

**Tree-thinking:  
Do Pictorial Representations of  
Evolutionary Relationships Help or  
Hinder Museum Visitors' Understanding?**

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# OVERVIEW

1. YOUR AUDIENCE: Public's & Students'  
Understanding of Evolution

*Differs by: Evolutionary Theory, Age-group, Species.*

2. Study One: Museum visitors'... (no trees)
3. Study Two: Museum visitors'... (with trees)
4. Implications: Building on our intuitions...

# NATIONAL/INTERNATIONAL SURVEYS

## Focus: Common Descent

US Gallup Poll (2007: unchanged 20 Yrs)

- 45%: God created humans (God Only)
- 38%: Theistic evolutionist (both)
- 13%: Evolutionist (no God)
- US (45%); Europe 70%; China 69%;  
Japan 78%; (Science -NSF Science & Eng. Indicators,  
2009/2010)
- Creationism NOT -general ignorance of  
science! (Mazur, 2005)

# **CHILDREN'S EXPLANATIONS**

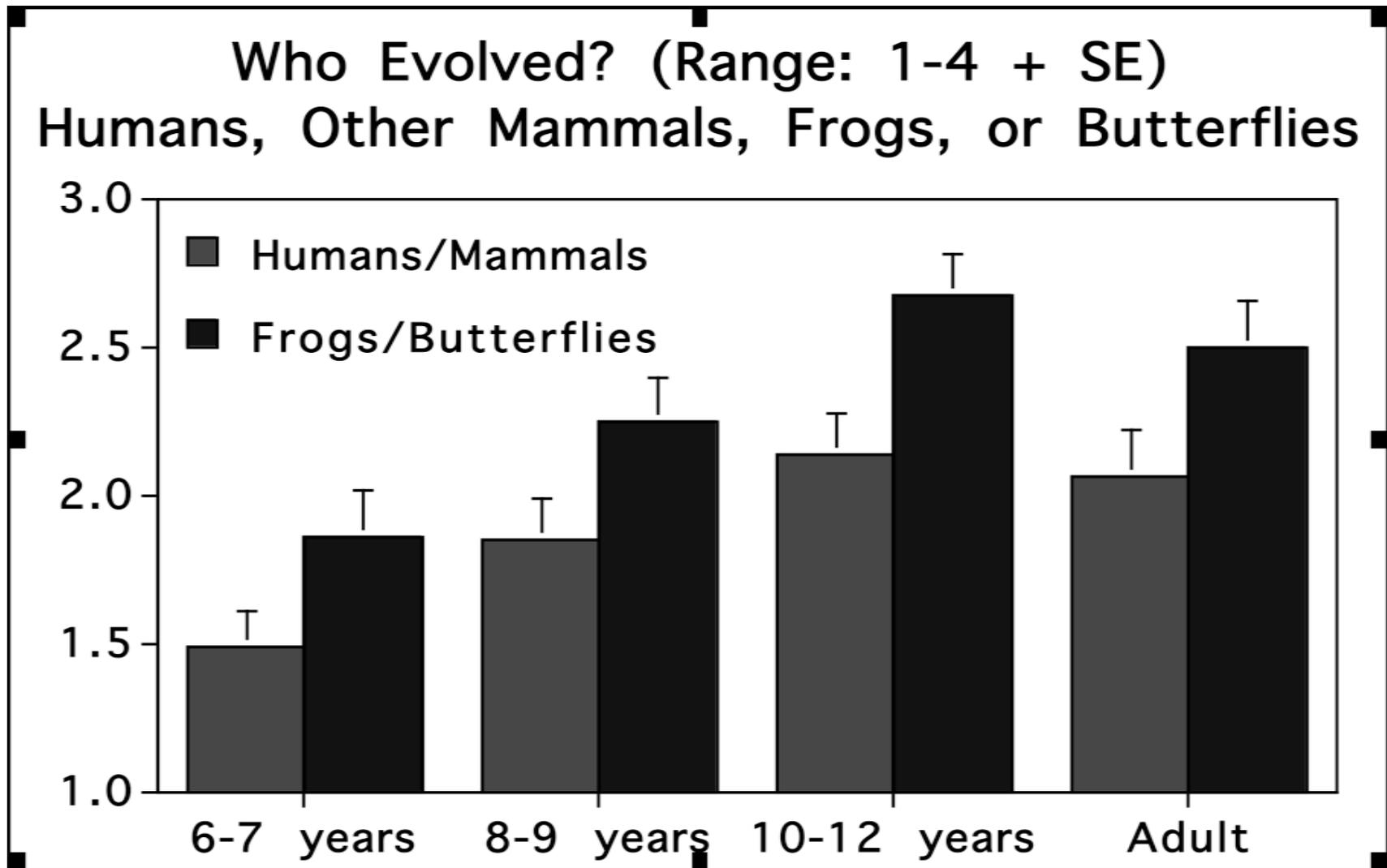
## **Focus: Common Descent**

- **5- 7 yrs: Proximate cause (“it was someplace else” “ it appeared”) & creationist.**
- **8-10 yrs: Creationist ("God made it") regardless of community or parental beliefs.**
- **10-12 yrs: Like the adult community (creationist, evolutionist, mixed)**

(Evans, 2000, 2001, 2008; Poling & Evans, 2004)

# Explanations Differ by Species

## Focus: Common Descent (Evans, 2008)



# SCIENCE EDUCATION RESEARCH

## Focus: Natural Selection

- High school, college, & medical students resist instruction (e.g., Brumby, 1975; Bishop & Anderson, 1990)
- “Need-based” adaptation: Rabbits get white fur in winter in order to hide themselves from predators
  - Ignores within-species variability
  - Natural Selection: Rabbit ancestors with white fur more likely to survive and reproduce

**CLAIM** One reason we don't get evolution: Intuitive "essentialism"

Each kind of animal has a unique unchanging "essence:" (Mayr, 1982)

Implications:

1. Common Descent: *One kind of animal cannot change into another*
2. Natural Selection: *Ignore within species variability*

Research Prediction: "Tree-thinking" challenges 1, but not 2

# Study 1: A Conceptual Guide to Museum Visitors' Understanding of Evolution

- 30, adult, natural history museum visitors
- 60% college educated or beyond
- Asked to explain 7 problems about the emergence of “new” species:
- Were NOT told that these were “evolutionary” problems
- Responses transcribed & coded (IRR >85%)

