NEUROPHILOSOPHICAL FOUNDATIONS

Disciplines of the Mind and Brain

- Once upon a time *philosophy* incorporated all the fields of inquiry other than the applied fields of medicine, law, and theology
  - What came to be identified as the *sciences* were known as *natural philosophy*
    - There were not clear boundaries between philosophy and many other inquiries
- But within universities specialized faculties gradually developed for what came to be identified as the various sciences--physics, chemistry, physiology
  - The brain was a focus of inquiry in physiology as it was in medicine
  - Inquiries into mental activities were pursued both within physiology and in philosophy
  - In the last decade of the 19th century psychology began to be recognized as a separate faculty with the laboratories of Wundt and James
  - Linguistics, anthropology, and computer science eventually became recognized disciplines

Interdisciplinary Research Fields

- Neuroscience: Created in the 1960s to integrate those parts of anatomy, physiology, chemistry, and genetics that focused on the brain
  - Psychology was a very minor player
- Cognitive Science: Established in the 1970s to integrate parts of psychology, computer science, linguistics, anthropology, and philosophy
  - Although listed as a discipline, neuroscience played almost no role
- Cognitive neuroscience: Developed around 1990 with the development of neuroimaging technology that allowed for addressing issues about how cognitive activities (language use, memory encoding) are performed in the human brain

Clicker Question

What was the relation between neuroscience and cognitive science in the 1970s and 1980s?

- They worked closely together in trying to understand how the brain supported cognition
- They were competitors. Each thought it had the most promising way to explain human behavior
- They largely ignored each other as there were not good ways to relate brain activity to cognitive processes
- Neuroscience was a sub-field of cognitive science. It had not yet acquired its own identity

Why the Delay in Relating Psychology to the Brain?

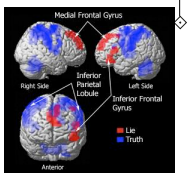
- Practical considerations
  - Most cognitive psychology research is done on humans but there were few tools to study the human brain, structurally or in action
    - Neuropsychology employed naturally occurring lesions, but one often couldn't tell where the lesion occurred
      - Used primarily to differentiate processes through doubled-dissociations, not to relate them to specific brain regions
- Principled objections (raised by philosophers, not psychologists or neuroscientists)
  - Putnam: mental life is multiply realized
    - So the brain tells us little about what accounts for mental activity
  - Fodor: the taxonomy of brain and mind cross-cut each other
    - So there is no mapping from mental activity to the brain, or vice versa

Clicker Question

How does Fodor invoke money in his discussion of how the taxonomies of different disciplines might cross-cut each other?

- He argued that it was lack of money that prevented neuroscience from developing an appropriate taxonomy for studying cognition
- He argued that just as the material study of money cross-cuts the economic study of money, neuroscience and cognitive taxonomies cross-cut each other
- He argued that just as economics lacks an explanatory taxonomy, so does psychology—one must turn to neuroscience for the correct taxonomy of brain processes

The Allure of Neuroimaging

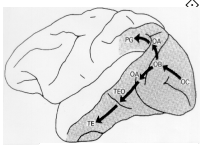


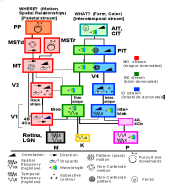
- The development of technology that enabled researchers to record activity in the brain as people performed cognitive tasks was highly captivating--especially the false-colored images of brains at work
  - The public became fascinated by the idea that imaging provided a way to read one's thoughts
  - The legal system was excited by the prospect of detecting lies and other aspects of human behavior
  - Neuroscientists became excited by the idea that they might be able to explain human behavior
  - Psychologists became excited by the prospect of grounding their accounts on secure empirical foundations
    - So much so that psychologists who didn't do imaging found it difficult to secure employment

