Nature vs Nurture: A Historical Perspective

● Learning arose in early speculations about intelligence and the brain.

● Observations without scientific method can lead to claims without testability.

● Scientific observations must be FALSIFIABLE—Karl R. Popper. and therefore testable.

● In early learning research-- this was not the case....
State of Psychology 400 BC-14th Century “Psychology”

Aristotle (348 BC) and the Egyptians localized the “mind” in the Heart. But “judgement” in the kidneys.

Despite Pythagoras (500 BC) thought that the Brain was the seat of intelligence.

Galen (100 AD) believed that the brain ventricles as reservoirs of the vital forces --“animal spirits” which then flowed to the heart and distributed through the body.

1500 years later, however, Cardio-centered theories of the mind were still considered true.
Mind-Body problem

- By the 12th century –mind firmly located in the brain. But anatomists-physiologists—liked to still guess what it did.

- Albertus Magnus(12th) located “feeling” to anterior ventricle and “memory” to the posterior ventricle. “Imagination” moved around alot.

- Willis (17th), an anatomist, placed memory and the “will” in the convolutions of the brain, imagination in the corpus callosum, perception in the corpus striatum and various emotions in the cerebrum.

- This type of speculation gave rise to Gall (19th) and Phrenology—the early notion that mental function could be located in brain.
Albertus Magnus

The three ventricles “feelings”, “memory” and the “soul”.
Gall and Phrenology

Franz Joseph Gall
Dr. der Arzneykunst zu Wien.

[Image: Portrait of Franz Joseph Gall]

Names, Numbers, and Location of the Organs

1. Amativeness
2. Conjugal Love
3. Parental Love
4. Friendship
5. Inheritance
6. Continuity
7. Constructiveness
8. Alimentiveness
9. Acquisitiveness
10. Secretiveness
11. Cautionness
12. Approbativeness
13. Self-Esteem
14. Firmness
15. Conscientiousness
16. Hope
17. Spirituality
18. Veneration
19. Benevolence
20. Constructiveness
21. Ideality
22. Sublimity
23. Imitation
24. Mirth
25. Individuality
26. Size
27. Weight
28. Color
29. Order
30. Calculation
31. Locality
32. Eventuality
33. Time
34. Taste
35. Language
36. Causality
37. Comparison
38. Human Nature
39. Gravity

[Diagram: Phrenology chart with numbered areas correlating to different names and characteristics]
Mind-Body Problem Again

- **Philosopher-psychologists** (16th century) were more concerned about the “seat of the soul”.

- Decarte (1596-1650) localized the soul in the pineal gland but more as a point of entry or interface between mind and body. This dualism in some ways allows the study of learning or cognitive function to be independent of the brain (“material”) this appeared as a “fact” in Lotze's volume on Medical Psychology as late as 1852!

- The effective impetus to the BRAIN being the organ of the MIND came in the 19th century finally with B. Rush (u.k.), P. Pinel (france) and W. Tuke (u.s.) who all independently proposed reform of treatment for the growing Insane populations. In effect afflictions of the MIND as disease.. pushing the Mind wholly into physiology.
Pineal Gland “third eye”

- Causes Feeling of Sleepiness
- Converts Nervous System Signals to Endocrine Signals
- Regulates Endocrine Functions
- Secretes the Hormone Melatonin
Origins of Learning Theory

- The origins of learning theory were entangled with the origins of Science.
- French and British were persuaded by Newton and Voltaire that science was mathematical and deductive.
- Biology—early physiology was based on observation—Galen (129-199 AD), Magnus (12th), Da Vinci (16th) dissection of bodies legal by 11th century.
- Germans were persuaded by Kant (Critique of Pure Reason, 1781) science was deductive but based on observation and thinking a lot—this lead to
- “Phenomenology” --Expert Observation (was the origin of experimental psychology --a taxonomy of “consciousness” and Introspection movement (Wundt, Tichtner, 1880s)
Rationalism

- Descartes, 17th Century, “I doubt therefore I exist”.
- Kant, Plato.

Claims:

Ideas are Innate:
- Knowledge about oneself
- Knowledge about Perfection (“God”)
- Knowledge about causality
Rationalism: Deduce facts about the world

- Once you determine which ideas are innate (fundamental ideas of the world; atoms of the world)
- Then Descartes or Kant would say, one can prove a theorem, like in geometry or any mathematical domain.
- Reasoning + Innate ideas = everything in world.
Rationalism Critique

- But what are innate ideas? Where do we draw the line?
- Identity, causality, perfection
- Other people, animals, stars, time, gravity...
- But what about: cars?, shoes?, bears?, Art Deco?, Phones?
- Fodor's response.
Introspection

- Rationalism led to a specific kind of methodology for studying the mind:
- Phenomenology, later termed Instrospection
  - Goethe attacks Newton's theory of Color (visible light composed of different frequencies) in a book --"Colours--1840"
  - Goethe book was based entirely on his sense perceptions and reasoning!
  - Newton of course had correct version 100 years earlier.
  - But in the 19th century Goethe book on color theory was extremely popular.
Wundt & Titchener (20th)

Introspectionism: highly trained observer observes some simple event - one that could be measured by quality, intensity, or duration - and records his/her responses to variations of those events.