(Evans, Spiegel, Gram, Frazier, Tare, Thompson, & Diamond, 2010)

# Explore Evolution

HIV

Diatom *Stephanodiscus yellowstonensis*

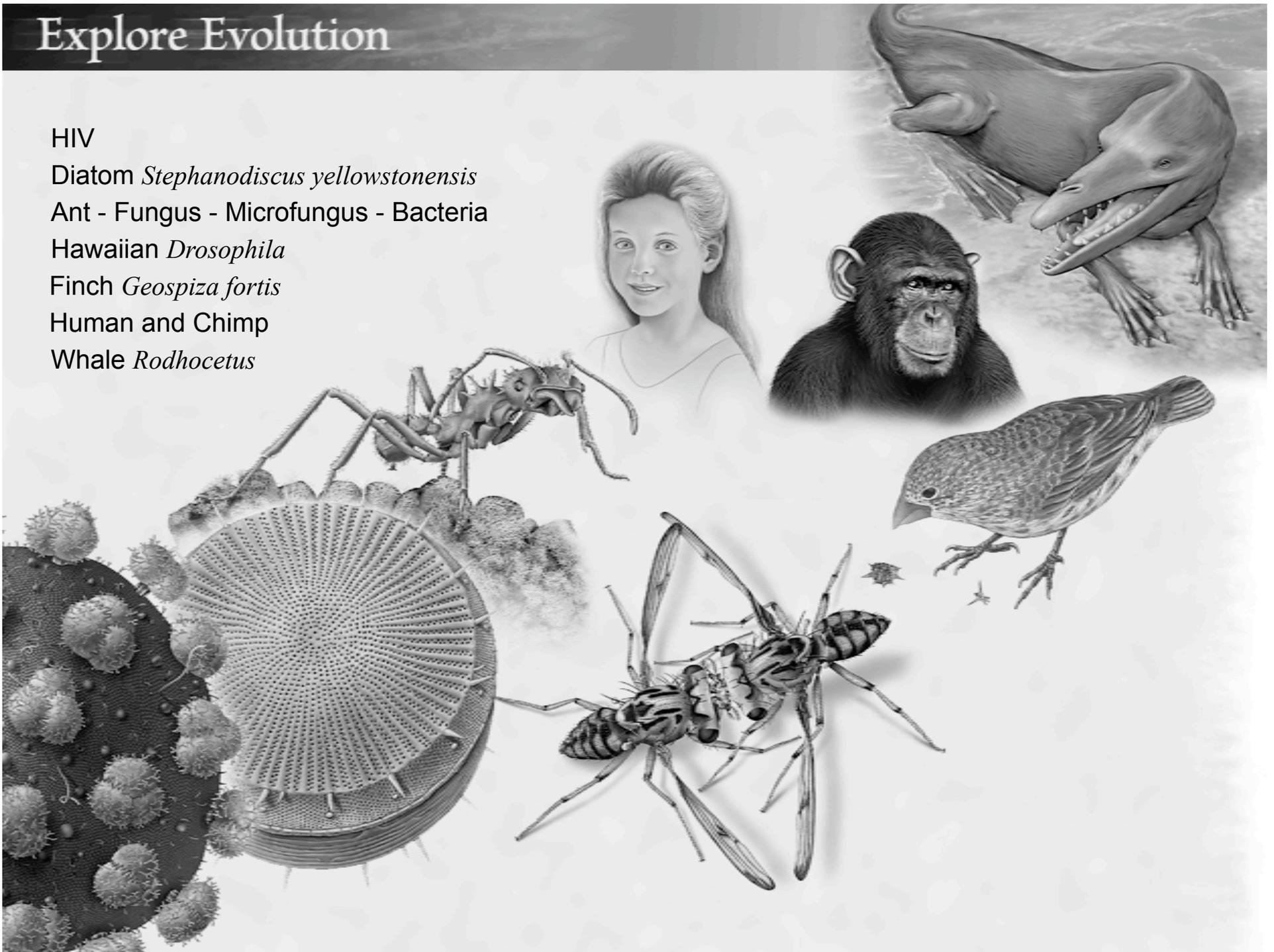
Ant - Fungus - Microfungus - Bacteria

Hawaiian *Drosophila*

Finch *Geospiza fortis*

Human and Chimp

Whale *Rodhocetus*



# Study One: Example of Question (NO Trees; No scaffolding)

FRUIT FLIES. There were once no fruit flies on Hawaii (*show map*). Then, about 8 million years ago, a few fruit flies landed on one of the islands. Now there are 800 different kinds of fruit flies in Hawaii (*show photos of flies*). How do you think that happened?

# Explanation Patterns

## 1. Evolutionary Reasoning

Evolutionary Themes: Term or Concept

## 2. Intuitive Reasoning

Need-based; Anthropomorphic

## 3. Creationist Reasoning

Explicit rejection; implicit belief

# Museum Visitors Explanations

Not ONE visitor was exclusively evolutionist  
MIXED PATTERNS

- Evolutionary/Intuitive (72%)
- Evolution/Intuitive/Creationist (28%)  
(Creation -Human mostly < public at large)

DOMINANT (Most Frequent) PATTERN

- 38% Evolutionary Reasoning
- 53% Intuitive Reasoning
- 6% Creationist Reasoning

# Themes: Related to Essentialism Claims...

Possible Range: 0-7 for each theme

1. Common Descent (Rarely Mentioned)  
*Common descent: M = 0.8; Range 0-2*  
*Between-species relationships: = 0*
2. Natural Selection (Mentioned more often)  
*Natural Selection: M = 1.0; Range 0-5*
3. Need-Based (Mentioned more often)  
*“Need-based:” M = 1.6; Range 0-6*

# FINCHES

## Evolutionary & Intuitive Patterns “Need-Based Reasoning”

- “Evolution for survival. ...Well, in order to survive, their body parts had to adjust to certain things, similar to the way giraffes' necks probably grew long as they reached for the plants at the top of the trees, so the beak grew longer in order to deal with the tougher seeds.”

