Alien Intelligences
The Minds of Other Animals

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Cognition

Adaptive Engagement with the World
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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
Some species do not distinguish colors
"Match to Sample"

Select this alternative, gain positive reinforcement
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...

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 Hawaii 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...
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
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
Other Species-Specific Constraints

**Taste Aversion Learning**

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

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

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

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

A → B → C

D → E → F

Dyadics

Power not = Rank (de Waal, 1986)

A → C

B → D

C → E

D → F

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

Power = Rank

A → B → C → D → E → F

Dyadics

Power not = Rank
(de Waal, 1986)

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

Power = Rank

A → B → C → D → E → F

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

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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

A > B > C > D > E

Dom<sub>A</sub>:Sub<sub>B</sub>  Dom<sub>B</sub>:Sub<sub>C</sub>  Dom<sub>C</sub>:Sub<sub>D</sub>  Dom<sub>D</sub>:Sub<sub>E</sub>
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

- Real Interactions

- $\text{Dom}_A: \text{Sub}_B$
- $\text{Dom}_B: \text{Sub}_C$
- $\text{Dom}_C: \text{Sub}_D$
- $\text{Dom}_D: \text{Sub}_E$
Knowing about the Relations Between Others

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

- Real Interactions
- Fabricated anomalies

- Dom_A Sub_B
- Dom_B:Sub_C
- Dom_C Sub_D
- Dom_D:Sub_E
Knowing about the Relations Between Others

Cheney, Seyfarth & Silk 1995
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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

BIG reaction to fabricated interactions
– investigate!

Investigate, since apparent rank changes may impact YOU as well!
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
Behaviorism:
Given stimulus of maze,
rat has learned a response
(go forward, turn right)
Behaviorism predicts:
Go forward, turn right
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>
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<tr>
<th>Stimulus</th>
<th>Pause</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Blue" /></td>
<td></td>
<td><img src="image" alt="Reward" /></td>
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Prospective Encoding

Effects of "Interference"

Stimulus | Pause | Choice
--- | --- | ---

TIME
Prospective Encoding

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Lines interfere **late** in delay = as animal makes mental image of lines it is "prospecting" for

Color interferes **early** in delay = animal at first retains mental image of color stimulus

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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

- 2
- 3
- 5
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...