Involves systematic analysis one's own mental experience in order to identify its elements.

“what does a flower smell like?” “what is roughness?” “How are you seeing?”

Empirical—no theory, 1000s of descriptions published and little consensus, due to lack of controls and lack of agreed consensus—Simon-verbal protocols --70s.
Empiricism

- British Empiricists
- In response to rationalism which had dominated philosophical thought for decades; focused on how “ideas” came about.
  - John Locke “the blank slate”, Berkeley, “mind determines matter”, Hume “Causality looks like contiguity”
- Three major tenets:
  - Associationism
  - Reductionism
  - Mechanistic
Bishop Berkeley (18th Century)

- 1. Our perceptions of objects are all perfectly accurate and objective.
- 2. Any knowledge of the empirical world is to be obtained only through direct perception.
- 3. Error comes about through thinking about what we perceive.
- 4. Knowledge of the empirical world of people and things and actions around us may be purified and perfected merely by stripping away all thought (and with it language) from our pure perceptions.

From this it follows that:

- 1. The ideal form of scientific knowledge is to be obtained by pursuing pure de-intellectualized perceptions.
- 2. If we would pursue these, we would be able to obtain the deepest insights into the natural world and the world of human thought and action which is available to man.
- 3. The goal of all science, therefore, is to de-intellectualize or de-conceptualize, and thereby purify, our perceptions.
The Doors of Perception

"If the doors of perception were cleansed every thing would appear to man as it is, infinite. For man has closed himself up, till he sees all things thru' narrow chinks of his cavern."

-- William Blake (19th century)
1. Associationism

• Began as a theory about how ideas combine in the mind by John Locke

• John Locke (1632-1704) was an Enlightenment philosopher. An Englishman, Locke's notions of "government with the consent of the governed" and man's natural rights (life, liberty, and estate) lead to the American revolution.

• Locke was one of the British Empiricists, which also included David Hume and George Berkeley. This group of philosophers maintained

  • born without innate capabilities—tabula rasa—blank slate.
  • Representations as result of experiences-- learning
  • Mind is a mirror of representations of nature
  • Naturalism--Rousseau
  • Simple processes (study of animals)

empirical methodology begun by the associationists kept its stronghold, and before the end of the nineteenth century experiments were conducted in areas such as memory (Ebbinghaus) and Animal Learning (Pavlov, Thorndike) (early 20th )
2. Reductionism

- More complex concepts result from simpler concepts:
- Red apple == Red + apple
- Simple associations lead to more complex associations
- Laws of more basic sciences can be used to explain less basic
  - Physics can explain chemistry
  - Biology can explain psychology etc.
3. Mechanistic

- The world as a big “machine”.
- The machine could be grasped by human experience.
- Empiricism maintained that different areas of knowledge were independent, hence ethics could not explain physics, physics could not explain politics.
- Segregation of knowledge sped progress in each field.
Hume and causality

- Causality is "the cement of the universe"
- All we observe is one billiard bill hitting another and the second moving. "This is the whole that appears to the outward senses. The mind feels no sentiment or inward impression from this succession of objects: Consequently, there is not, in any single, particular instance of cause and effect, anything which can suggest the idea of power or necessary connexion."
- Hume maintained that we cannot differentiate between true causal connections and contiguity in space and time. In effect for the observer there is no difference.
Michotte 1970 (causality)

- Flash Demo:
- http://cogweb.ucla.edu/Discourse/Narrative/michotte-demo.swf
Casuality in the pigeon (Killeen, 1979)

Can non-verbal animals detect causality?

Pigeon is presented with 3 keys. The middle key is white and the pigeon is trained to respond to it. At some point it goes out and a RED key (I caused) or GREEN key (Uncaused) is presented. Unbeknownst to the pigeon is that the computer is responding at the same rate an pattern that it is and arrange a choice at a fixed time distance from 10ms to 1sec from its last response.
Based on a fixed time distance that varied from 50-70ms, animals could not determine whether they caused the event or it was uncaused. After 500ms they were 100% sure they did not cause it. However, paying them off for saying “I caused it” longer delays made them “lie”.

