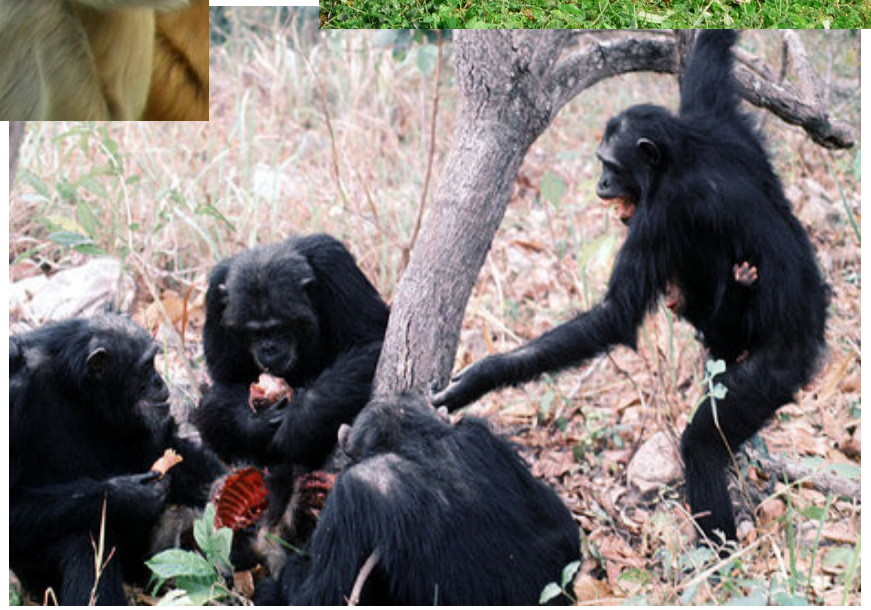
Primate Foraging Skills

Cogs 143 * UCSD

The Socio-Ecology of Foraging

Many factors to take into account

- Diet
- Habitat
- Predator avoidance
- Competition
- Other social factors
- And more!



Cognitive Issues

Ecological Validity

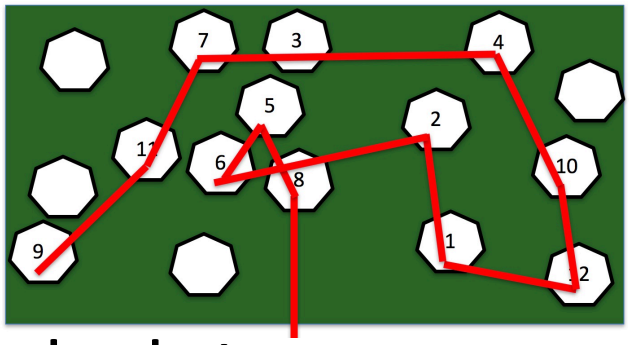
- Research in lab should be designed to test the real-world problems the animals face
  - However, this has often NOT been the case!
- These lectures will attempt to redress this, by *translating* experimental findings into possible adaptive functions
- In particular, we will look the cognition required to
  - **Identify**
  - **Locate**
  - **Process**

Cognitive Issues

"**Goals**"

- Studying the cognition of foraging tends to involve attributing a "*Goal*"
- Can we identify behavioral criteria for this (invisible) abstract concept?

  - Path efficiency? Per degree of linearity, travel speed, points & abruptness of direction
  - BUT . . .



- e.g. Many species take efficient route when resources **scarce**, circuitous when **abundant**

- e.g. Wooly monkeys typically do not go directly to ripe fruit trees, visit all, possibly to **monitor** ripening

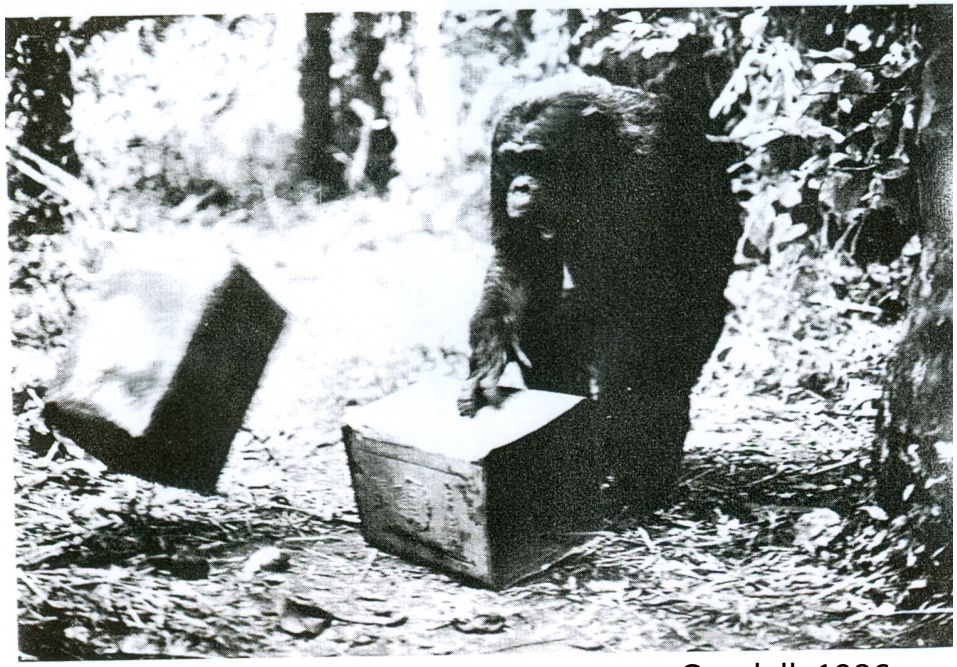
- See *Janson & Byrne 2007* reading re: challenges for studying foraging cognition, assessing "value", etc!

Cognitive Issues

Individual Differences

In cognitively sophisticated species, ability and experience vary across individuals.

Especially w/prolonged development, many influences shape adult performance.



Goodall, 1986

Individual Differences

- Age
  - An orangutan will eat palm throughout its life
  - But, as its body size & strength changes,

    so do the age & parts of the palm it can access & the procedures it can use

Cognitive Demands

Procuring food requires

IDENTIFYING,

LOCATING

& **PROCESSING**

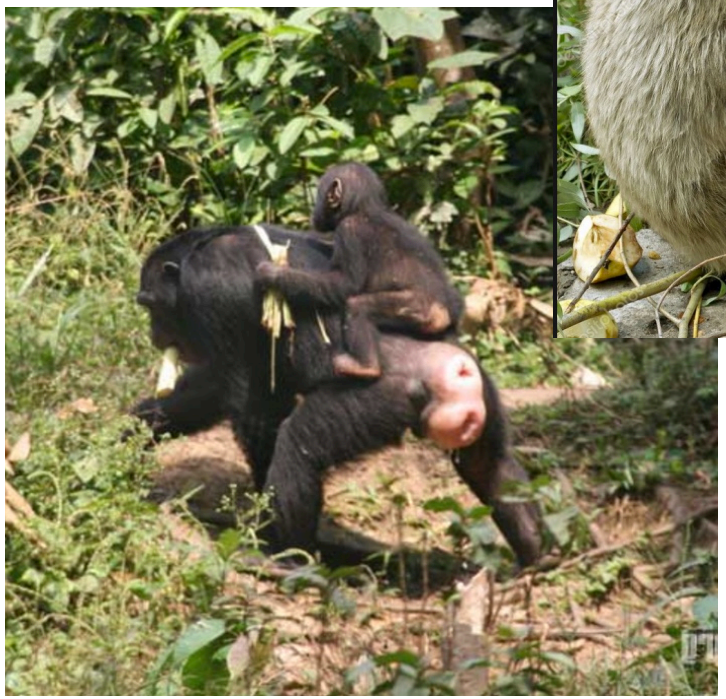
edibles from the environment.

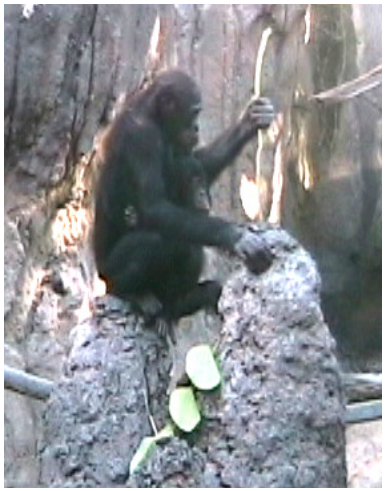
Identifying edibles . . .

Identifying

Eat What Mom Eats

- Observe, share, imitate
  - Infant's first foods are from its Mother's mouth and hands





Re: **Mirror Cell** assumptions

- Note many infant primates watch Mom's hands *before* their own
- So mapping may not be from own, to other's hands!

Identifying

Eat What Mom Eats

- Medicinal use of foods
  - e.g. Bristley leaves scrape, catch, clear internal parasites
  - e.g. Certain flowers settle upset stomach

- Infant possibly associate foods with mom's symptoms?
  - e.g. Bad breath, fever, lethargy, etc.

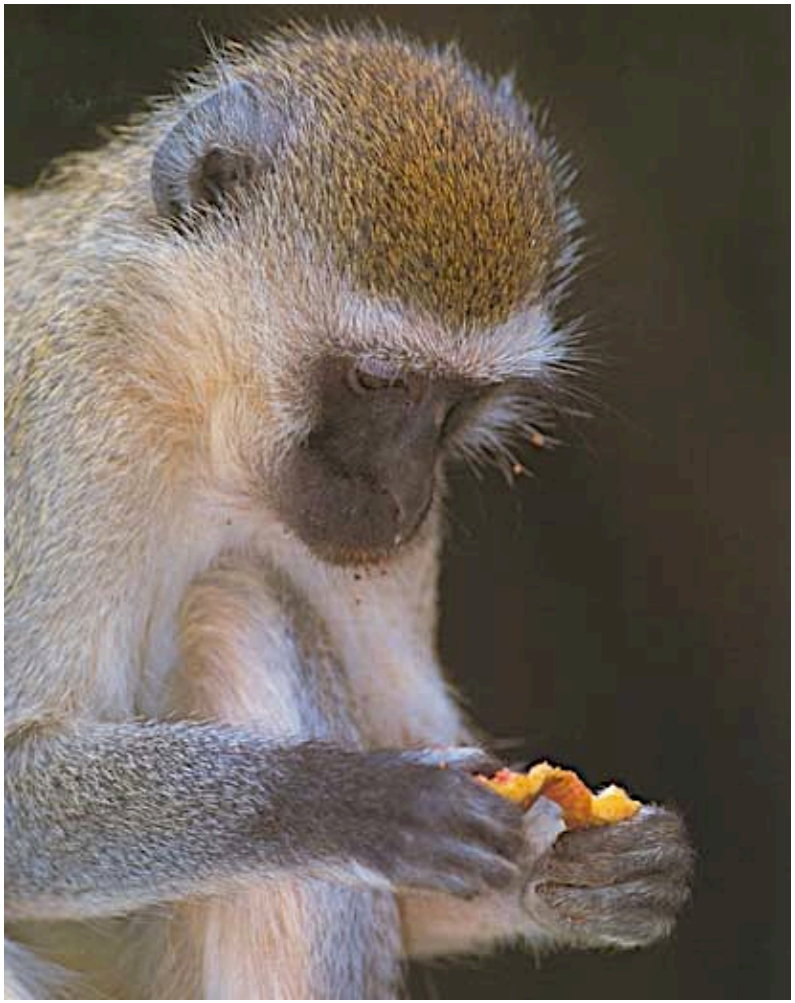
Identifying

Discriminate “Things”

Recognizing a thing,

& esp the right KIND of thing,

when you see it...