# **SUMMARY (No Trees)**

- Only, 38% visitors consistently give evolutionary explanations
- (see also Macfadden et al., 2007 & Abrahams-Silver & Kisiel, 2008 – Australia & Canada)
- Humans elicit more creationist reasoning
- Common descent and taxonomic relationships rarely mentioned
- Significantly more likely to mention a mechanism of change (natural selection and/or need-based reasoning)

# Study 2: "Tree-Thinking"

- 30 Adults (Novices)
  - 13, 15-18 year-olds (youth)
  - 21, 11-14 year-olds (child)
  - Similar demographics to Study 1 participants
  - Typical gallery visit to "Explore Evolution"
  - Pre- and Post-test qualitative and quantitative Interviews; demographics
  - 15 Evolutionary Biologists (Expert Control)
- (Evans et al., in preparation)

# Stimuli: Evolutionary Graphics

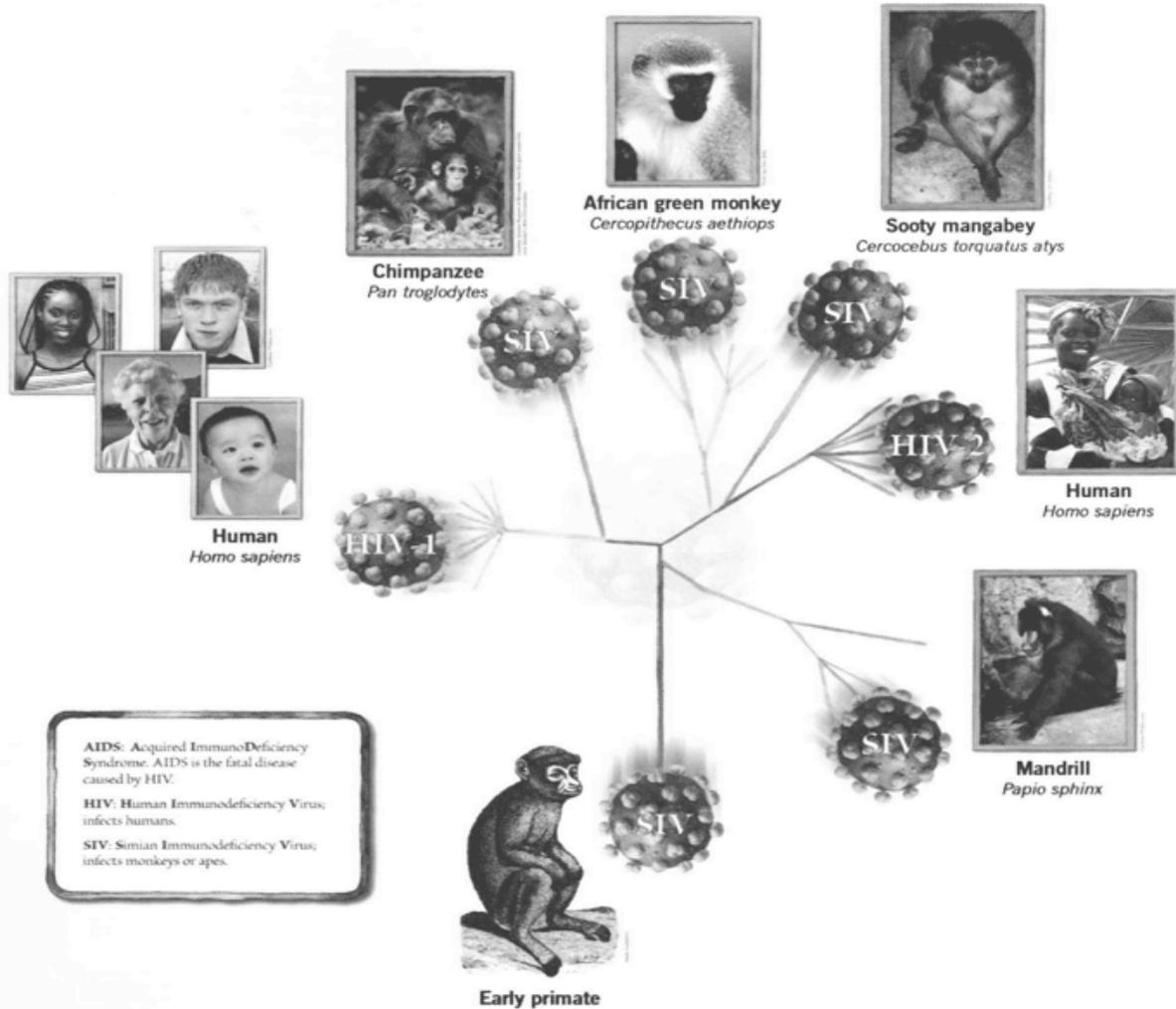
- Virus, fly, whale and human graphics

## Two Main Questions

- What do you think this picture is trying to show?
- How do you think that happened?
- Responses transcribed & coded (IRR > 85%)