Philosophy After Her Children Left Home

- After scientists created their own disciplines, philosophers were left, for the most part, to address what they take to be foundational questions about the nature of knowledge, the types of things that exist, and the source and status of value
  - And not factual questions about the processes of knowledge acquisition, the specific properties of things, or the values given individuals or cultures adopt
- Division between pure and naturalized philosophy
  - For some philosophers, the questions of philosophy can and ought to be pursued by purely philosophical techniques
    - Conceptual analysis, fitting intuitions, phenomenological analysis
  - For others, philosophy should be continuous with the sciences
    - Invoking results in the sciences to address philosophical questions and maybe even contributing to the sciences
      - At least in helping them understand themselves

Example: Vision and Diagrams





- Philosophical accounts of science have emphasized reasoning and logic--scientific inquiry as an exemplar of rational inquiry
  - Logic operates on linguistic symbols
- But our primate brains seem primarily developed for vision and processing information presented visually
  - And scientists often rely on visual representations/ diagrams to present their results and theories
    - And conduct their reasoning in terms of them
- A few researchers in cognitive science have noted that diagrams encode information differently than linguistic representations
  - And emphasize the close connection between how information is represented and how it is processed
  - A very few philosophers have started to inquire as to how people (sometimes scientists) reason with diagrams

Neurophilosophy vs. Philosophy of Neuroscience

- (Naturalized) philosophers interested in neuroscience tend to divide into two clusters
  - Those who see neuroscience as helpful in addressing philosophical questions–*Neurophilosophy*
    - What is the mind?
    - What is our self? How do we know it? What does it do?
    - What is consciousness? Does it matter to how we behave?
    - In what sense, if any, are people free agents?
  - Those who seek to understand the nature of science using neuroscience as a model–*Philosophy of Neuroscience*
    - What suffices to explain phenomena?
    - How are explanations developed and evaluated?
    - How do explanations of the different sciences relate to one another?

Example of Neurophilosophy: What is a Mind?

- Traditional views (long-predating neuroscience)
  - Materialism–the mind just is a material substance
  - Dualism–mind is a different type of substance than matter
  - Philosophical behaviorism–materialism and dualism both commit a category mistake–minds are not things (material or immaterial)
    - Mental processes are manifest in behavior
- Neurophilosophical Views
  - Identity theory–a mental activity just is a specific activity in some part of the brain
  - Functionalism–a mental activity is an organized function where that function may be realized in things other than the brain
    - Martians, computers, other species
      - For some functionalists, this shows the folly of studying the brain to learn about the mind

The "Received" Philosophy of Science

- Deductive-nomological model of explanation (as articulated in the mid-20th century)
  - Explanation involves deriving a statement of the phenomenon to be explained from laws and statements of initial conditions:

    Laws (Newton's force law: $f=ma$)

    Initial conditions (object of a given mass is acted upon by a specific force

    ∴ Phenomenon to be explained (Object will experience a specific acceleration)
- Hypothetical-deductive method
  - The scientific enterprise is grounded in observations
  - Hypotheses (laws) advanced to explain observations
  - They are evaluated in terms of what phenomena could be explained from them
    - If the prediction is false, reject the hypothesis (maybe!)
    - If it is true, the hypothesis is supported/confirmed (maybe!)

Clicker Question

Which of the following is not a explicit feature of a covering-law or deductive-nomological explanation?

- Laws
- Initial conditions
- Causal interactions of parts
- Events to be explained

Foundationalism and Reductonism

- Empirical Foundations
  - All our knowledge of the world is grounded ultimately in sensory experience, which we then represent in *observation sentences*
  - Hypotheses generated to account for observation sentences already accepted and tested against them and new ones resulting from further experience
  - Instruments simply extended this ability to acquire observations
- Reductionism
  - Every science develops its own observation sentences and generates hypotheses to account for these
  - But some sciences are more basic—e.g., physics
  - Hypotheses/laws of higher sciences should ultimately be derivable from those of physics