Identifying

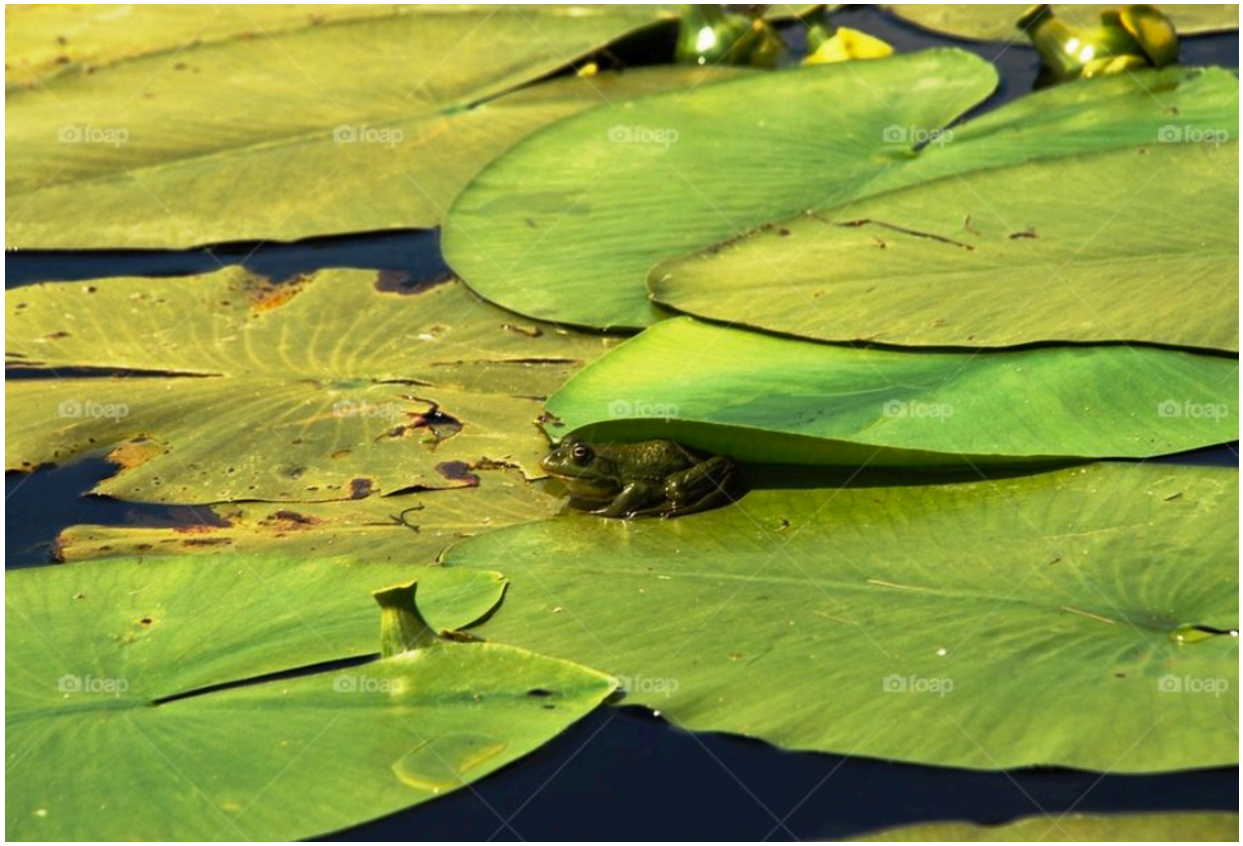
Discriminate “Things”

The world is a cluttered, dynamic, occluding place!

Is an object that moves out of sight treated as though it still exists?

Object Permanence

AKA “Visible Displacement”



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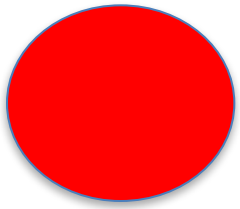

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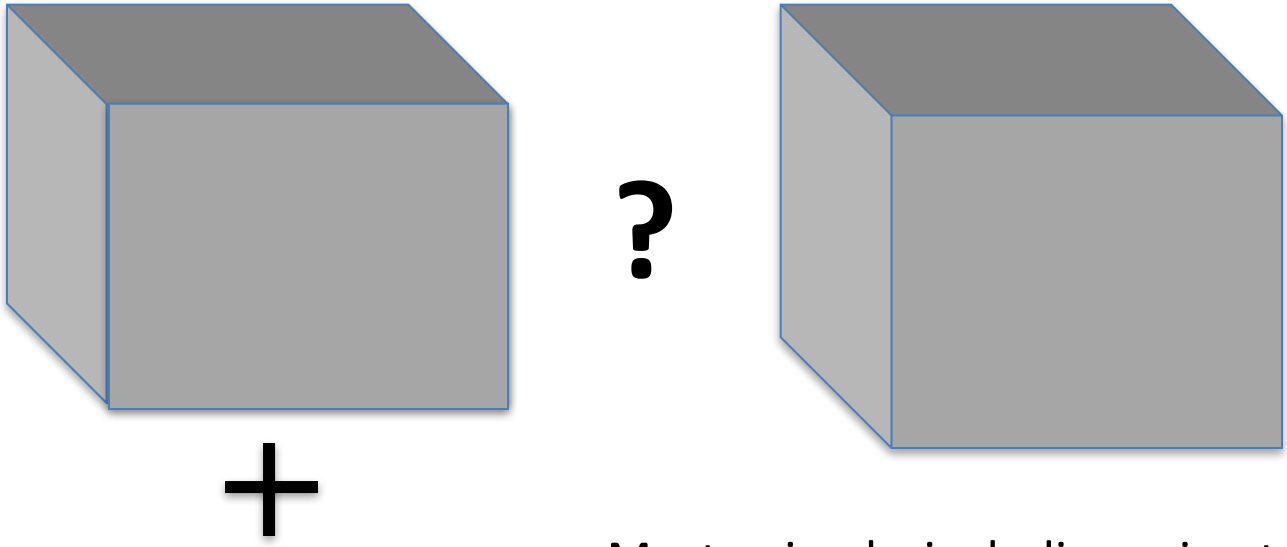


Most animals, including primates,
& 6-month old children, succeed at this task

Identifying

Discriminate “Things”

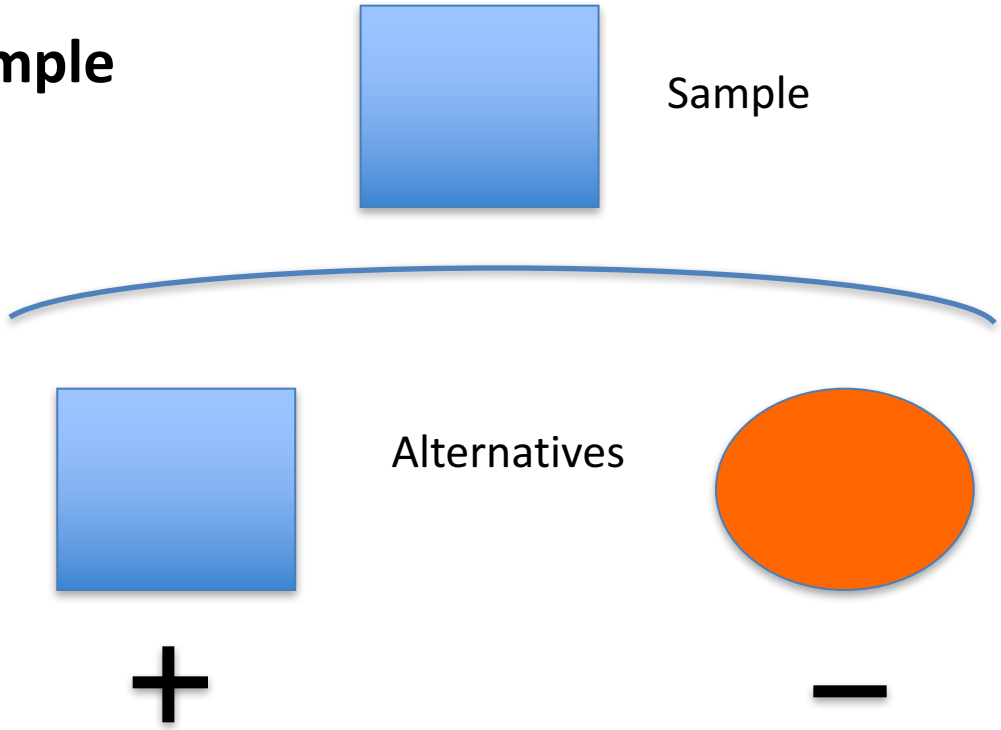
Match-to-Sample

- Found a good one?
- Now find another just like it!

Identifying

Discriminate “Things”

Match-to-Sample

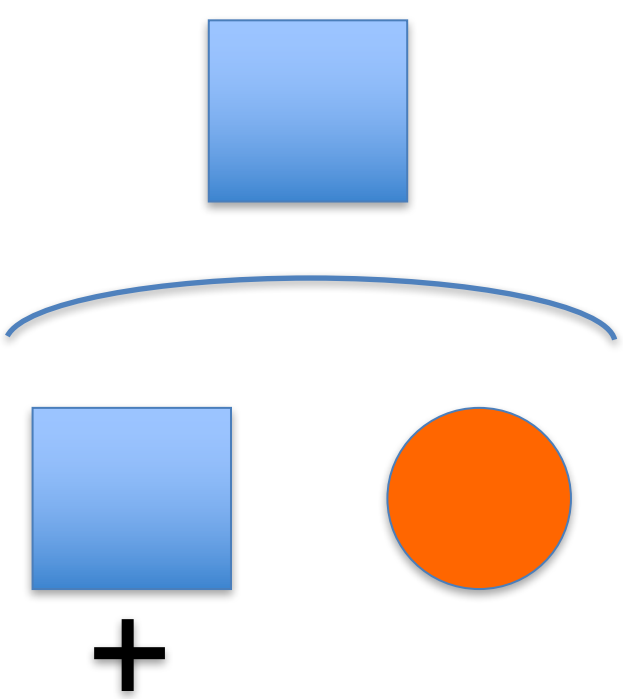


Select this alternative,
gain positive reinforcement

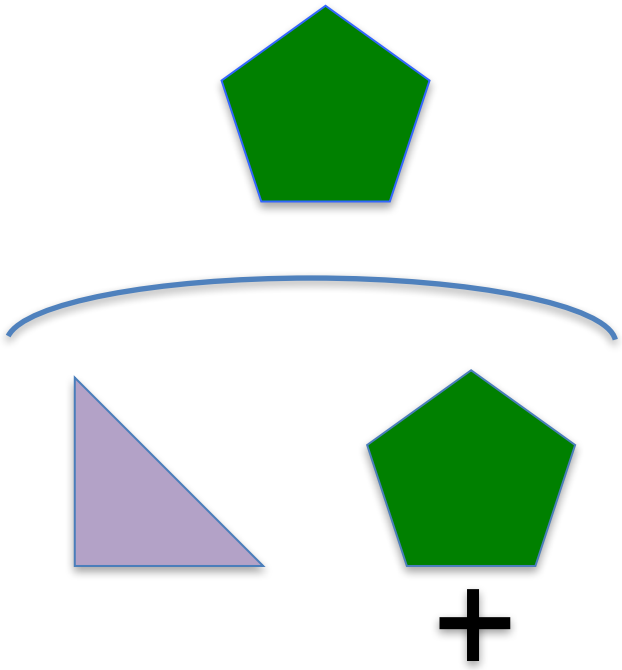
Identifying

Discriminate "Things"

Transfer = A "savings in learning" from one problem to the next
= A decrease in # trials to criterion



e.g. 100 trials required to reach criterion (such as 8/10 consecutive trials correct)...

