Evolution of the Human Mind (COGS 184GS)

- Who are we? How did we come to be?
- How have human brains/minds changed over 5 million years?
- What factors helped select for the "language ready" mind?
- What insights can we gain from studying nonhuman primates?
- How did music & art emerge? Whence ethics?

The Mind of the Dolphin (COGS 143GS)

- Insights from a comparative perspective
- How does a dolphin brain compare to a human’s?
- Which cognitive abilities are shared? Are species-specific?
- What similar selective pressures may have shaped both?
- What might it be like to "think like a dolphin"?

University of St. Andrews Centre for Social Learning & Cognitive Evolution

Weekly excursions include:
- Observe wild dolphins at Moray Firth
- Learn to knap stone tools
- Guided tour, gathering wild foods
- Visit primate research at Edinburgh Zoo
- Discuss issues with leaders in the field

http://globalseminar.ucsd
Alien Intelligences
The Minds of Other Animals

Dr. Christine M. Johnson
Dept. of Cognitive Science, UCSD
Cognition

Adaptive Engagement with the World
Adaptive Engagement with the World
To study cognition in nonhuman animals....

- Begin by assessing species-specific sensory-motor constraints
- Consider general learning principles
- Include ecological demands on cognition
- Examine implications for understanding human cognition
Species-Specific Sensori-Motor Constraints
"Visible Light"
Some species do not distinguish colors
"Match to Sample"

- Sample
- Alternatives

Select this alternative, gain positive reinforcement
Match to Sample
Not taking such constraints into account...

Sample
Not taking such constraints into account...

Sample

Unsurprisingly, they performed poorly
Dolphin Vision:
Sensitive to Motion & High Contrast
Alternatives

Success!
Primate (including human!) cognition is likewise constrained
Species-Specific Sensori-Motor Constraints

Primates have forward-facing eyes
Forward facing eyes

Good Depth Perception

For hunting (insects)

For arboreal locomotion
Opposable thumbs, grasping hands
Other animals also have dexterous hands with opposable thumbs...

But notice, they cannot see their own hands
Other animals also have dexterous hands with opposable thumbs...

Primates can see their own hands
Hand-Eye Coordination
Hand-Eye Coordination

>> Tool Use
Hand-Eye Coordination

>> Tool Use
Trunk-Eye Coordination

Eye-Beak-Foot Coordination
But in other animals, not...

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**Dolphins Evolve Opposable Thumbs**

‘Oh, Shit,’ Says Humanity

HONOLULU—In an announcement with grave implications for the primacy of the species of man, marine biologists at the Hawai Oceanographic Institute reported Sunday that dolphins, or family Delphinidae, have evolved opposable thumbs on their pectoral fins.

I believe I speak for the entire human race when I say, ‘Holy fuck’,” said Oceanographic Institute director Dr. James Aoki, noting that the dolphin has a cranial capacity 40 percent greater than that of humans. “That’s it for us monkeys.”

Aoki strongly urged humans, especially those living near the sea, to see DOLPHINS page 65.
General Learning Principles

- Some general learning principles appear to apply to ALL

- e.g. Animals in general tend to detect & use EVENT CORRELATIONS

- When events reliably co-occur, with experience, animals will use Event 1 to predict Event 2
General Learning Principles

Temporal Contiguity
Bell & Food must occur close in time for animal to learn correlation
Event Correlations

- Rain
- Sun
- Bird with a worm
- Bird with food
General Learning Principles

Win Stay / Lose Shift

Peck White-on-Black, Get Reward

i.e. If Win (get reward) then Stay (continue same response)

BUT, if rules change, and pecking white-on-black NOT rewarded (= lose), animal will Shift its strategy to peck white-on-white
But even these widespread learning principles can sometimes be overridden by ecological demands.

E.g. Hummingbirds do poorly on Win Stay / Lose Shift.

Win-Shift is the SMART strategy!

So, we need to keep Ecological Validity in mind when designing cognitive experiments.
Other Species-Specific Constraints

Taste Aversion Learning

![Image of a rat holding a piece of cheese]
Other Species-Specific Constraints

Taste Aversion Learning

**Immediately**
(due to experimenter-administered lithium chloride)

**> 1 hour later**
(due to experimenter-administered lithium chloride)

**Temporal Contiguity**
predicts rat will learn association between novel food & illness
But it does **NOT**!

Only learns association with >1 hour delay!

