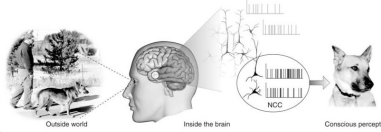


FIG. 5. The circuit that gives rise to consciousness on the AIR theory.

Alternatives: Neural Synchrony Hypothesis

- Puzzle: If different features of objects are processed in different brain areas, how do they get bound together
- Oscillations in the 40 Hz range are common in cortex during cognitive performance
 - Hypotheses: Areas that oscillate in synchrony at about 40 Hz are bound
 - And correspond to the objects of which we are conscious



Alternative: Global Workspace Hypothesis

- Working memory: at a given moment there is a limited amount of information that is active and available for use
 - Miller's (1956) magic number 7 plus or minus 2
 - Often accompanied by inner speech
- But we are able to recruit very different information into working memory
 - Sensory inputs (visual, auditory, tactile, etc.)
 - Information from long term memory
- Hypothesis that this involves temporary global integration of information that is used for reasoning, problem solving, etc.
 - And that this information is what one is conscious of at a given time