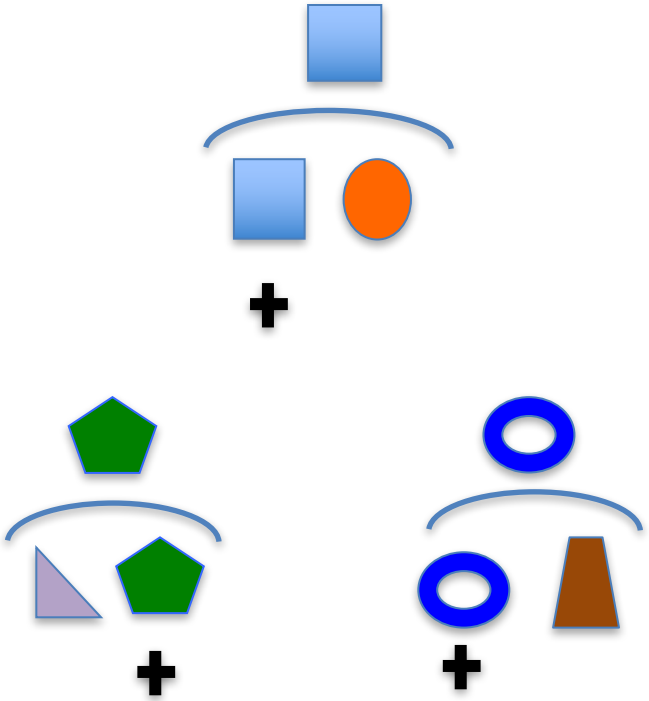


...Next problem, only 20 trials required to reach criterion

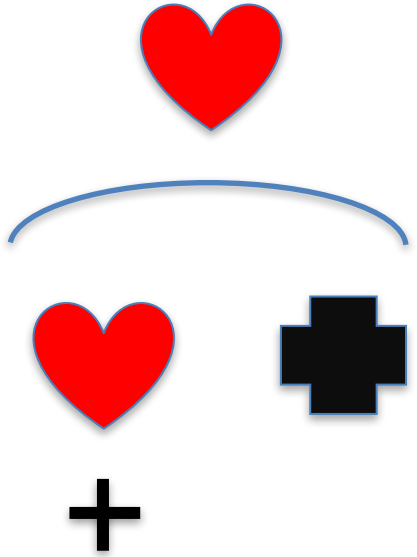
Identifying

Discriminate “Things”

First Trial Success = Full, immediate transfer to novel problem



Training trials



Novel Test –
stimuli never used before

Correct on first trial w/novel stimuli?

Primates can reach First Trial Success on MTS & related tasks.

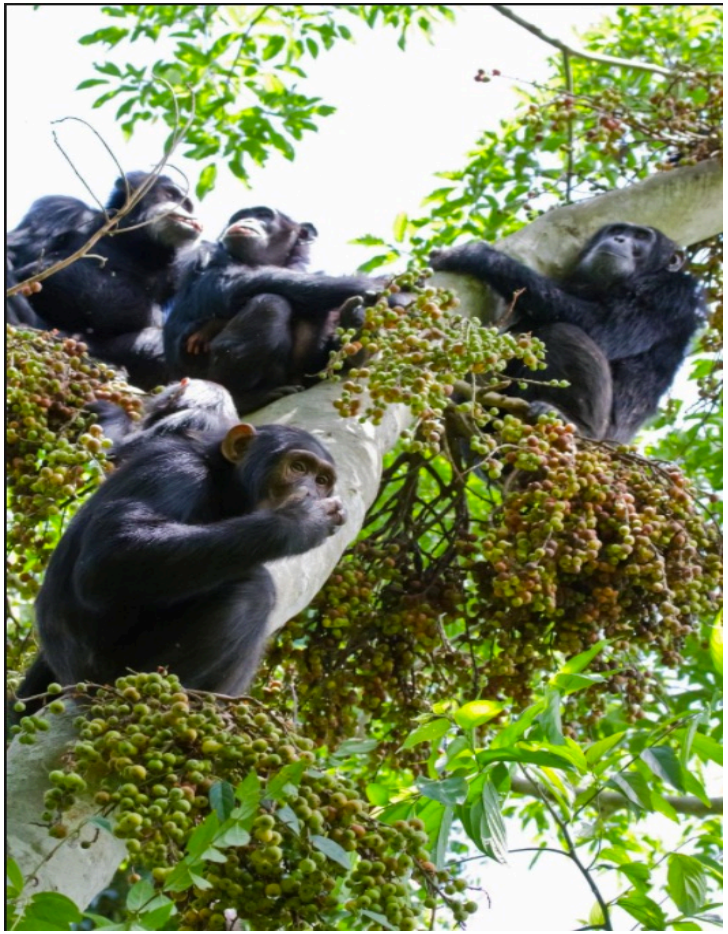
Identifying

Assess Patch Size & Quality

Others things being equal,
primates prefer clumped resources
& the bigger the better!

- In lab, tolerate delays for larger rewards
  - i.e. Good at "**delayed gratification**"
    - Per Prefrontal Cortex development

- In wild, likewise, walk farther for more
  - But trade-offs!
  - Have to also avoid predators, competitors



See Janson & Byrne 2007 reading
re: avoiding circular definition of "**Value**"

Identifying

Building Associations

Sensori-Motor Integration

PLAY helps develop basic sensori-motor skills

Size constancy

Distance perception

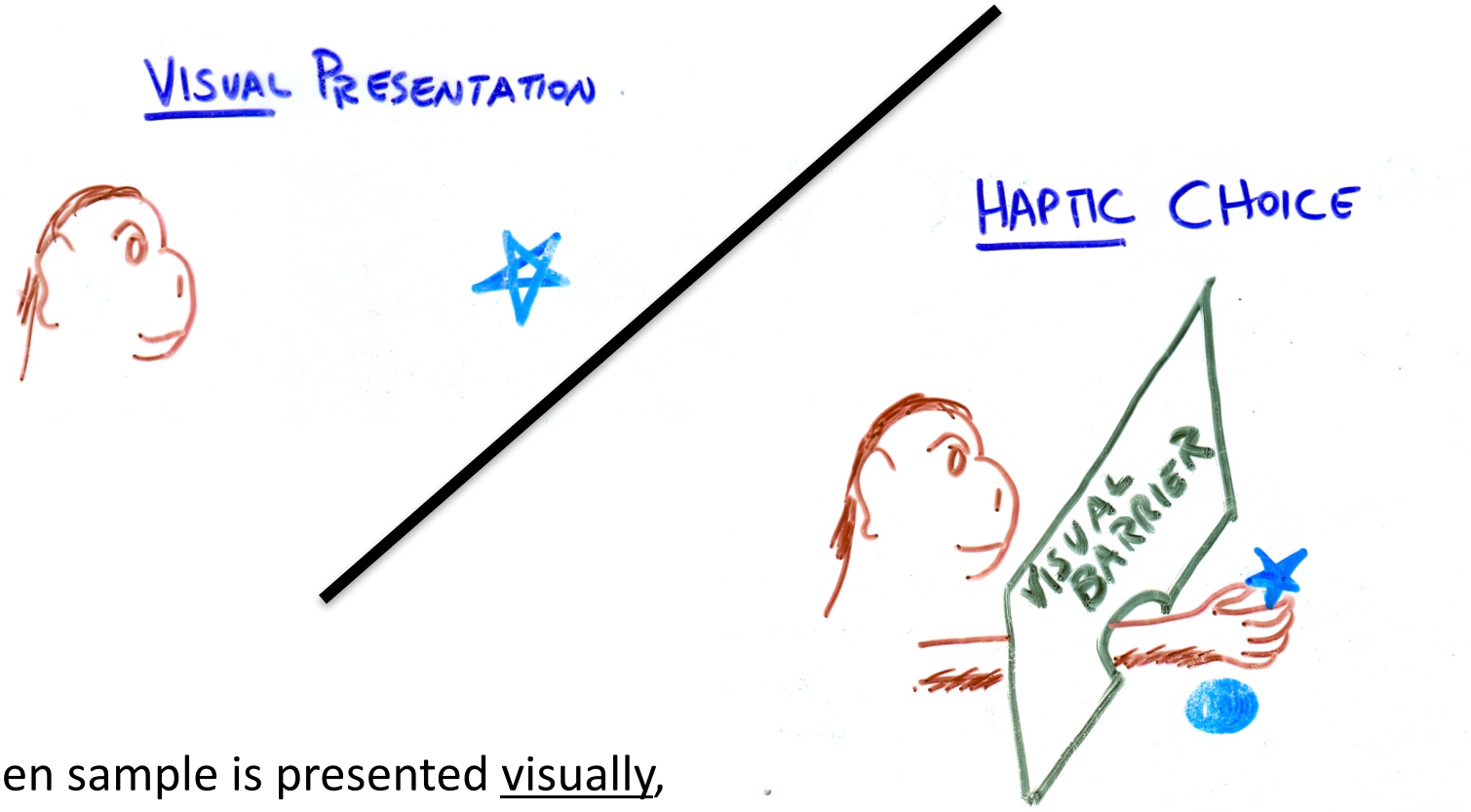
Hand-eye coordination

Etc., etc...

Identifying

Building Associations

Cross-Modal Matching



When sample is presented visually,

primates easily find matching alternative by touch

(or vice versa)

Identifying

Building Associations

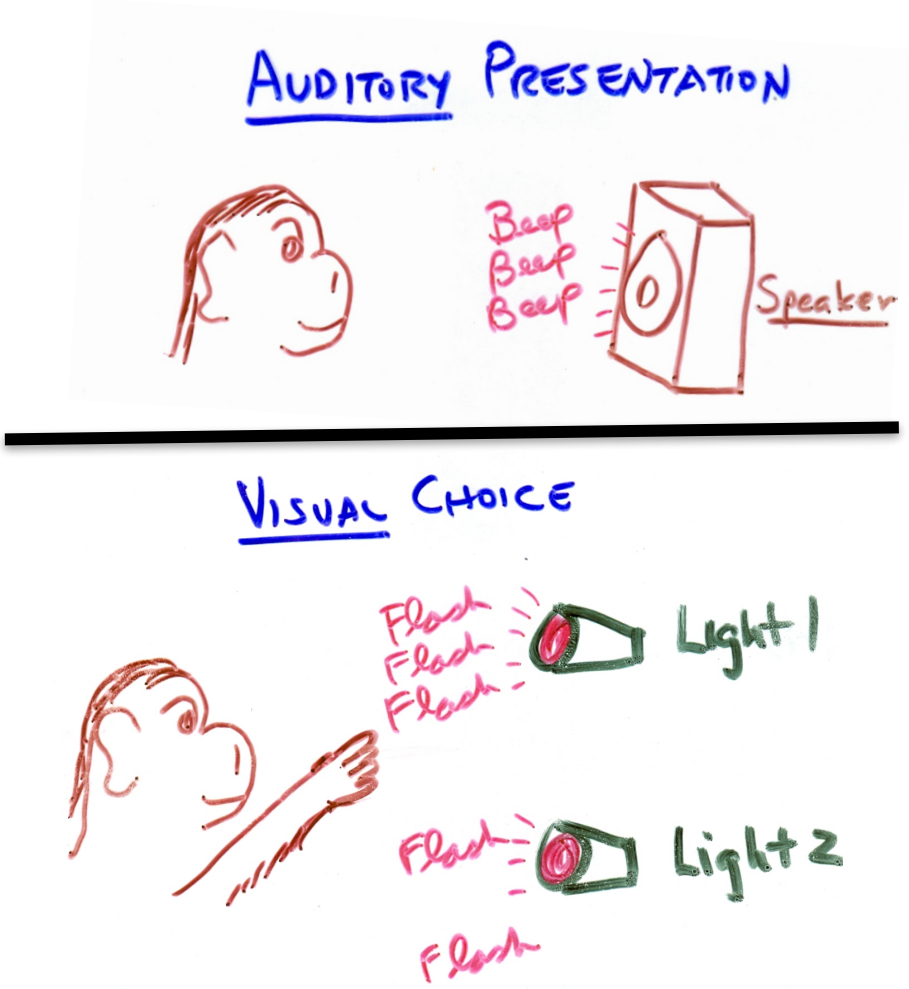
Cross-Modal Matching

Primates also succeed

at auditory to visual matching,

(& vice versa)

based on temporal patterns.