Because if novel food WAS poison, would normally take >1 hr to affect rat!
Socio-Ecology is also a factor
Social Complexity

Power = Rank

In a “simple” hierarchical society, C only needs to track its own dyadic relationships.
Social Complexity

Power = Rank

Power not = Rank
(de Waal, 1986)

COALITIONS between lower ranking individuals can out-compete higher ranking individuals
Social Complexity

Power = Rank

Power not = Rank
(de Waal, 1986)

COALITIONS between lower ranking individuals can out-compete higher ranking individuals
Social Complexity

Power = Rank

Dyadics

Power not = Rank
(de Waal, 1986)

COALITIONS between lower ranking individuals can out-compete higher ranking individuals

So, C must track not just its own dyadic relations, but also the relations between others.
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

Make audio recordings of calls that occur during dominance interactions

A > B > C > D > E

Dom$_A$:Sub$_B$
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

Make audio recordings of calls that occur during dominance interactions

\[ \text{Dom}_A: \text{Sub}_B \quad \text{Dom}_B: \text{Sub}_C \quad \text{Dom}_C: \text{Sub}_D \quad \text{Dom}_D: \text{Sub}_E \]
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

During playbacks, use real call interactions and fabricated, anomalous combinations

<table>
<thead>
<tr>
<th>Real Interactions</th>
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<tbody>
<tr>
<td>Dom&lt;sub&gt;A&lt;/sub&gt;:Sub&lt;sub&gt;B&lt;/sub&gt;</td>
</tr>
<tr>
<td>Dom&lt;sub&gt;B&lt;/sub&gt;:Sub&lt;sub&gt;C&lt;/sub&gt;</td>
</tr>
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Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

During playbacks, use real call interactions and fabricated, anomalous combinations

Diagram:
- Real Interactions
  - \(\text{Dom}_A; \text{Sub}_B\)
  - \(\text{Dom}_B; \text{Sub}_C\)
  - \(\text{Dom}_C; \text{Sub}_D\)
  - \(\text{Dom}_D; \text{Sub}_E\)
- Fabricated anomalies
  - \(\text{Dom}_C; \text{Sub}_B\)
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

Play back real & fabricated call pairs from hidden speaker
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

NO reaction to real interactions

BIG reaction to fabricated interactions – investigate!
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
Playback experiments to wild Chacma Baboons

Suggests know relations between others; as a result, recognize violations of those expectations

Investigate, since apparent rank changes may impact YOU as well!

BIG reaction to fabricated interactions – investigate!
How can we KNOW what animals know??

Behaviorism:
The Mind as "Black Box"

Cognitive Revolution:
There ARE things we can know about the "contents" of an animal's mind...
Cognitive Maps
Go forward, turn right

Food
Behaviorism:
Given stimulus of maze,
rat has learned a response
(go forward, turn right)

Go forward, turn right
Food
Cognitive Science:
Rat has developed a mental representation of the maze.

Rat goes forward, turns LEFT.

Food

SUCCESS!
Prospective Encoding

First Train:
See Blue, pick Horizontal - See Red, pick Vertical

<table>
<thead>
<tr>
<th>Stimulus</th>
<th>Pause</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Blue" /></td>
<td><img src="image" alt="Pause" /></td>
<td><img src="image" alt="Reward" /></td>
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<td><img src="image" alt="Pause" /></td>
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</tbody>
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Effects of "Interference"

Prospective Encoding

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</thead>
<tbody>
<tr>
<td><img src="image1" alt="Blue Dot" /></td>
<td><img src="image2" alt="Pause Symbol" /></td>
<td><img src="image3" alt="Pigeon" /> + <img src="image2" alt="Pause Symbol" /></td>
</tr>
<tr>
<td><img src="image1" alt="Blue Dot" /></td>
<td><img src="image2" alt="Pause Symbol" /></td>
<td><img src="image3" alt="Pigeon" /> ? <img src="image2" alt="Pause Symbol" /></td>
</tr>
<tr>
<td><img src="image1" alt="Blue Dot" /></td>
<td><img src="image4" alt="Orange Dot" /></td>
<td><img src="image3" alt="Pigeon" /> + <img src="image2" alt="Pause Symbol" /></td>
</tr>
</tbody>
</table>

TIME
<table>
<thead>
<tr>
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<th>Pause</th>
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**Prospective Encoding**

- **Stimulus**:
  - Lines interfere _late_ in delay = as animal makes mental image of lines it is "prospecting" for.

- **Choice**:
  - Color interferes _early_ in delay = animal at first retains mental image of color stimulus.

**TIME**
Symbol Use

Some animals have been tested for their ability to do more complex reasoning, such as involving SYMBOLS.
Symbol Use
Symbol Use

Spontaneous Addition
Symbol Use

Once number trained, briefly see series of numbers. Must touch squares in order.

Chimps perform better than college students!

Matsuwa et al. 2000
“Greedy Giveaway Task”

Chimp 1: Reach to one of two piles of M&Ms

Chimp 2: Eat M&Ms

These chimps are number-trained.
"Greedy Giveaway Task"

Chimp 1 inevitably reaches for larger pile...

Large pile of M&Ms

Small pile of M&Ms

Chimp 1 must watch as Chimp 2 gets selected (larger) pile!
Chimp 1 gets stuck with remaining pile.
“Greedy Giveaway Task”

But, if replace piles with associated numbers . . .

8 = Large pile of M&Ms
3 = Small pile of M&Ms
“Greedy Giveaway Task”

But, if replace piles with associated numbers . . .

Chimp 1 will reach for smaller number!
i.e. respond “rationally”, and gain larger reward
“Greedy Giveaway Task”

Even after above, if presented with piles, revert to reaching to larger pile!

Large pile of M&Ms  Small pile of M&Ms

Only succeed when SYMBOL intercedes...
Consider the implications for HUMAN cognition...