Confirmation and Falsification

- Hypotheses/laws are general—they apply not only to the observation sentences known when they were advanced, but to future conditions
  - When the conclusion of the D-N is a unknown event, we speak of prediction, not explanation
- Successful predictions are thought to provide evidence for/confirm the hypotheses or laws from which they are generated
- Popper, however, noted that the inference underlying confirmation is invalid

  If the law is true, my prediction will be true
  <u>My prediction is true</u>
  ∴The law is true
- Popper contended that one can only falsify, not confirm hypotheses
  - The method of science is to conjecture (advance hypotheses) and refute (eliminate those that make false predictions)

Kuhn's Challenge

- 1962: in *The Structure of Scientific Revolutions* Kuhn offered an account of how science changes over time
  - Not through the accumulation of new facts brought under a gradually expanding body of laws
  - But through revolutionary changes in which old frameworks are rejected and new ones advanced
    - Newton did not expand Aristotle's physics--he replaced it
      - Circular motion is not basic--linear motion is
    - Einstein did not expand Newton's physics--he replaced it
      - There is no absolute rest--only a maximum velocity
    - Cognitive psychology did not expand on behaviorism--it replaced it
      - Mental processes are not just mini S-R connections but involve rules operating over representations

Discussion Question

Might the development of neuroscience represent a Kuhnian revolution in which neuroscience replaces cognitive psychology and cognitive science

Yes. Studying the brain is a replacement for studying behavior

No. Studying the brain won't answer many of the questions addressed to psychology and cognitive science

No. Studies of the brain in fact draw upon cognitive psychology and cognitive science to identify the characterize the operations through which the brain generates behavior

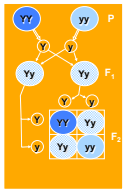
Other

Kuhn's Normal Science

- Kuhn wondered why people thought revolutions were the main subject of *The Structure of Scientific Revolutions*?????
  - He thought that his account of normal science was far more important
    - For him, scientists are typically not testing big theories, but forcing nature to fit the then accepted world view (paradigm)
      - Making all behavior fit an S-R or operant conditioning model (e.g., Skinner's account of verbal behavior)
      - Only when nature resists too much will change (the cognitive revolution) happen
        - And such change will not be governed by reason since the basis for reasoning is placed in question
- Independent of Kuhn's particular account of normal science, he transformed how many philosophers approach science
  - Many began to look to actual science to see how it works and not assume it fits an a priori logical framework

Biology and Mechanistic Explanation

- Despite the received view's focus on laws, biologists (including neuroscientists) seldom refer to laws (except laws of chemistry and physics, as appropriate)
- Apparent counter example: Mendel's laws of dominance, segregation, and independent assortment
  - None of which are true (there are exceptions to each)
  - What Mendel did offer was a sketch of a mechanism of inheritance
    - He posited factors, a process through which they were inherited, and a account of how they related to traits
    - He had no evidence for the mechanism other than that it gave the right answers to inheritance patterns in peas
    - But in the 20th century Mendel's factors were named *genes*, their location on chromosomes established, their composition out of DNA was determined, and the mechanism by which they are expressed in proteins discovered



Characterizations of Mechanisms

- Machamer, Darden, and Craver [MDC] (2000)
  - "Mechanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions"
- Bechtel and Abrahamsen (2005, cf. Bechtel and Richardson, 1993):
  - "A mechanism is a structure performing a function in virtue of its component parts, component operations, and their organization. The orchestrated functioning of the mechanism is responsible for one or more phenomena"
- Besides the incidental differences in vocabulary, the major difference involves the last phrase of MDC—imposing an order from start to termination conditions

Mechanistic Versus Nomological Explanations

- Both nomological and mechanistic explanations can be concerned with causal phenomena—something happens which brings about something else
  - Nomological explanations focus on the regularity (law) characterizing the change itself and does not specifically identify causes
  - Critical feature of mechanistic accounts is that they focus on the system in which change is occurring and ask what is going on inside to produce its behavior—specific causes
    - Laws are not central to mechanistic accounts (they may be invoked to characterize operations, but they need not be)
- Mechanistic explanations are not presented as logical arguments
  - Whereas in D-N explanations logic is the "glue" that links laws and initial conditions to phenomena being explained, in mechanistic explanations scientists model (mentally, physically, or computationally) how the parts and operations produce the phenomenon