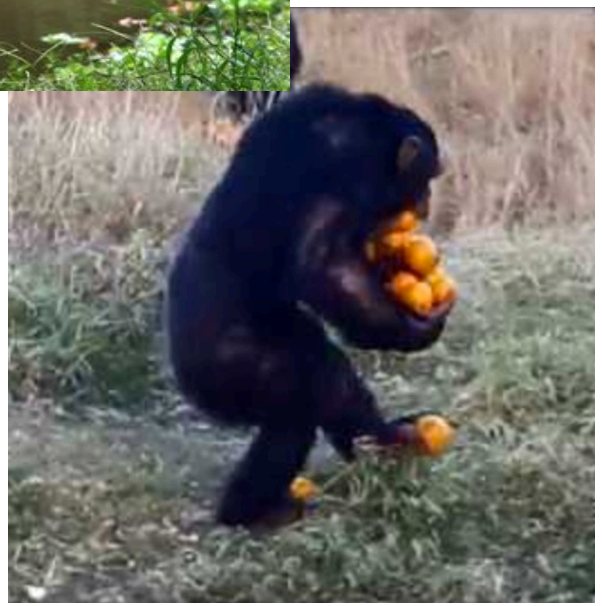


Identifying

Building Associations

Learning Affordances

- Will this branch hold my weight?
- Can these fit in my hand?
- Is this someone I can mount? (?)
- Is this water over my head? (!)
- Etc...



Canonical Cells in Parietal Cortex recognize affordances

Building Associations

Detecting Predictive Regularities

- Menzel (1991) placed store-bought persimmons on ground in Japanese macaque home range

- After finding, monkeys then traveled to (as yet unripe) persimmon trees in range

Identifying

Building Associations

Detecting Predictive Regularities

- Grey-cheeked Mangabeys alert to Hornbill (bird) alarm calls
  - Learn association between call and shared predator

- Mangabey then alarms (famous “whoop gobble”)
  - Serves as sentry for other local primates

Identifying

Building Associations

“Rule-Based” vs. “Associative” Learning

- Cognition concerns not only what, but *HOW* an animal learns

- When animal faced with resources that are...
  - unpredictable, patchy, ephemeral --
    - as they are for, especially, frugivorous primates

cognitive processes can arise to adapt to variability, novelty

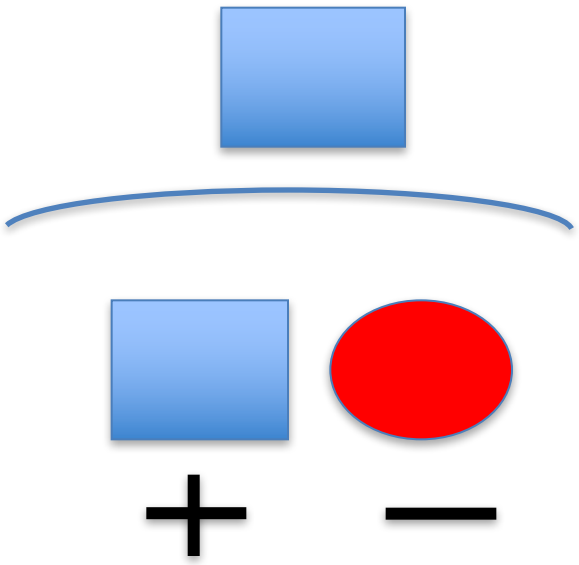
- i.e. “**Rule Based**” learning is esp useful here

Identifying

Building Associations

"Rule-Based" vs. "Associative" Learning

"Identity" MTS
(IMTS)



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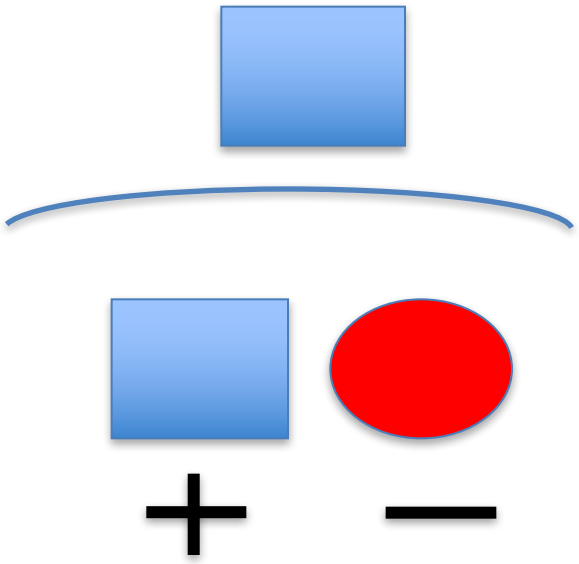
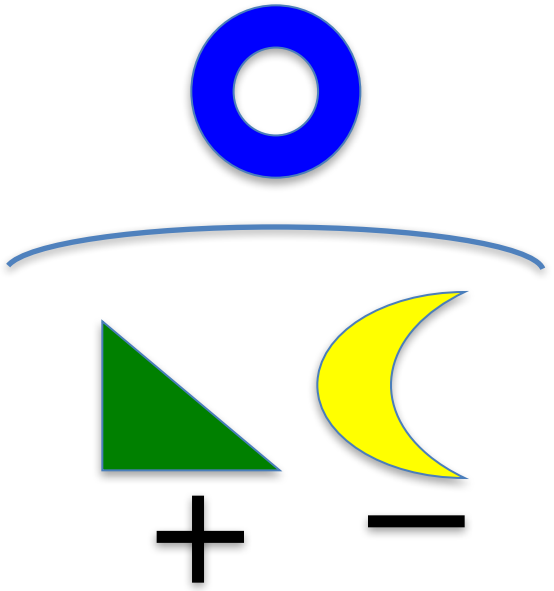


"Conditional" ("Symbolic") MTS
(CMTS)



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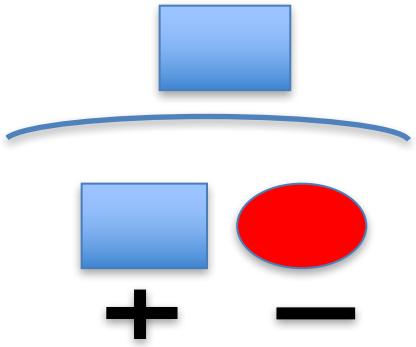

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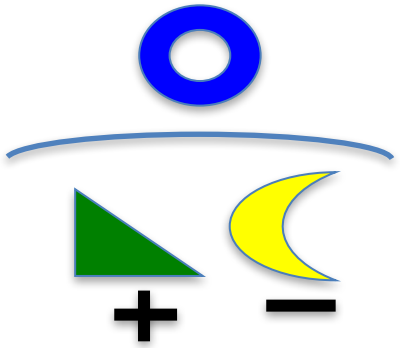

Pigeons show "transfer" between these problems

i.e. Both involve "See one, pick one of 2". So second is the "same problem" to a pigeon.

Identifying

Building Associations

"Rule-Based" vs. "Associative" Learning

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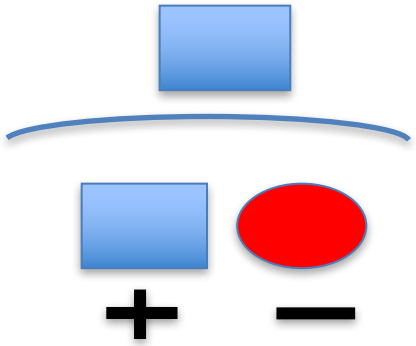
(IMTS)



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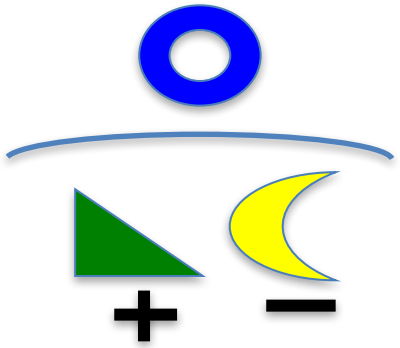
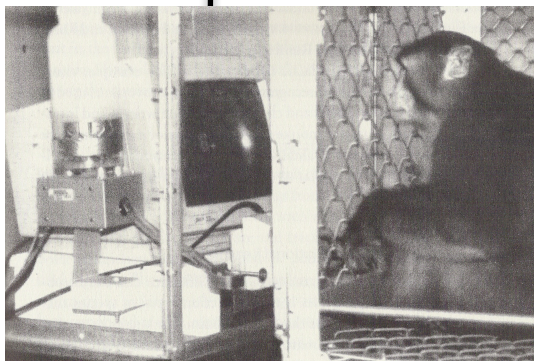


Primates do NOT show "transfer" between these problems



See first problem as rule-based (pick SAME), so second is not the "same problem" to a primate!

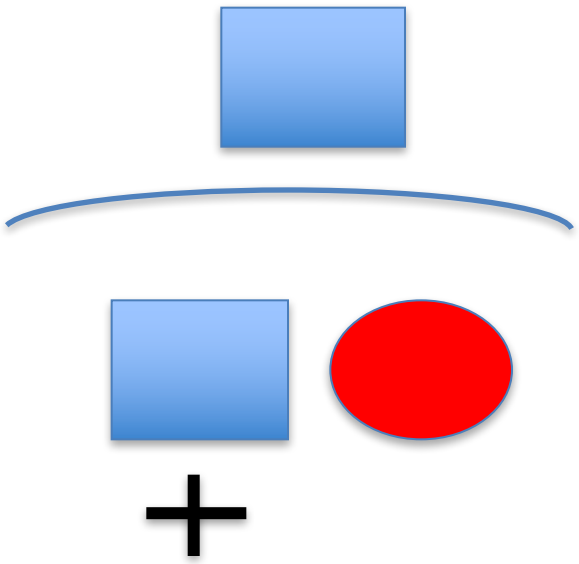
In fact, do WORSE on CMTS, if they were first trained on IMTS.

Identifying

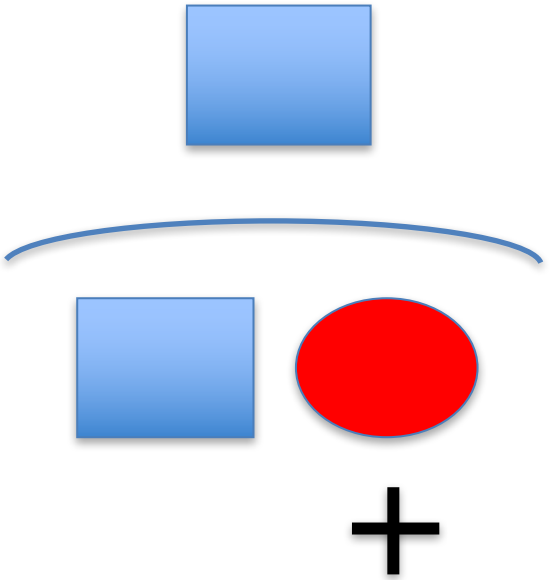
Building Associations

"Rule-Based" vs. "Associative" Learning

"Identity" MTS



"Oddity"

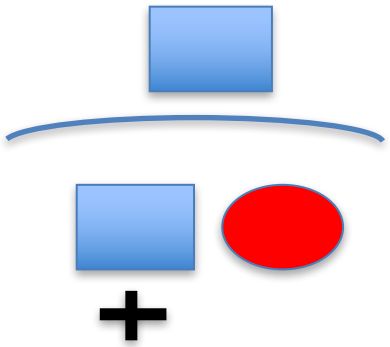


Identifying

Building Associations

"Rule-Based" vs. "Associative" Learning

"Identity" MTS



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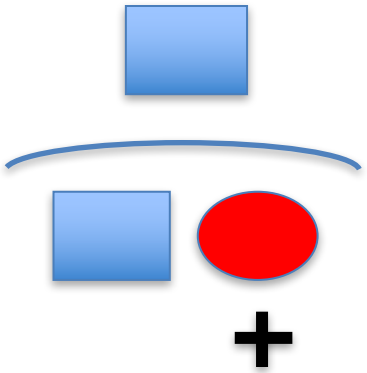
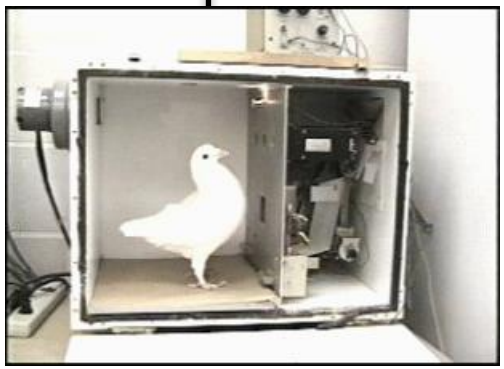


