Issues and Methods

Psyc 6200, CSCI 6402, etc.

Instructors

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Text: Pinker, S. “How the Mind Works”

Lots of reading!

Requirements

Six to eight sets of short essay questions

Term paper

Book review

Review of literature on a selected topic

E-mail, the Web, etc
Class Discussion List

Logon to your e-mail account. Persons using web-based email accounts should take care when sending their subscribe messages. Do NOT send specially-formatted messages, for example, messages with colors, backgrounds, etc.

You sign up by sending an e-mail message to listproc@psych.colorado.edu.

The program is really stupid. Your message must start on the first line and exactly follow the template below. The body of the message should be:

subscribe issues-methods Your name

followed by several blank lines

For example, a student named John Doe would sign up by sending:

subscribe issues-methods John Doe

You will get an e-mail message back from the system saying that you have successfully registered.
## Tentative Outline

<table>
<thead>
<tr>
<th>Dates</th>
<th>Topic</th>
<th>pinker</th>
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<tr>
<td>1/15-17</td>
<td>Intro to course and basic themes</td>
<td>Ch. 1</td>
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<tr>
<td>1/22-24</td>
<td>The computational model of mind; intro</td>
<td>Ch. 2</td>
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<td>1/29-31</td>
<td>Problem solving as a model of mind</td>
<td>Ch. 2</td>
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<tr>
<td>2/5-7</td>
<td>Generate and test; Connectionist models;</td>
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<td>2/12-14</td>
<td>Rule based models of skill acquisition &amp; expertise</td>
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<td>2/19-21</td>
<td>Evolutionary psychology: an introduction</td>
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<td>2/26-28</td>
<td>Vision: Computational and neuroscience</td>
<td>Ch. 4</td>
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<td>3/5-7</td>
<td>continued</td>
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<td>3/12-14</td>
<td>Language: Pinker verses Donald</td>
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<td>3/19-21</td>
<td>Infant cognition</td>
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<td>3/26 –3/28</td>
<td>Spring break</td>
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<td>4/2-4</td>
<td>Judgment and decision making</td>
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<td>4/9-11</td>
<td>Game theoretic approaches</td>
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<td>4/23-25</td>
<td>Creativity, Scientific Discovery</td>
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<td>4/30-5/2</td>
<td>Culture and cognition</td>
<td>Ch. 7</td>
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Outline of Today’s Lecture

Introduction to Computational Model of Mind (Continued)
  Questions from last lecture
  Wrapping up the levels issue
  Production Systems
  Connectionism

Introduction to Evolutionary Psychology
  The Role of Biological Evolution in Cognitive Science
  Pinker verses Tomasello
  A Time Line
Cognitive Architectures

The fixed structure that realizes a symbol system

[Knowledge Level]

[Symbol Level]

[Functional Architecture (Pylyshyn and Anderson)]

[Neural-Circuit Level]

All the same physical system — A matter of description

*Fixed* can mean changing relatively slowly

<table>
<thead>
<tr>
<th>Lifetime</th>
<th>$10^9$ s</th>
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<tbody>
<tr>
<td>Development</td>
<td>$10^6$ s</td>
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<tr>
<td>Skill acquisition</td>
<td>$10^3$ s</td>
</tr>
<tr>
<td>Knowledge acquisition</td>
<td>10 s</td>
</tr>
<tr>
<td>Internal actions</td>
<td>$10^{-1}$ s</td>
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</table>

Architecture change?
Production Systems


Production System

RULES
- Describe Knowledge Required to Perform Task
- Rules, Productions
  IF condition THEN action (Condition- Action Pair)
  IF (Goal and a specific situation)
  THEN (do actions)

WORKING MEMORY
- Symbolic Data, Working Memory Elements
  • Current Goals
  • Symbolic Representation of External World

Recognize-Act Cycle
The Human Information Processing System as a Production System

Newell and Simon (1972, pp. 804-5)

1. Capable of expressing arbitrary calculations.

2. Homogeneous representation of control information.

3. Each rule of an independent fragment of behavior. Implications for learning and skill acquisition.

4. Strong stimulus-response flavor; historical implications.

5. Meaningful elements of a complete skill.

6. Working Memory equivalent to Short Term Memory.

7. Rules possible general model for long term memory.

8. Nice balance between goal-direct and stimulus-bound control.

9. Parallel recognition process with serial action generation process.
Production Systems and Wetware

How Do We Build Rule Following Computer System Out of Neurons?

Mulloch and Pitts “Neurons” to Logic Gates
Logic Gates to a Register Machine
A Register Machine Is A Turning Machine
But, real neurons are not organized directly into a register machine

Connectionism

Densely Interconnected Networks and Auto-Associators

Content addressable memory
“Graceful degradation” or pattern completion
Constraint satisfaction
Hard (symbolic) verses soft (real) constraints

Tradeoffs
Generalization
Learning

Build a Rule Following Machine Out of Connectionist Parts
Where Is Pinker Leading Us?
And Do We Want to Follow Him?