Features of Mechanistic Explanations

- Dualism of Parts and Operations
  - Operations are the producers of changes
    - Types of causings
  - Parts are the things that engage in operations
- Organization:
  - Productive continuity: operations must link entities into a continuous network
  - In biological mechanisms, the organization is often extremely complex (simultaneous interactions, feedback loops, etc.)

Decomposition and Recomposition

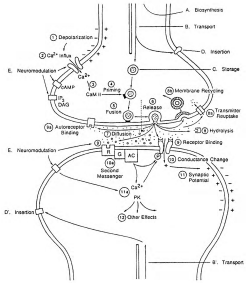
- To discover the parts and operations within a mechanism researchers must **decompose** it
  - Adopt strategies to reveal the parts and what they are doing
    - Researchers must be creative in designing ways to reveal parts and operations
    - In the case of the visual system, it took 150 years to identify the main brain areas and determine what some of them do
- But individual parts don't by themselves produce the phenomenon to be explained
  - Researchers must develop ways to **recompose** the mechanism
    - Mentally in their heads
    - In diagrams
    - Physically in scale models
    - Computationally using mathematical simulations

Mentally Simulating Mechanisms

- An early example in Machamer, Darden, and Craver:
  - In the mechanism of chemical neurotransmission, a presynaptic neuron transmits a signal to a post-synaptic neuron by releasing neurotransmitter molecules that diffuse across the synaptic cleft, bind to receptors, and so depolarize the post-synaptic cell
- The account has the form of a narrative—relating a sequence of happenings
  - Each of these occurs at a place and in a relative time order
  - This narration invites one to visually imagine the events and to see them happening in a connected fashion
    - As one might imagine the activities in a human-made device
- Understanding such narratives becomes challenging when multiple activities are occurring at once or where operations thought of as later feed back to modify operations thought of as earlier

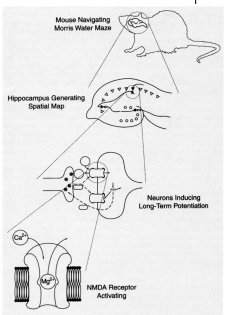
Diagrams of Mechanisms

- Often mechanisms are explicitly presented visually in diagrams
  - Iconic shapes or text labels are used to designate parts
  - Often arrows are used to indicate activities such as transport of substances or reactions
    - Sometimes arrows are labeled with text
- In this case the sequence of steps is noted with numbers
  - But a viewer does not have to follow the sequence specified but can direct attention to new areas of interest



Hierarchy of Mechanisms

- The entities (parts) of a mechanism may themselves be mechanisms
  - One explains how they perform the activity (operation) in virtue of the parts and operations within them
  - Important to note that there is now a new explanatory goal—explain the operation within the previous mechanism
- Explanatory hierarchies bottom out in activities left unexplained
  - The question that motivated the inquiry can be answered without explaining these activities
  - Someone else, however, may find it worthwhile to explain them
  - Or some puzzles arise that require investigating them



Contrasting Meanings of Reduction

- *Reduction* generically refers to explaining a given phenomenon in terms of something more basic
- But the alternative senses of explanation offer a different view of reduction
  - On the received view, laws are central to explanation
    - Laws are in turn explained by deriving them from more basic laws

      Laws of reducing science (Neuroscience)

      Boundary Conditions

      ∴ Laws of the reduced science (Psychology)
  - On the mechanistic picture, the operations of parts of a mechanism are explained by decomposing them into their own parts and operations
    - But at each level one must recompose the parts—understand how they are organized so as to work together
    - The lower-level parts are not privileged since we also need to understand the organization and context in which the mechanism functions,, which is not found at the lower-level