Pigeons show some "transfer" between these problems

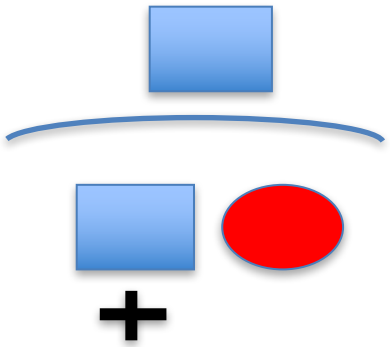


Identifying

Building Associations

"Rule-Based" vs. "Associative" Learning

"Identity" MTS



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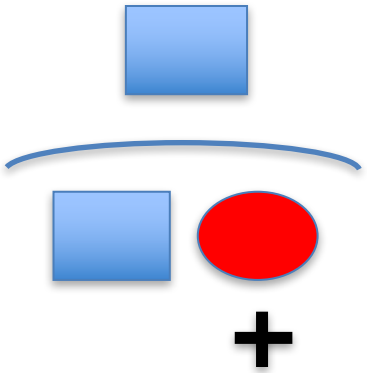
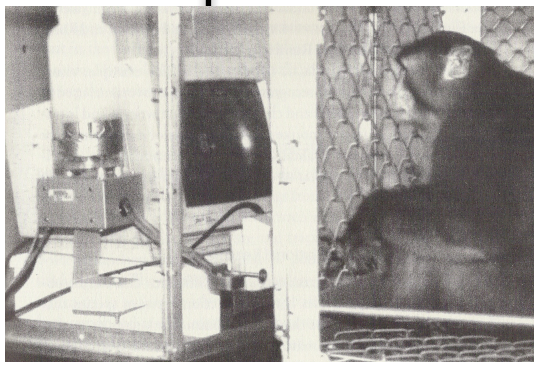


Primates show even more "transfer" between these problems



Same relationship involved in both.

i.e. Need to first determine what is SAME, to then determine which is not

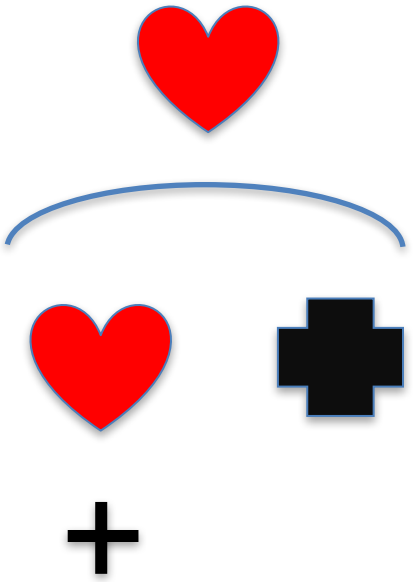
Apes especially reach First Trial Success

Identifying

Building Associations

"Rule-Based" vs. "Associative" Learning

- *Pigeon*: "**Associative**" learning
  - Based on the reinforcement contingencies of each new set of stimuli
- *Primate*: "**Rule Based**" learning
  - Subject applies rule "pick same"
- **Rule Based** allows greater flexibility
  - Enables subject to respond to NOVEL situations, w/out further learning
  - So, "first trial success" with novel stimuli indicates that a rule is being applied
  - Pays off esp in species with variable diets/conditions/goals



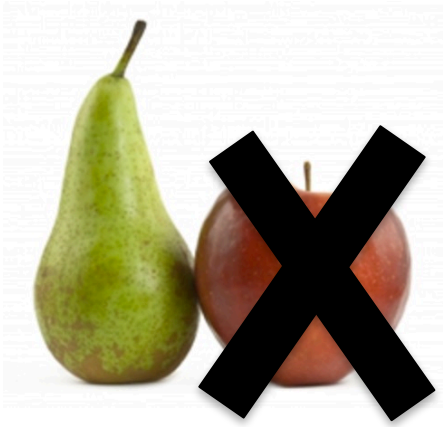
Novel Test -
Correct on first trial

Identifying

Inferences

IN THE LAB

- Based on such, primates can make inferences about competitors & targets
  - e.g. Chimps watches Experimenter hide apple @ X, and pear @ Y
    - Chimp distracted, then sees Experimenter eating an apple
    - Chimp will only seek pear (i.e. finds pear @ Y, stops searching)



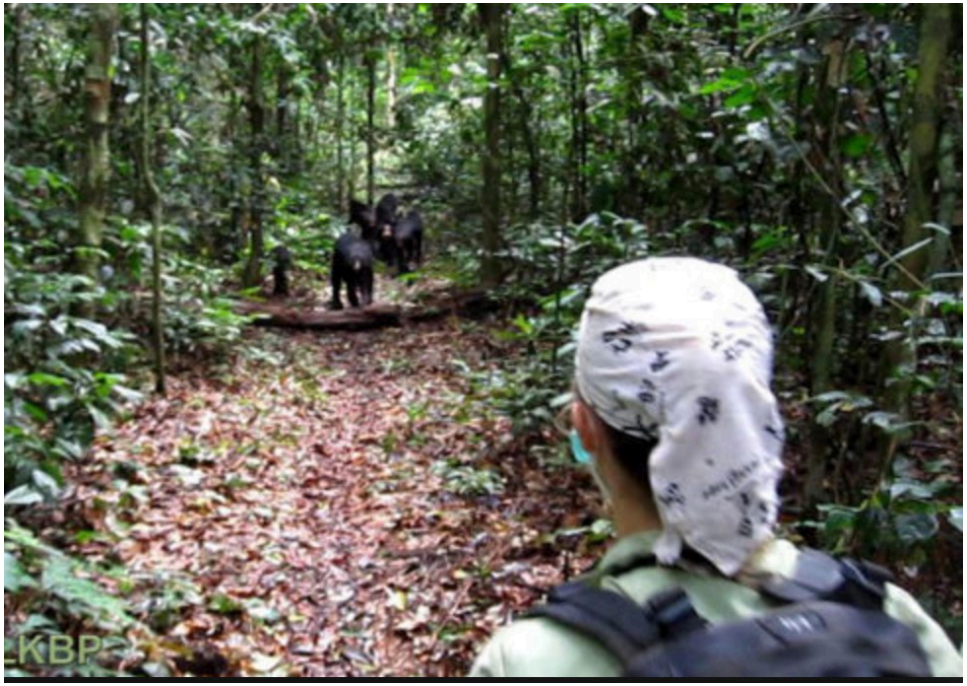
- Many Others!
  - Based on what competitor can/cannot see (More to come!)

Locating edibles . . .

Searching Environment

In the field:

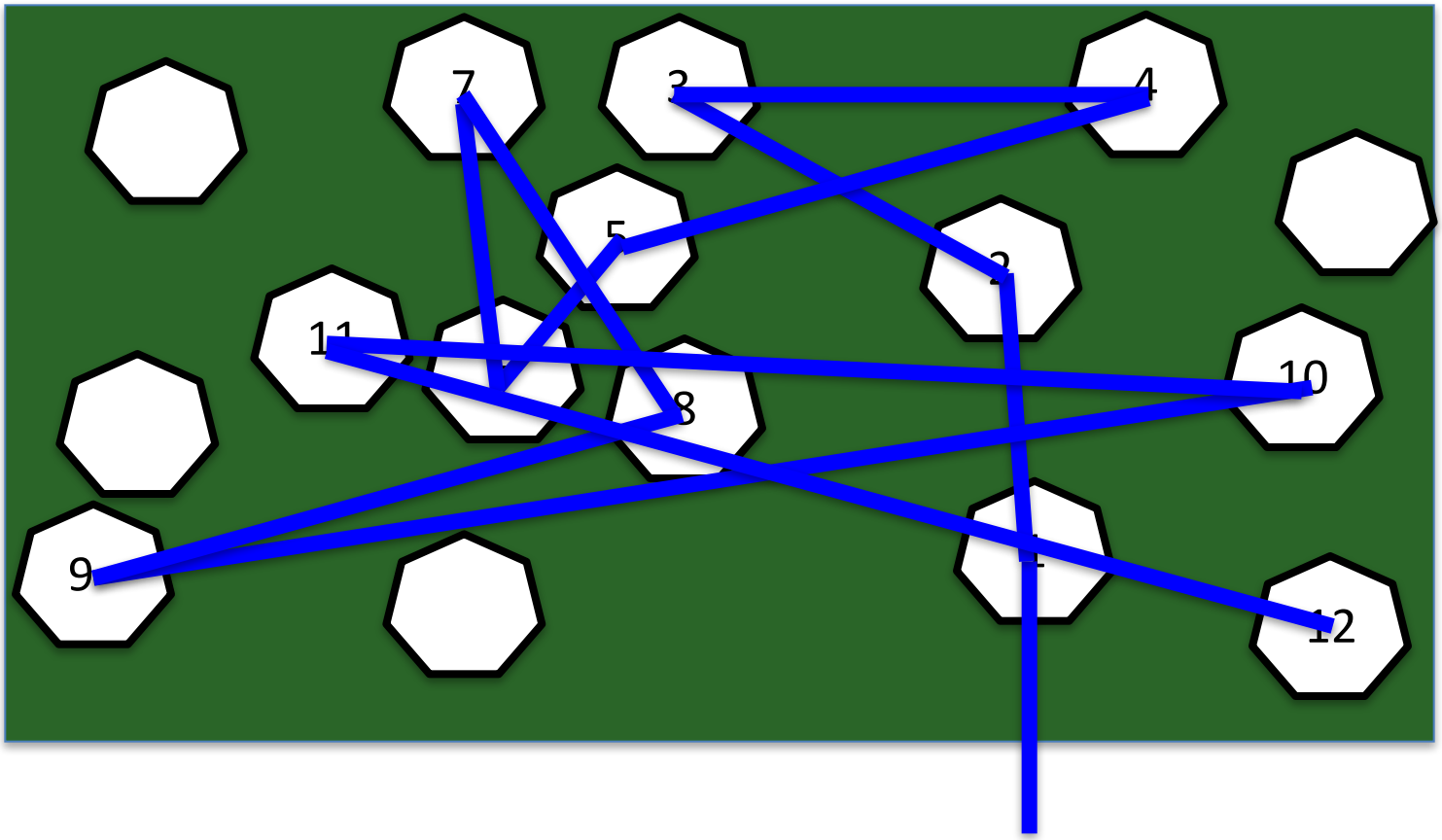
- Most appear to use landmarks and re-use paths
  - e.g. Turns at key landmarks tend to be abrupt deviations
- Also tend to move faster and more directly toward preferred ("valued") resources