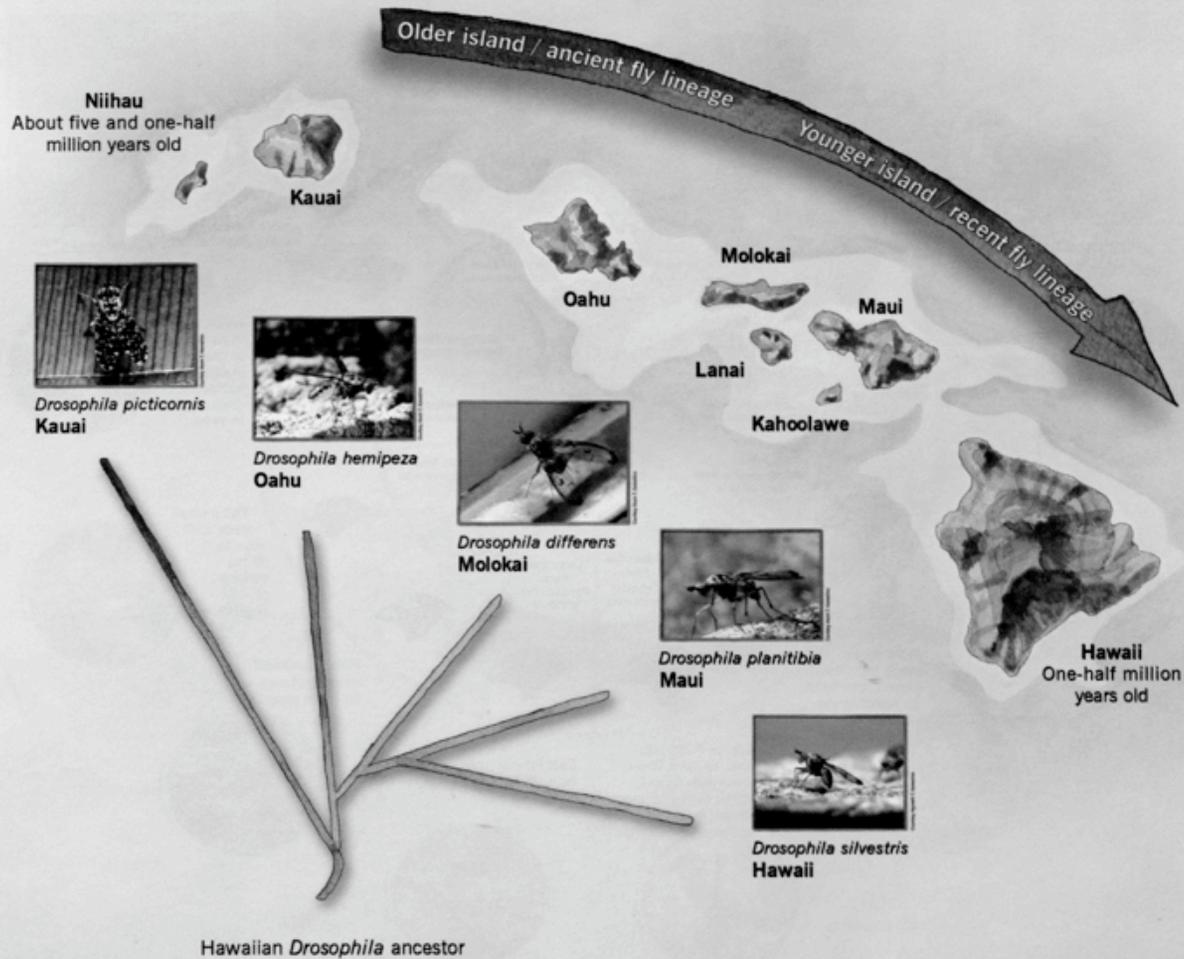
# The Genealogy of a Killer

HIV causes AIDS, one of the greatest threats to public health worldwide today. The disease evolved from viruses that infect African primates.



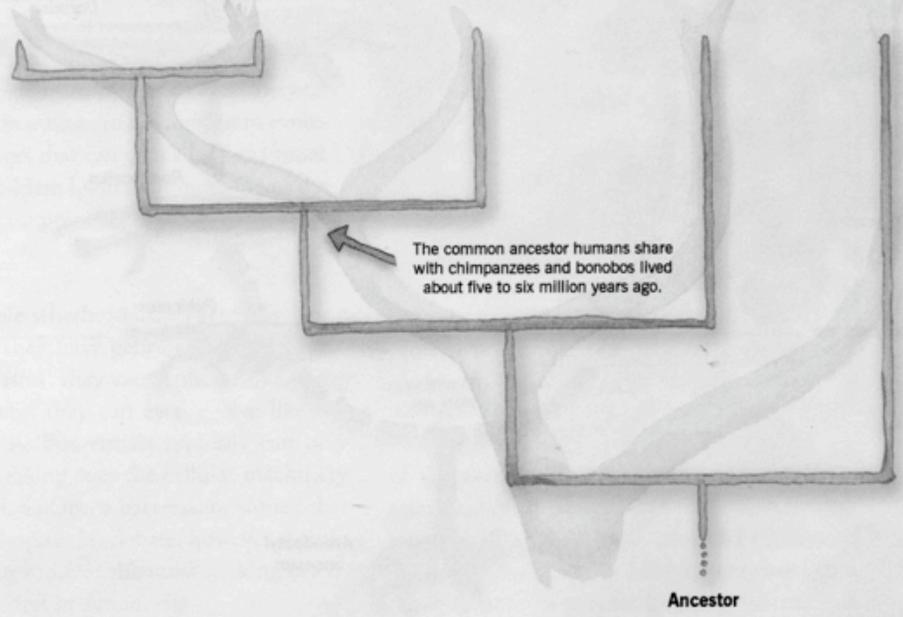
# Hawaii as a Nursery of Evolution

More than 800 species of *Drosophila* flies live on the islands of Hawaii and nowhere else on Earth. They may all descend from a single pregnant fly that came there several million years ago.



# Our Closest Living Relatives

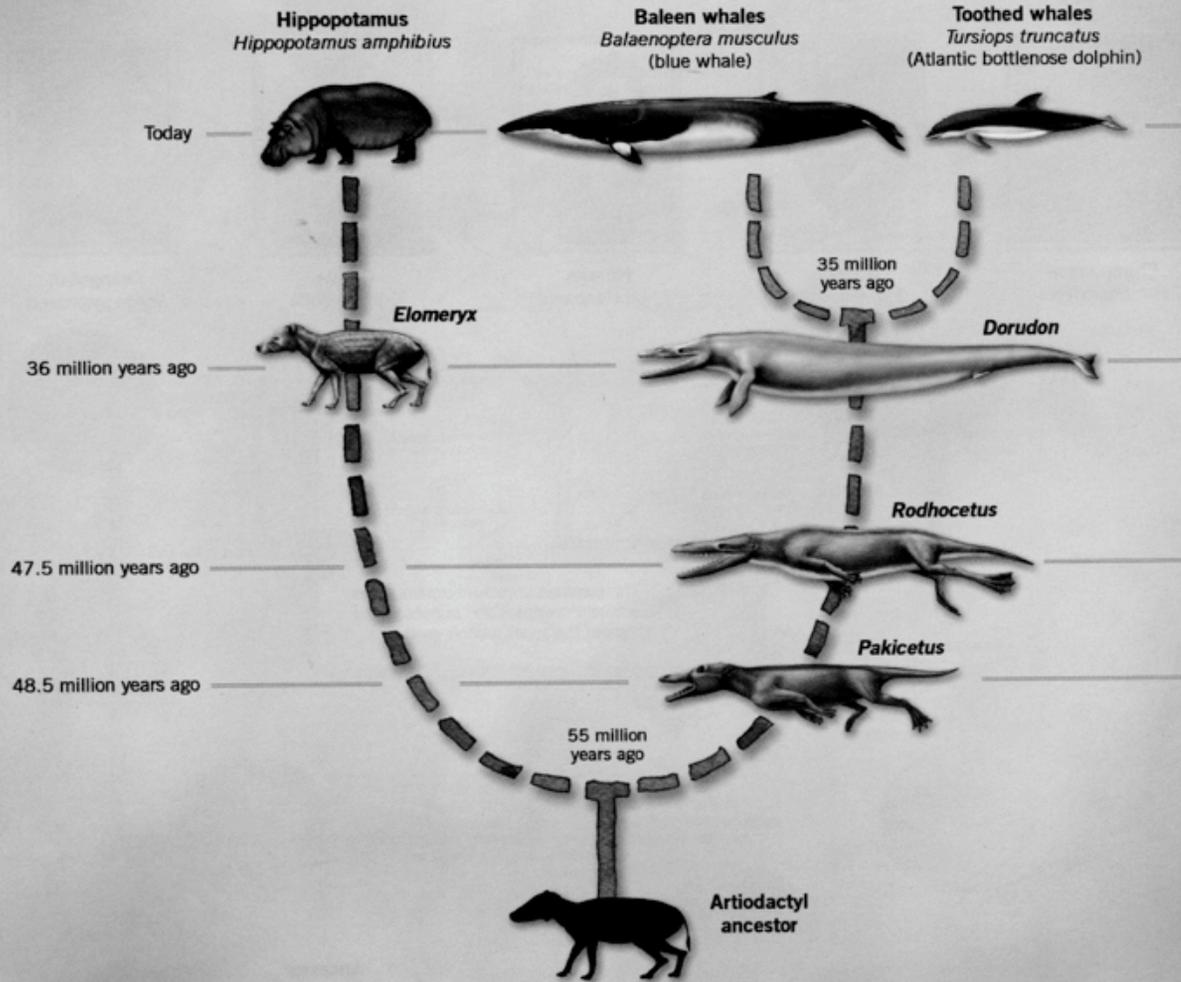
DNA reveals that humans share a common ancestor with apes, our closest living relatives.