Chapter 3: Revenge of the Nerds
   Get Smart
   Life’s Designer
   The Blind Programmer
   Instinct and Intelligence
   The Cognitive Niche
   Why Us?
   What Now?
Problems With Modern Research On Cognition

Merlin Donald’s Observations About Cognitive Science
   Based on the study of two kinds of minds
   1) Literate young adults
   2) Computer simulations

Ignoring
   Origins of language and other cognitive functions
   Evolution
   Culture, Science, Fads, ....

Depressing View of Human Abilities
   Schacter, D. Seven Sins of Memory
   Not logical
   Bad statisticians
   Poor decision makers

The Standard Social Science Model
   Content Free Models of Mind, e.g., Logic, Probability, etc.
   Information Processing Models of Cognition
Cosmides and Tooby: The Standard Social Science Model is Wrong

Where Social and Cognitive Sciences Went Astray

The Standard Social Science Model (SSSM) (C&T)

All Specific Content Of Human Mind Originally Derives From The "Outside"

from the environment and the social world
general learning and reasoning mechanisms

Small Number Of General Purpose Mental Mechanisms

have no pre-existing content built-in to their procedures
not designed to construct certain contents more readily than others
have no features specialized for processing particular kinds of content.

The Depressing Conclusions About Human Capabilities Are Wrong
Cosmides and Tooby: Evolutionary Psychology

Human minds have a standard collection of reasoning and regulatory circuits that are
Functionally specialized
Frequently, domain-specific
Modules that are analogous to organs
Design by evolution
Designed to solve problems faced by our hunter-gatherer ancestors

Vision
Hearing
Motor Control
Memory Systems
Language
Concept Formation and Reasoning
  Physical causation
  About plants and animals (natural kinds)
  About artifacts
Species Unique Human Behaviors
Tomasello (1999, p 510)

Creation and Use of Symbols
Proto Languages?????
Spoken and Written Language
Mathematics, etc
Start of complex symbol use, 6,000 years ago

Creation and Use of Complex Tools
Starting 50,000 years ago
Only very basic stone tools for 1st 2 million years

Creating and Participation in Complex Social Organizations and Institutions

Political Organizations (From Diamond)
Bands 10s to 150 before 11,000 bc
Tribes 100s after 11,000 bc
Chiefdoms 1,000s after 5,500 bc
States >100,000 3,700 bc (Mesopotamia)
approx. 500 bc (China, Mesoamerica)
All This Occurred In A Very Short Time Span

6 Million Years Ago: Split Between Humans and Apes
Next 4 Million Years: Various Species of Australopithicines
  Brain size around 500cc (Ape like)
  Bipedal
Last 2 Million Years; Genius Homo
Last 50,000: Clear evidence of human culture

Too little time for the evolution to have generated big differences in ape and human cognition

Find small difference that generates huge differences in behavior
What Are The Big Issues in The Evolution of Cognition

What Drove the Evolution of Cognition?

Changes in the Environment (Jungle to Savanna)
Challenges Defined by Hunter-Gatherer Life Style
Within Group Social Processes
  Within Group Conflict and Competition
  Coalition Formation and Maintenance
  Reciprocal Altruism
  Child Rearing
  Sexual Competition
  Hunting
Between Group Conflict
  Competition Between Bands
  Competition Between Different Species of Homo

**THE BIG ISSUE:** Language
  costs, benefits
  intermediate steps
  modern cognition => grammar?
  grammar => modern cognition?
What Are The Big Issues (Cont.)

What Were the Major Steps

Common ancestor, Australopithecines, homo erectus,

brain size
range
culture

social organization
tools
evidence for proto-languages
Overview 2

Approximate Time-Line For The Succession Of Hominids, In Years Before Present (Donald, 1991)

5-6 million years ago: Hominid line and chimpanzee line split from a common ancestor

• tool use
• social organization/group size
• learning by imitation(?)
• precursors of language (?)

4 million years: Oldest known australopithecines

• erect posture
• shared food
• division of labor
• nuclear family structure
• larger number of children
• long weaning period

2 million year ago: Oldest known habilines

• as above, with crude stone-cutting tools
• variable but larger brain size
Time Line (Continued)

1.5 million years ago: *Homo erectus*

- much larger brain
- more complex social organization
- hunting large animals (?)
- more elaborate tools
- migration out of Africa
- use of fire, shelters
Time Line (Continued)

300,000 ya: archaic sapient humans
- second major increase in brain size
- anatomy of vocal tract starts to assume modern form
- tools: very similar to *erectus*
- social organization: very similar to *erectus*

.150 to 200,000 ya: modern humans
- mitochondrial Ev
- tools: similar to *erectus*
- social organization: similar to *erectus*
Overview 2

Time Line (Continued)

50,000 ya: Fully modern humans

Language

• high-speed vocal communication system
• large lexicon containing thousands of entries.

Complex oral cultures

• myth, religion, and social ritual
• specialize, complex, multi-component tools and weapons
• sewn clothing
• cave painting, jewelry
• modern hunter-gatherer cultures

12,000 ya: The Great Leap Forward

domestication of plants and animals ~12,000 ya
writing before 6,000 ya
phonetic alphabets ~5,000 ya