Locating

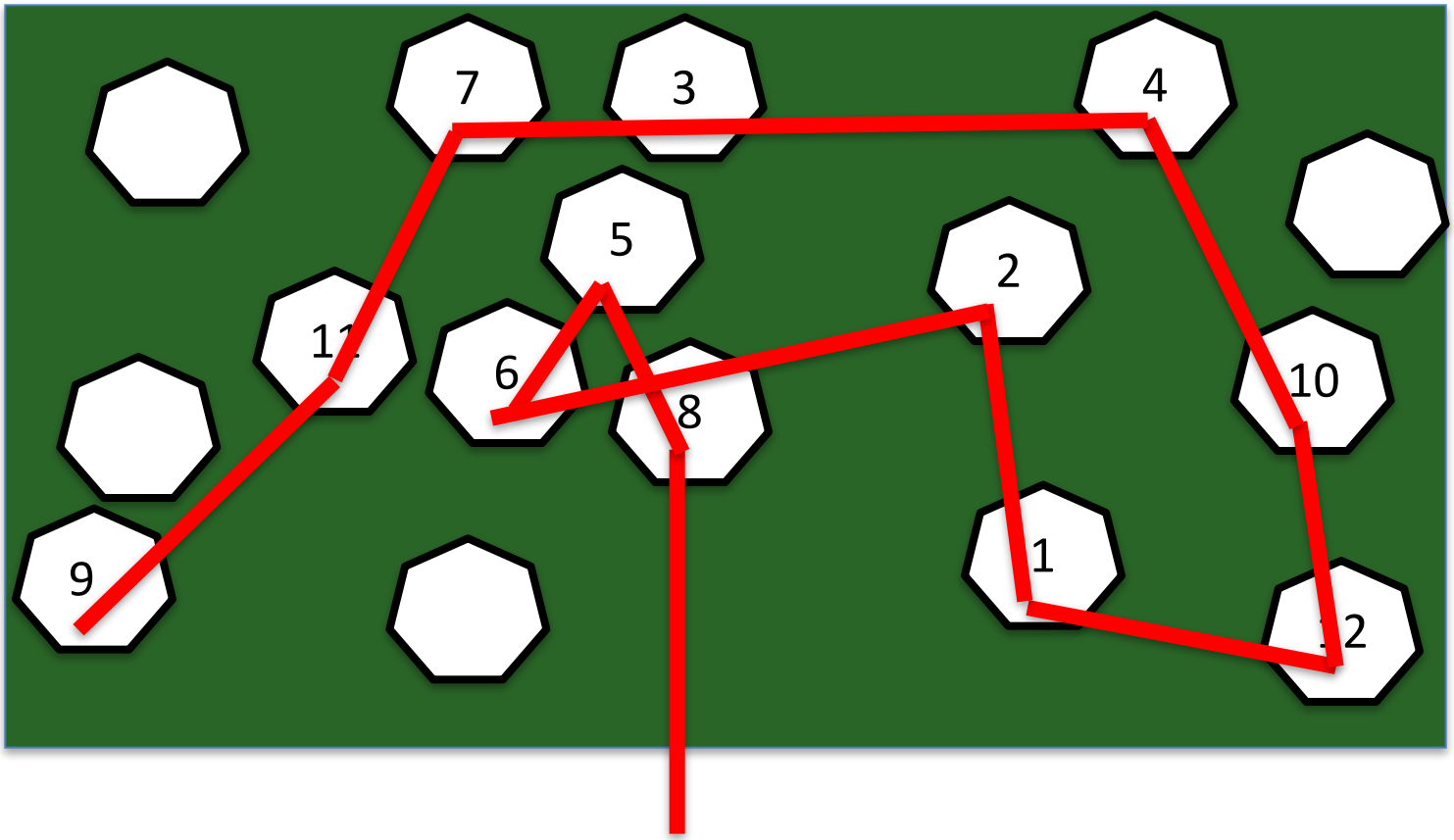
Searching Environment

IN THE LAB: Shown baiting, along inefficient path



Searching Environment

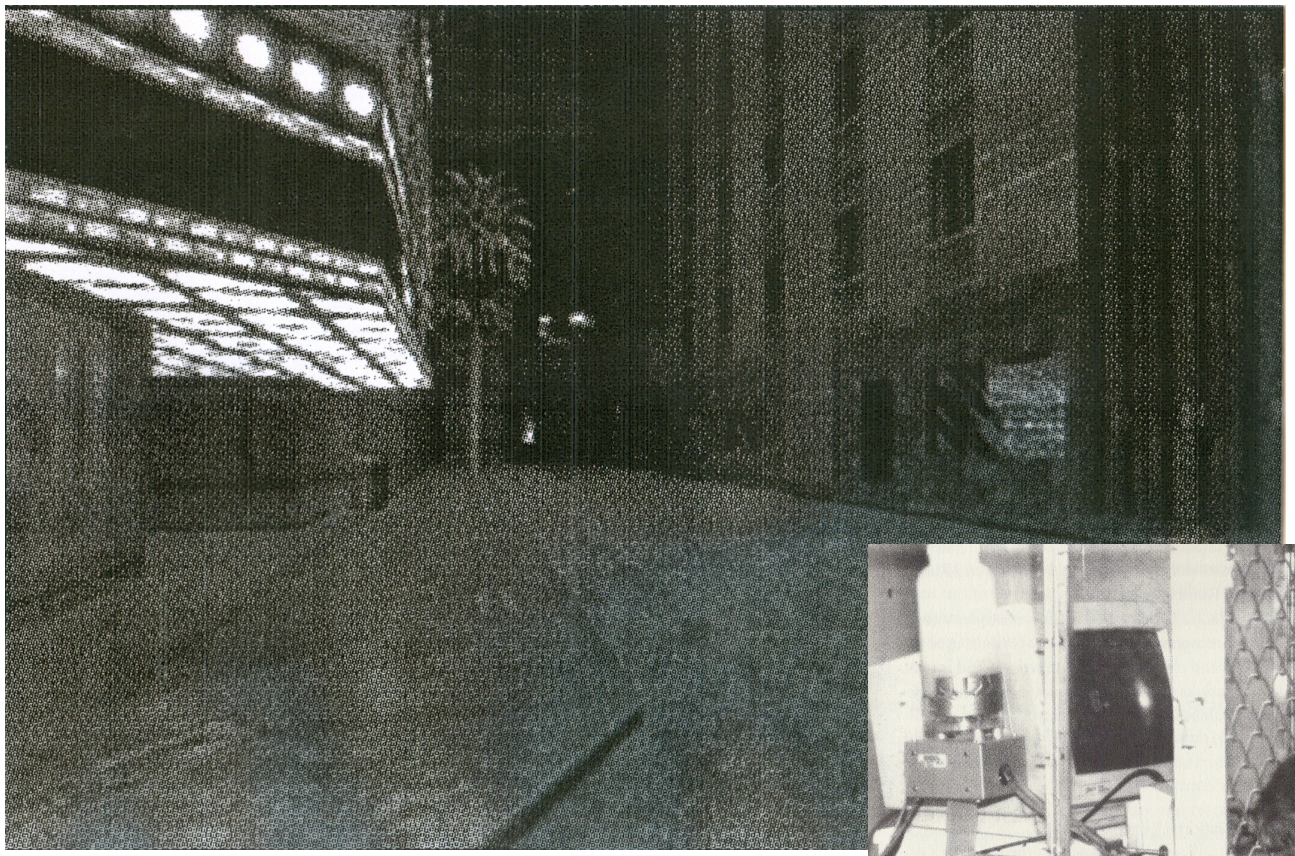
IN THE LAB: Chimp searches efficiently



Chimp alone

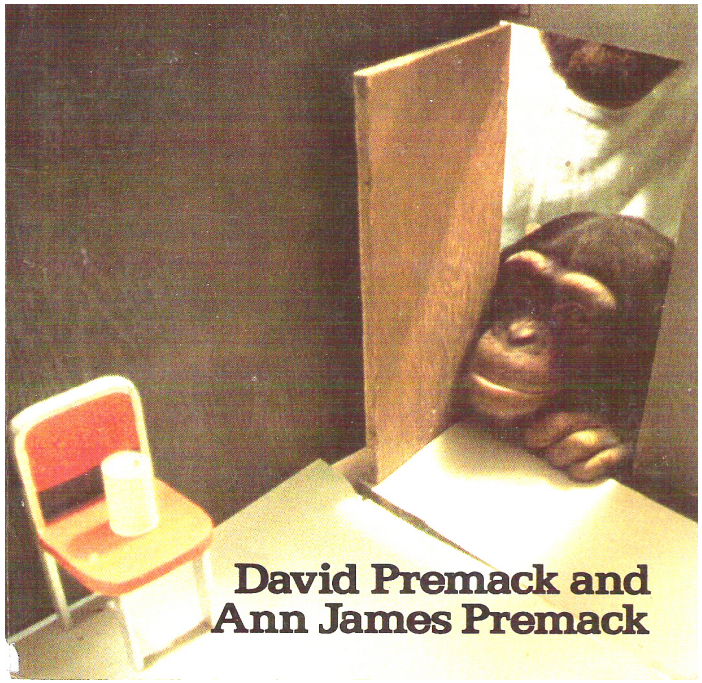
Searching Environment

Primates can also learn “paths” through virtual environment.
through VISION only.

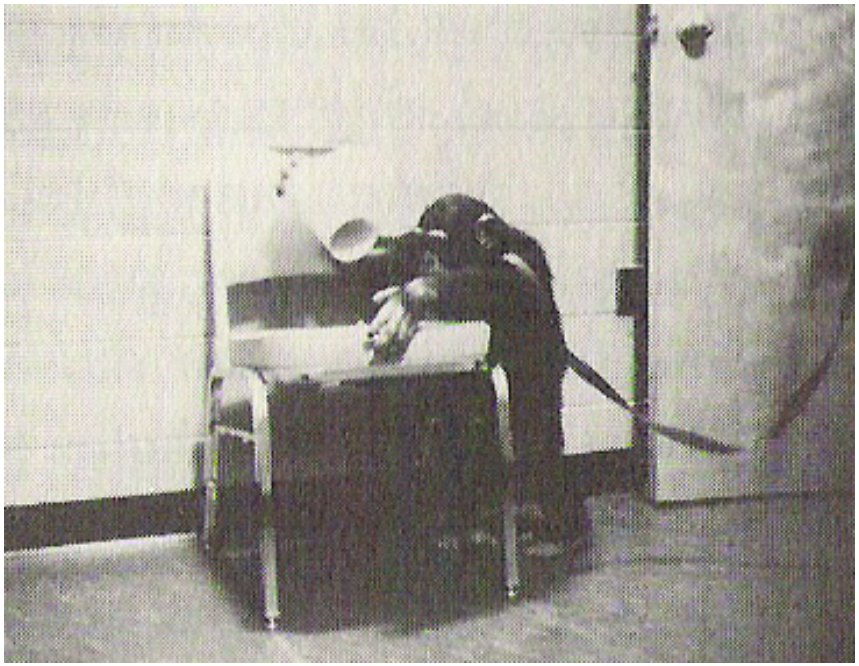


Searching Environment

- A few chimps tested can even use 3D model to represent real-world locations



- Shown model "reward" hidden in model



- Some subjects (females) can find actual reward in modeled room

(See Kuhlmeier et al 1999, 2002)

Locating

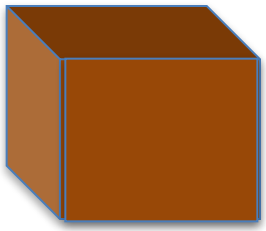
Moving Targets

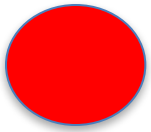
e.g. Often need to track animate prey, such as insects, reptiles

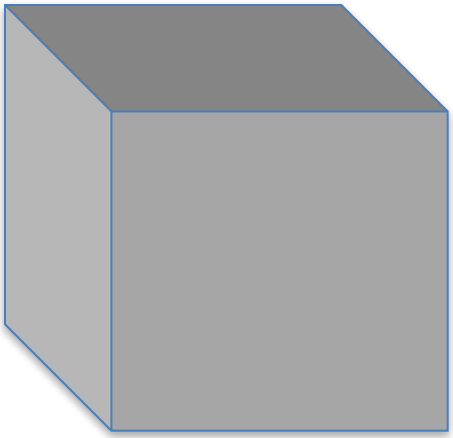
e.g. Even plants can move when handled, transported by others