UNSM Angie Fox and SMM illustration, Chimpanzee photo courtesy Michael Neugebauer, Bonobo photo courtesy Mike Nepper Milwaukee County Zoo, Human, Gorilla, Orangutan photos courtesy photos.com.

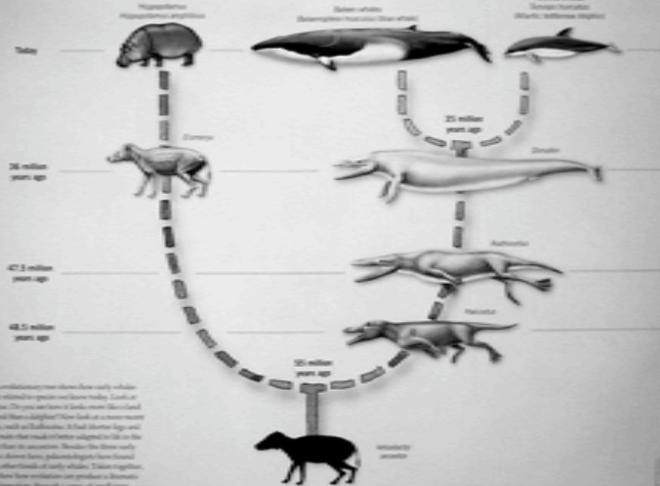
# Whales: Evolution from Land to Sea

Today's whales evolved from four-legged land mammals that lived about 55 million years ago.



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The transition from these early whales to modern whales was a gradual process. Land at 55 million years ago was a vast, flat plain. The sea was shallow and warm. The land mammals that lived there had four legs and were adapted to life on the ground. As the sea level rose, some of these mammals began to spend more time in the water. Over time, they evolved into whales through a series of small steps over millions of years.

## Taking the Plunge

As they began to spend more time in the water, whales evolved several adaptations that helped them survive. These include:

- V** **Flippers:** The front legs of whales evolved into flippers, which are used for steering and stability in the water.
- I** **Blubber:** Whales have a thick layer of blubber that helps them stay warm in cold water.
- S** **Streamlined Bodies:** Whales have a body shape that is adapted for swimming, with a rounded snout and a tail that is used for propulsion.
- T** **Respiration:** Whales have a blowhole on top of their heads, which allows them to breathe air while swimming.

## Linking Whales to the Past

Philip Gingerich compares the skulls of ancient whales with the skeletons of living whales. By discovering their similarities and differences, he is learning how whales evolved from land mammals.



**Meet the scientist**  
Philip Gingerich is a paleontologist who studies the evolution of whales. He has discovered many new species of ancient whales and has helped to establish the evolutionary link between land mammals and modern whales.

### Evidence for Whale Evolution



## Transitional Whale



# Focus 1: Common Descent "Between" Species Change

Do "trees" (graphics) elicit themes related to common descent?

1. Relationships
2. Common Descent

What do you think this picture is trying to show?