Killeen (Causality in the Pigeon)
Rationalism-Empiricism
Into the 20\textsuperscript{th} Century

- Over the last century there has been a tug-of-war between rationalism and empiricism.
- Recall that Psychology was deeply into rationalism --
  - Introspectionism
  - Gestaltism
Associationism & the Rise of Behaviorism

- Pavlov- Classical Conditioning (1890)
- Thorndike—Law of Effect (1900) technology of Associationism was invented!
- Watson.. (1900)
  - "Give me a dozen healthy infants, well-formed, and my own specified world to bring them up and I'll guarantee to take any one at random and train him to become any type of specialist I might select--doctor, lawyer, merchant-chief, and yes, even beggarman and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors." (1930)
  - Case of little Albert-- danger of associationism
  - Psychology as Behaviorists View it (J.B. Watson: 1913)
- 1900-1960s Rationalism, Introspectionism literally stamped out by Watson and others.
Rise of Neural Networks
1950-1970

Final Nails in the Rationalist Coffin

McCulloch and Pitts Proves theorems

Brain == Computer

Hebbian Learning rule -- neural associationism

1956 Dartmouth Meeting Cognitive Science invented

1957 - Rosenblatt announces new Learning Machine the PERCEPTRON
The Return of Rationalism 1956-1970

- Perception—Nativism, Gestalt
- Linguistics 1950-60s
- Artificial Intelligence—The New Rationalism
Perception as Wholistic

• Helmholtz and Herring. (1900)

• Herring held that retinal receptors had built in left-right/up-down binary responses built in from birth. Percp Nativist

• Helmholtz held that sensory channels interacted in some dynamic way producing combinations sensory input that could be independently factored

• Gestaltism-- configural information not dependent in any additive way on simpler information—contradicting associationism
Perception Examples

- http://dragon.uml.edu/psych/illusion.html
Gestalt Theory
Koffka & Kohler
Problems in Insight learning

• Kohler was trapped on a island during WWI and started these studies with 6 apes that happened to be in the compound he was in charge of.

• Only one of his Apes was able to do the insight task –Sultan.. and examination of his notebooks.. suggested.. that the apes would stack boxes and swing sticks quite independent of the task—worse apparently Sultan was coaxed to climb the boxes and swing his stick at the bannana.
The trouble with Language

• Associationism cannot obviously account for language!
• “The boy threw the ball”
• Article noun verb article noun
• Noun phrase -verb phrase
• Sentence
• Hierarchial and recursive (np(np)-vp)
Chomsky --1950s

• The Dartmouth meeting 1956.

• Three talks back to back:
  – G. Miller – memory limited buffer 7+-2
  – A. Newell- computer program could prove mathematical theorems
    - Showing that Human Language cannot be accounted for by very simple grammars.
    - Also produced the Chomsky Hierarchy
Learning is EASY & HARD!

- **Perceptron Convergence Theorem**—Frank Roseblatt—1961—Proved that any Classifier guaranteed to learn simple classifications in FINITE TIME.

- **GOLD's Theorem—1967**—Proved that learning from POSITIVE EXAMPLES ONLY IS IMPOSSIBLE!

- **Minsky & Papert—1969**—Proved that learning HARD classifications—not just Hard—but IMPOSSIBLE!
The effect of the Negative Learning Theorems

Gold's theorem produced a CHILL on language Learning research for almost 30 years!

Minsky and Papert's theorem almost STAMPED OUT Neural networks for 40 years!
Re-Attack of Empiricism: Connectionism 1986-?

1986-- Parallel Distributed Processing Rumelhart & McClelland.

Backpropagation invented... undoes Minsky and Papert!

1000s of people enter the field. First Neural Information Processing Conference 1500 attendees 1987.

Cognitive Science dominated by Connectionism for the next 15 years.
Connectionism Flourishes

Connectionism flourishes

1. combines associationism and gestaltism (but not in a rationalist way)
2. materialism-- neural versimulitude
3. learning
4. rules
5. abstraction

But no system level principles... More on this later.
Rationalism Returns yet again! The Pinker attacks.

- A more virulent form-- Biological Determinism
- Language as modular and a matter of maturation. Most cognitive traits may be!
- Pinker & Prince: Past tense -- a simple case
- McClelland and Rumelhart have a simple model which accounts verb forms.
- Pinker & Prince argues that it fails since regular verbs require a “rule” and irregular verbs require some similarity based on phonemic patterns.
Two Kinds of Verbs?

- Pinker and Prince argued:

  Regular verbs (rule add “ed”):
  - talk--talked
  - jump—jumped
  - laugh—laughed
  - live--lived

  Irregular Verbs (similarity-association?):
  - sing--sang
  - drink—drank
  - think—thought
  - sit--sat

  Children often make irregular errors—over applying “ed” rule
  - run---runned, hit--hitted
Thorndike's Connectionism

Next time we look at the Rise of Associationism in the early 20th Century and how Learning was first studied.