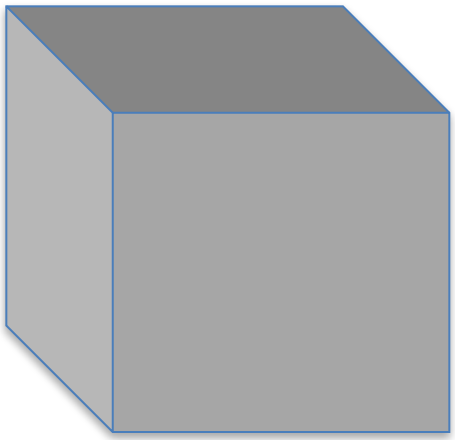
Moving Targets

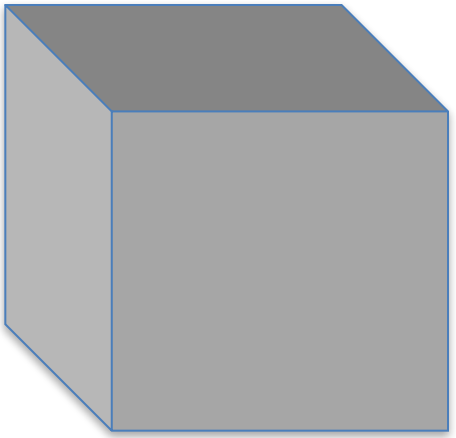
Invisible Displacement





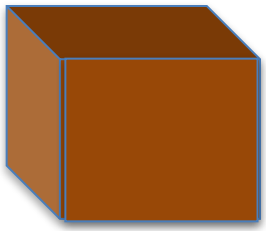


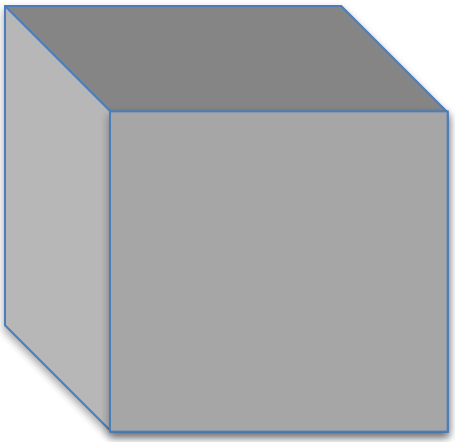


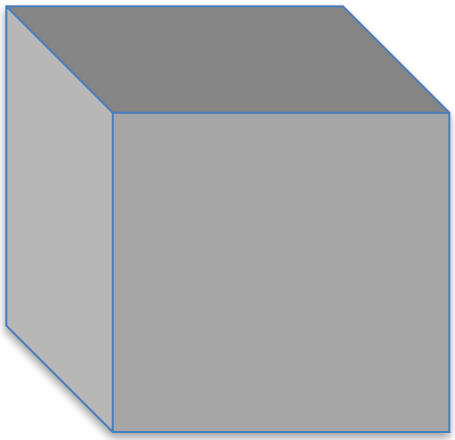


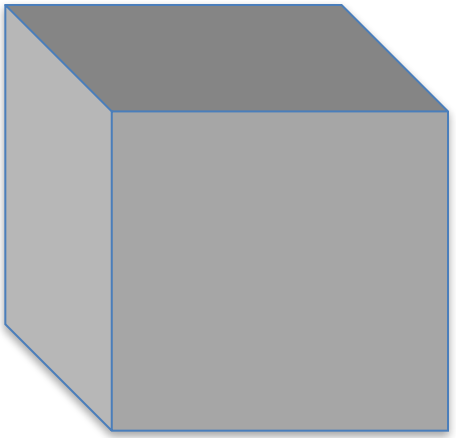
Moving Targets

Invisible Displacement



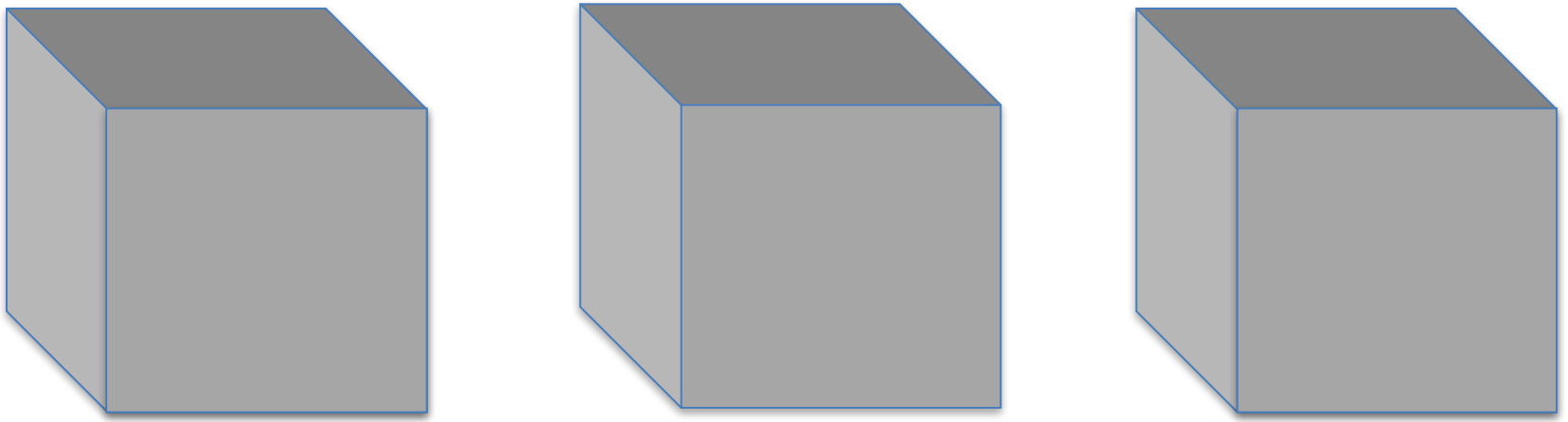






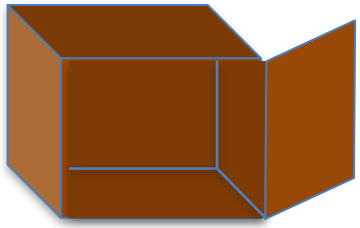
Moving Targets

Invisible Displacement



Moving Targets

Invisible Displacement



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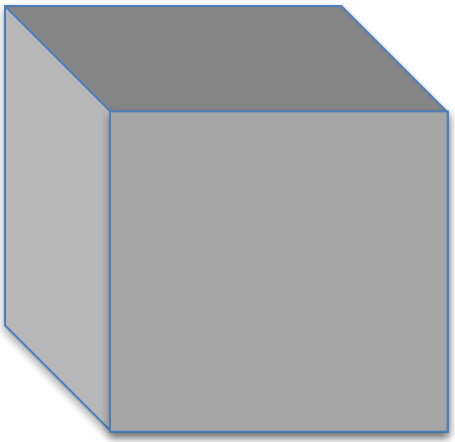
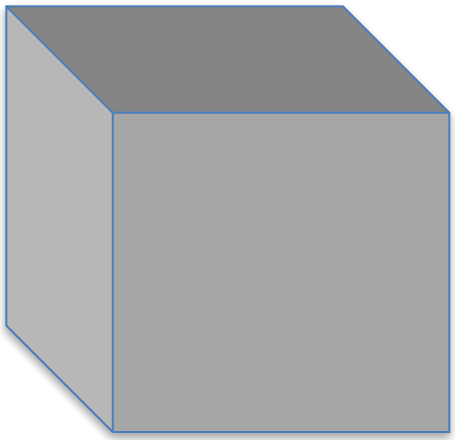
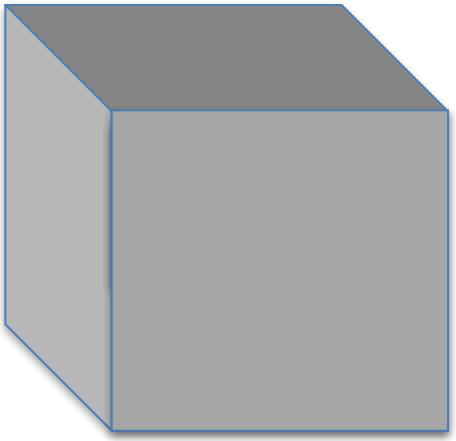




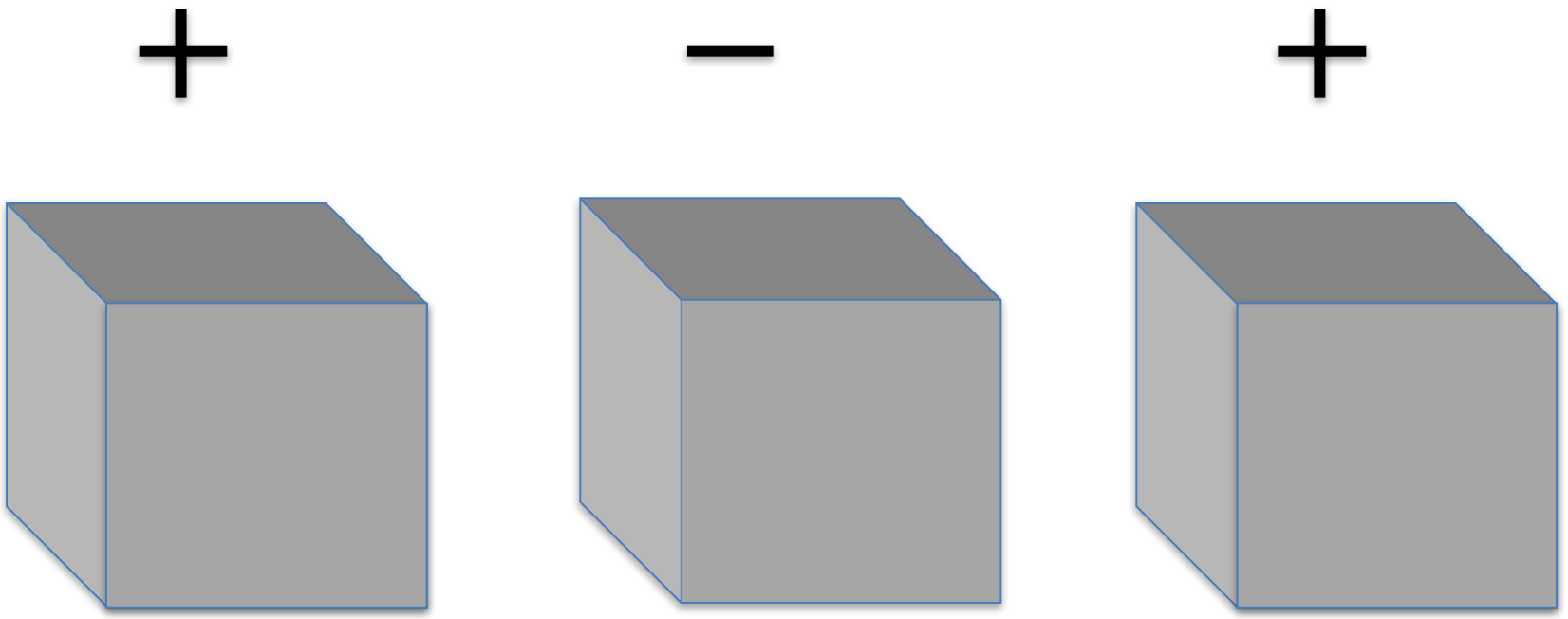


Moving Targets

Invisible Displacement

Several Apes, but only one (bright!) Cebus have succeeded.

In Humans, “Visible Displacement” at 6 mo’s; “Invisible Displacement” at 18 mo’s



Locating

Moving Targets

Visible Displacement

e.g. Watch food disappear into the mouth of another

Invisible Displacement

e.g. Watch food disappear <u>into the HAND</u> of another, who then moves away with it??!

(Perhaps why so few nonprimates pass Invisible Displacement tests?)

Locating

Controlling Resources

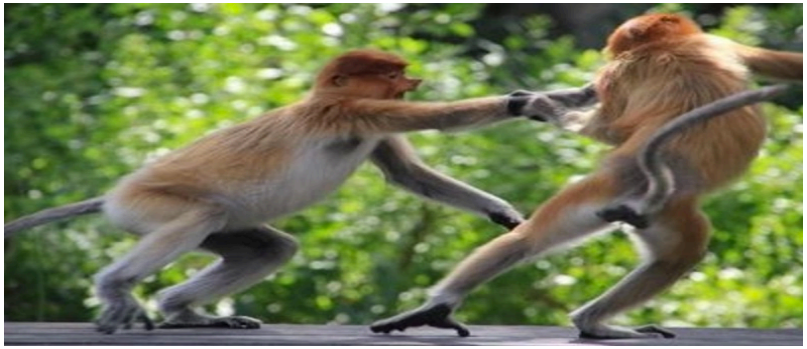
- Defend territory
  - Monogamous pairs secure smallish feeding ranges
    - Meet nuclear family's needs
      - e.g. Lesser Apes (Gibbons & Siamangs)
      - e.g. New World Callitrichids (Marmosets & Tamarins)
    - Drive off non-family; Older offspring often stay to help
  - Pairs may duet to mark claim

Locating

Controlling Resources

Can literally stuff your face...