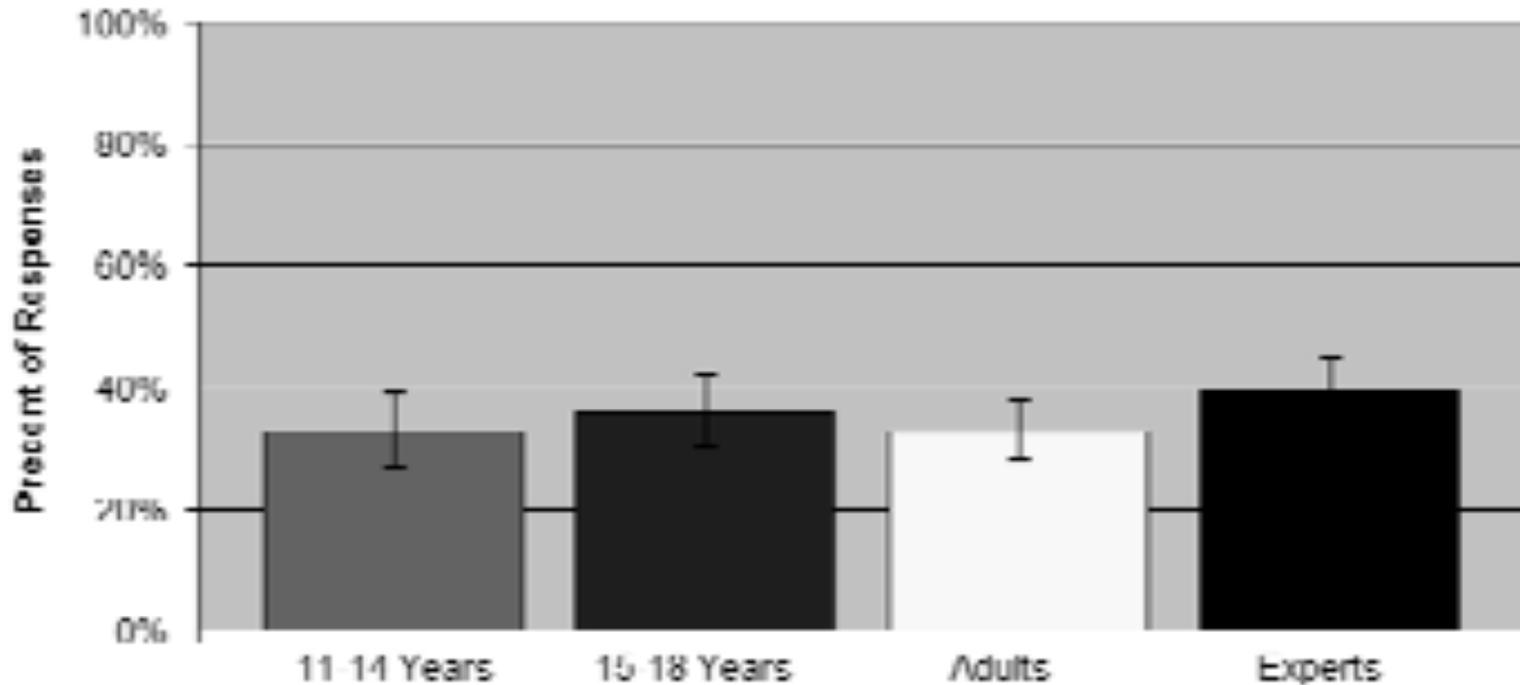
- Adult Novice (Virus): “First thing I guess that leaps out at me is I see pictures of humans, primates and the HIV virus. And it’s set up to show some sort of relationship between the three. ...”

What do you think this picture is trying to show?

- Expert (Fly): “...it’s the relationship, the phylogenetic relationship between the fruit flies that live in the Hawaiian Islands.”

What do you think this picture is trying to show?

Relationships Between Species



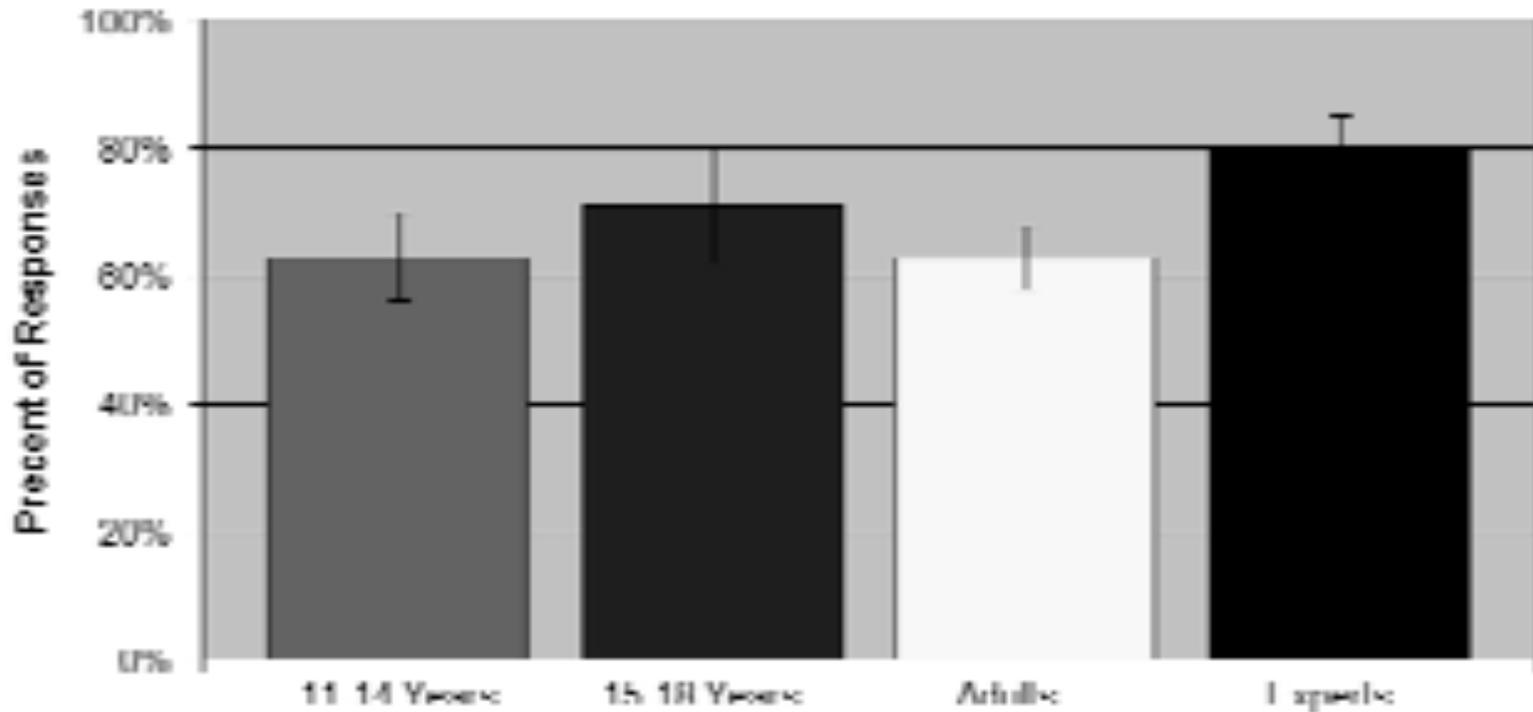
What do you think this picture is trying to show?

## Common Descent

- Adult Novice “How hippopotamuses and modern whales have a common ancestor. And how some of the earlier fossil records they think played a part in that.”
- Youth “... and they both evolved from a land walking mammal”

What do you think this picture is trying to show?