- Compete for a given resource
  - Higher ranked animals can often displace others from resources



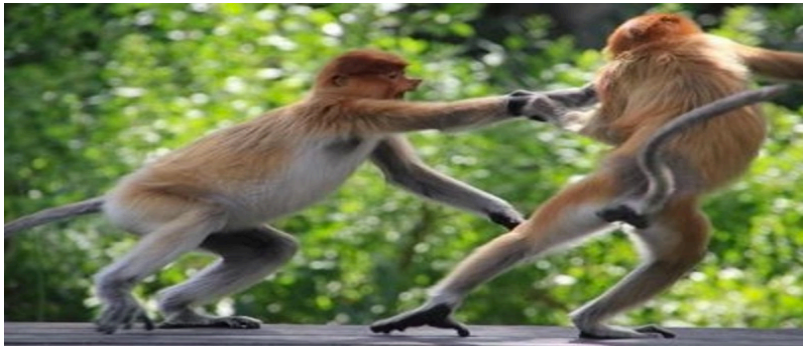
  - Food can be fought over, stolen,
    - allowed to be taken...
    - but rarely given
    - (except mother to infant)

Locating

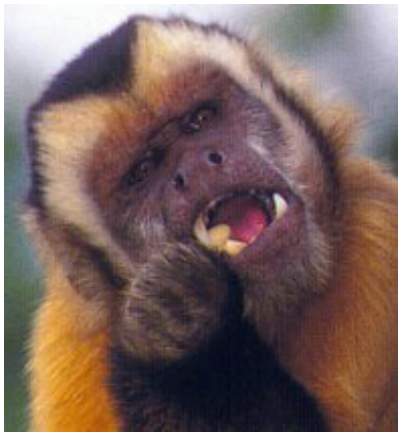
Controlling Resources

Can literally stuff your face...

- Compete for a given resource
  - Higher ranked animals can often displace others from resources



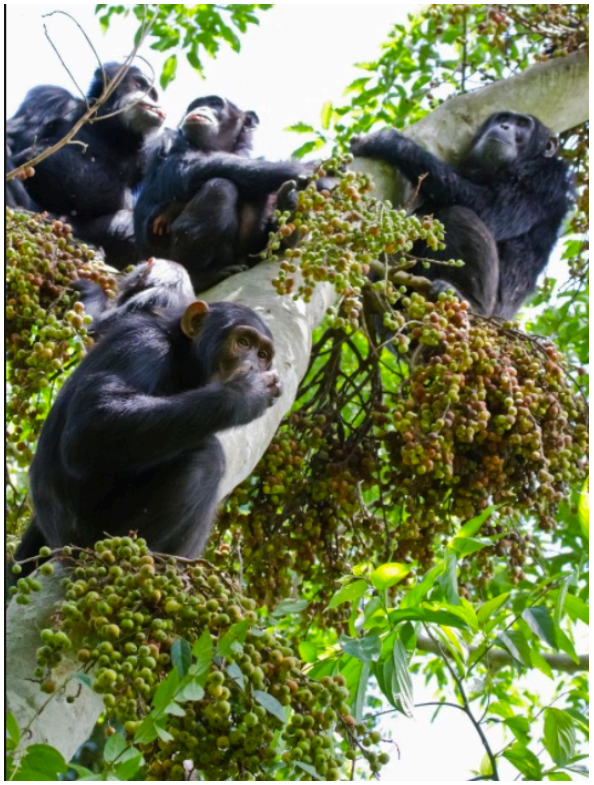
  - NOTE: All nonhuman primates have pronounced canines!
    - Good for cracking nuts, etc.
    - AND for threatening competitors!



Other Social Factors

Social Structure: *Pan* vs. *Pan*

- *Pan troglodytes* – Fairly intolerant, avoid competition
  - Forage in small groups
    - e.g. Mother & offspring



  - Although will give food call if resource is plentiful
    - e.g. Abundance of figs on one tree

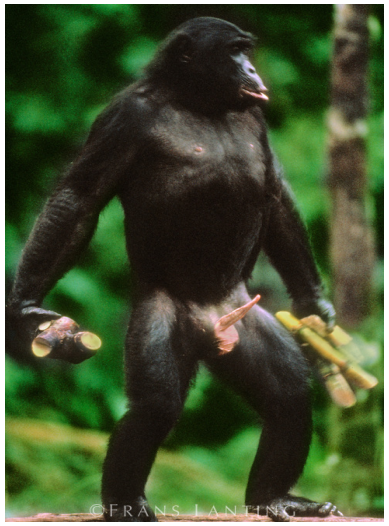
Locating

Other Social Factors

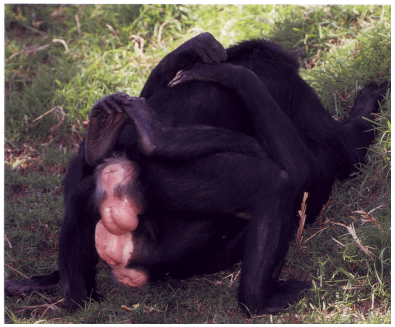
Social Structure: *Pan* vs. *Pan*

- *Pan paniscus*
  - More tolerant
  - Feed in larger groups

  - When competition raises anxiety, all have sex to promote calm



- Bonobos rub genitals with
  all gender & age partners
  (except mothers & their non-infant sons)



Locating

Other Social Factors

- Gender
  - Female chimps in Tai (Ivory Coast) more likely to change direction for better food
    - i.e. Toward rarer trees with fruit of higher fat content
      - Females often “eating for two”

Tai Forest, Ivory Coast
Dense, old growth forest

Rich *Panda oleosa* fruit

Processing edibles . . .

Processing

Follivory

- Leaves as primary diet
  - Easy but relatively poor nutrition, requires significant time investment

- Not very cognitively demanding
  - Negative correlation between brain size & gut length & in primates
    - More leaves in diet, longer gut (for bacteria that digest leaves), **smaller brain**

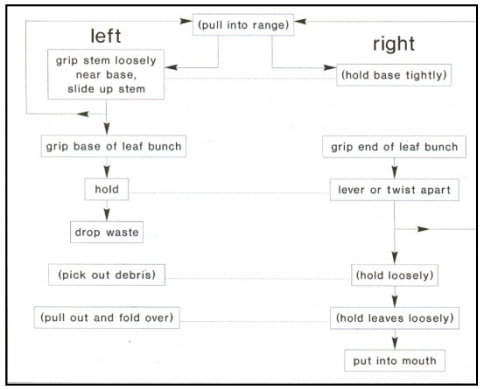
Processing

Follivory

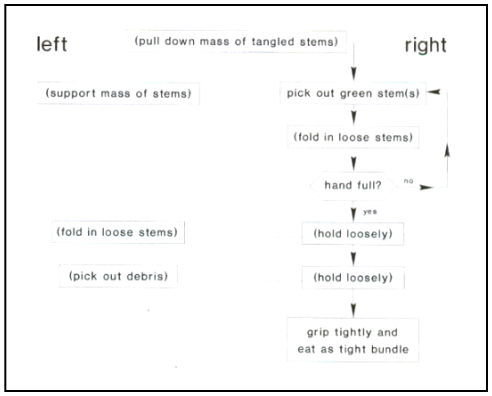
EXCEPTION:

- Large-brained Gorilla largely follivorous
  - BUT, sophisticated bi-manual dexterity
  - And simultaneous indiv finger control
    - Require more brain!

- Enables eating e.g. nutritious but well defended nettles
  - Processing hierarchically organized
    - e.g. Substitute, iterate sub-routines w/out disruption



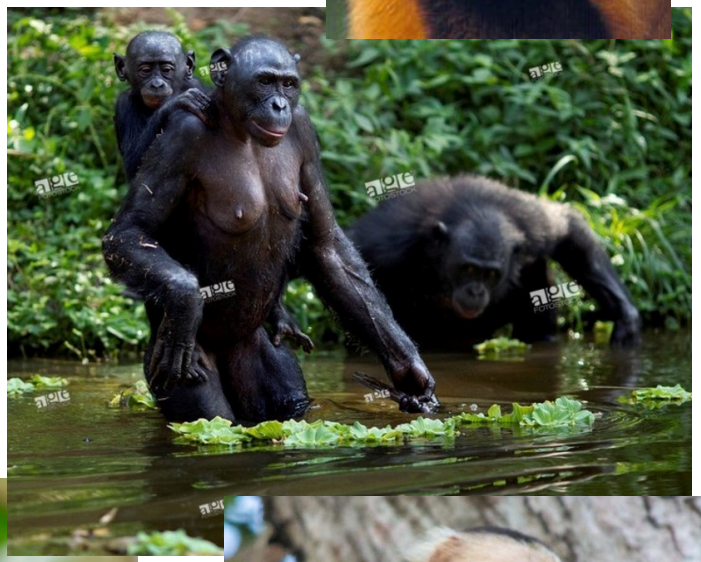
(Byrne et al, 2001)



Processing

Frugivory/Omnivory

- Diet includes **Ripe Fruit**
- Tends to include wider variety of foods (Omnivory)
  - More demanding!
  - Different locations
  - Seasonal changes
  - Varied processing



- Correlates with **larger brain**.

Processing

Fugivory/Omnivory

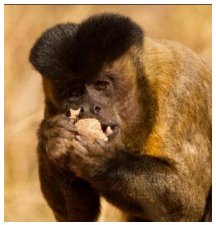
In the lab:

- While data on primate understanding of "when" is scarce,
  in one interesting study with Cebus (highest EQ in New World)
  - If amount of food added to containers increases with wait
    - *Cebus* will <u>postpone re-visit</u> to obtain a bigger reward
    - Requires <u>tracking amount of time</u> passed since last visit

- Correlates with **larger brain**.

Processing

Extractive Foraging



Sometimes even big canines are not enough...

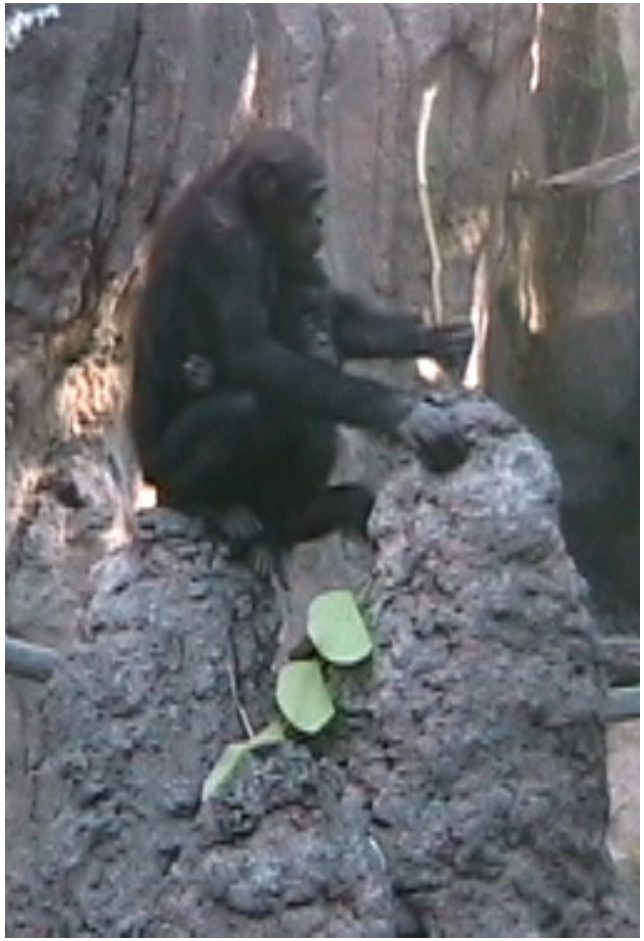
- Some nutritious foods are difficult to extract from environment
  - e.g. Hard shelled, underground, defended
    - Requires **Tools**

- <u>Only</u> Cebus, Chimps, and Orangutans
  (and of course, humans)
  commonly seen to use tools in wild
  - e.g. Crack nuts w/stone or log
  - e.g. Prepare stick to "fish" for ants or termites
  - Test the waters?

Processing

Extractive Foraging

- Includes Traditions
  - Socially transmitted,
    group-specific practices



Including those enculturated by humans...

More to come!