Common Descent



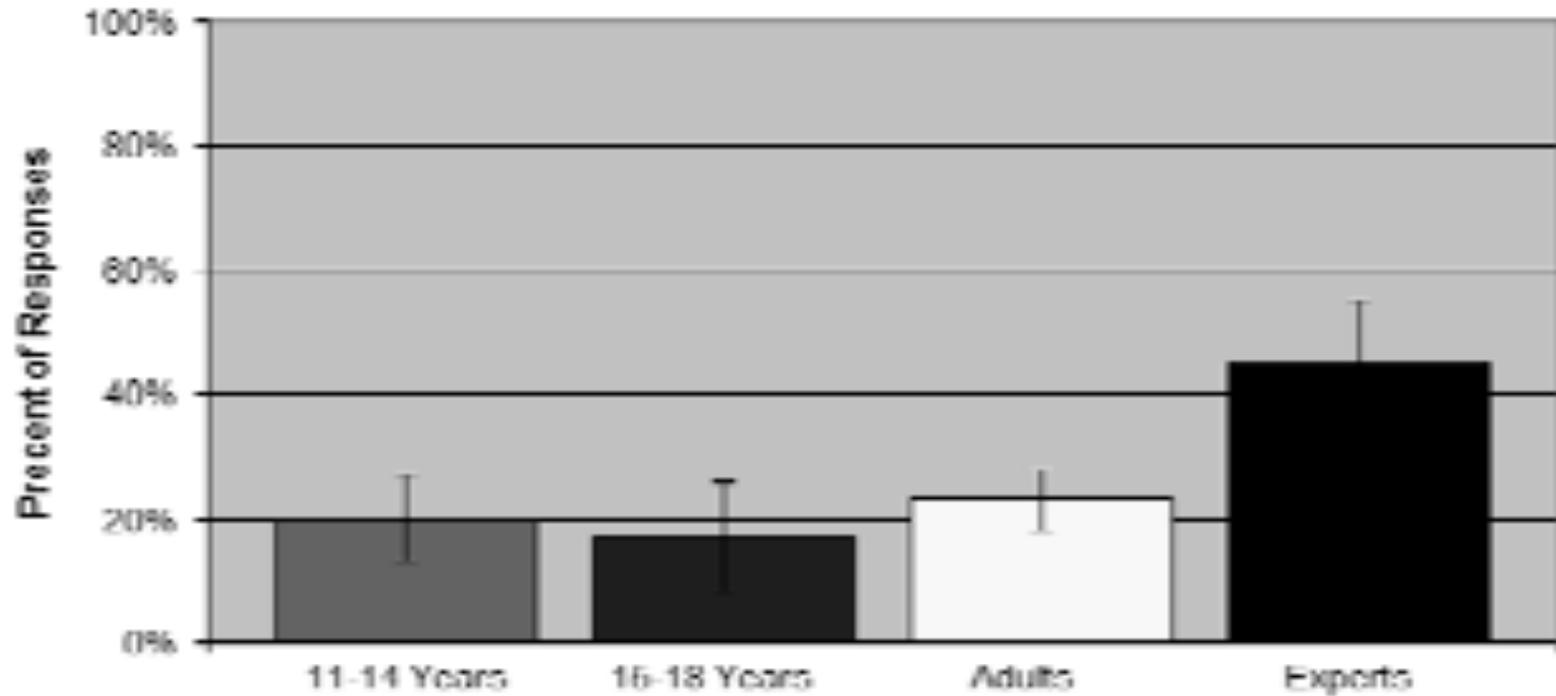
## Focus 2: Within-Species Variability

Do “trees” elicit themes related to within-species variability?

1. Natural selection
2. Need-based reasoning

# How do you think that happened?

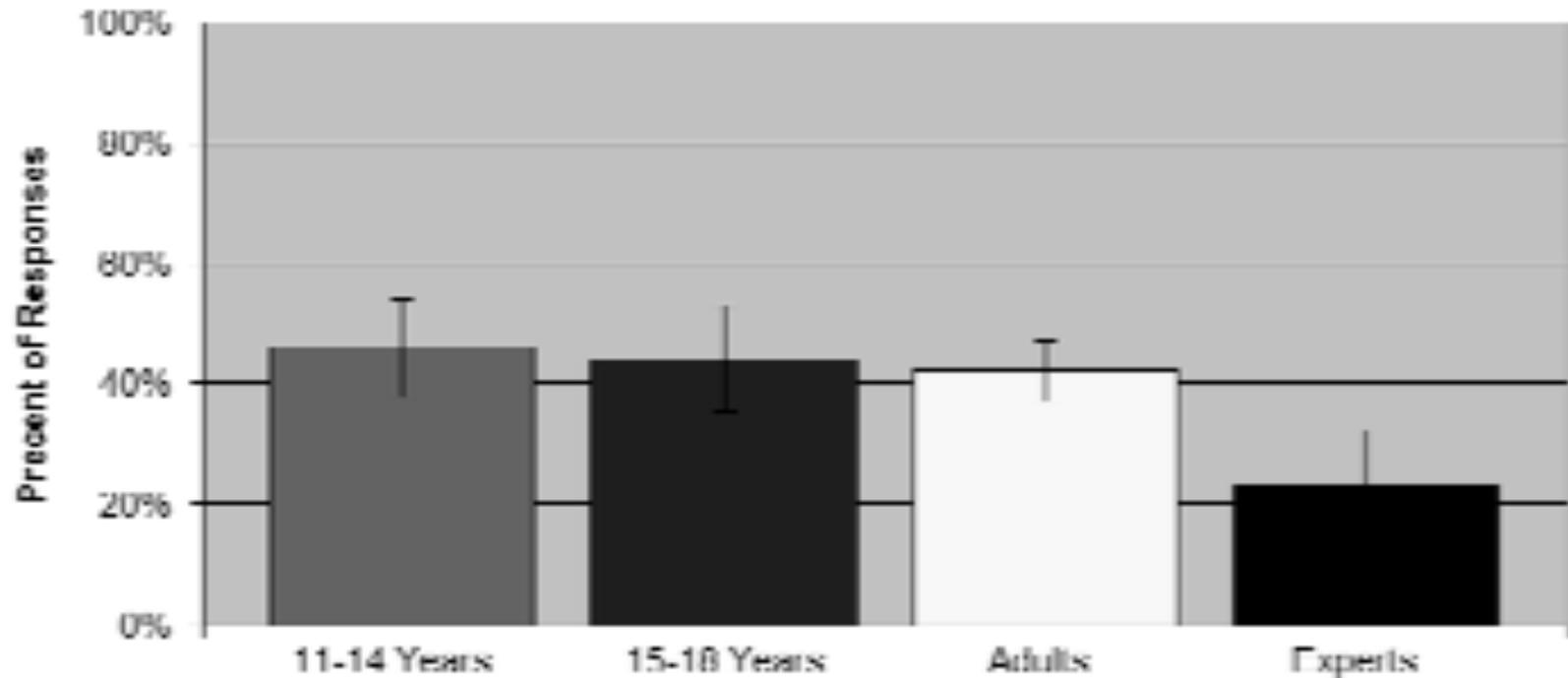
## Natural Selection



# How do you think that happened?

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## Need Based



# Conclusion: In contrast with Study One (no "Trees")

## Common Descent

"Tree-thinking" elicits explanations of:

- Between species relationships
- Common descent

## Natural Selection

"Tree-thinking" impedes visitors' (but not experts') grasp of:

- Natural selection

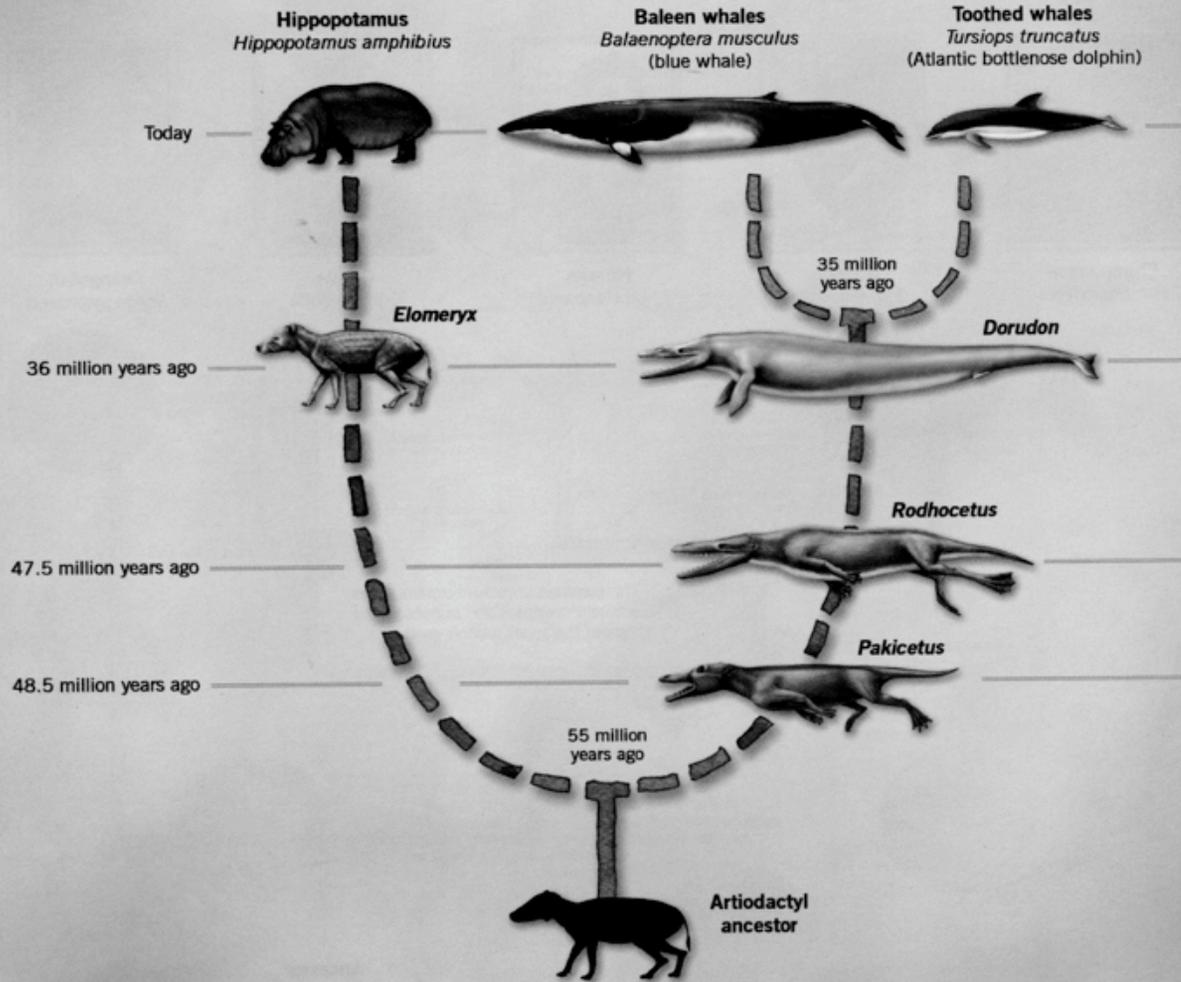
Elicits need-based reasoning

# Why? Trees both challenge and reinforce intuitive beliefs

1. “Trees” challenge the essentialist intuition that change from one kind of animal to another is impossible
  - Foster grasp of species relationships
2. “Trees” reinforce visitors’ intuitions about the mechanism of change
  - No portrayal of within-species variability
  - Present prototypical members of a taxon
  - Implied directionality, towards a goal

# Whales: Evolution from Land to Sea

Today's whales evolved from four-legged land mammals that lived about 55 million years ago.





**Primate Graphic: Easiest to interpret -many noted the human**

Adult Novice: “I think it’s interesting it’s done this way, that the picture of the human was right in the middle rather than off to the end...”

# Additional Results

1. Nature of science: No visitor mentioned the scientific process (Experts often did)
2. Scientific language: (Experts > Novices)
3. Time (Experts > Novices)
4. Intuitive belief: Change from one “kind” to another (Novices > Experts)

# Interpretation: Implications for Exhibit Design

What is your message? Who is your audience?

1. A different learning progression for common descent and for natural selection

*Fostering one does not necessarily help the other (see also Evans et al., 2010a; 2010b)*

2. Consider age-group/expertise differences
3. Consider species/taxon differences
4. Consider the context/the entire exhibition

# Conceptual Gap: The Case of Evolution

<b>Everyday Concepts</b>	<b>Transitional Concepts</b>	<b>Scientific Concepts</b>
Cultural Ideas Intuitive Ideas	?	Scientific Theories

# What are the Effects of “Evolution Interventions”?

Everyday Concepts	 Transitional Concepts	Scientific Concepts
<ul style="list-style-type: none"><li>• Cultural Ideas</li><li>• Intuitive Ideas</li></ul>	<ul style="list-style-type: none"><li>• Need-based Language</li><li>• Mixed Intuitive/ Evolutionary Concepts</li></ul>	<ul style="list-style-type: none"><li>• Darwinian evolution</li></ul>

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