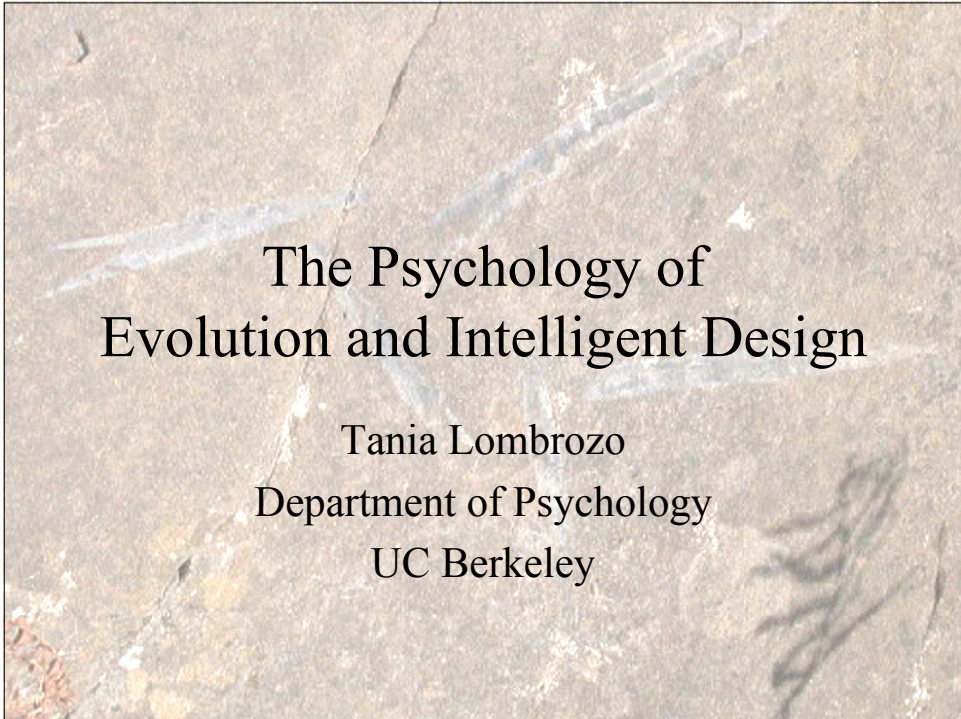


## From magic to muons: why people believe in strange things

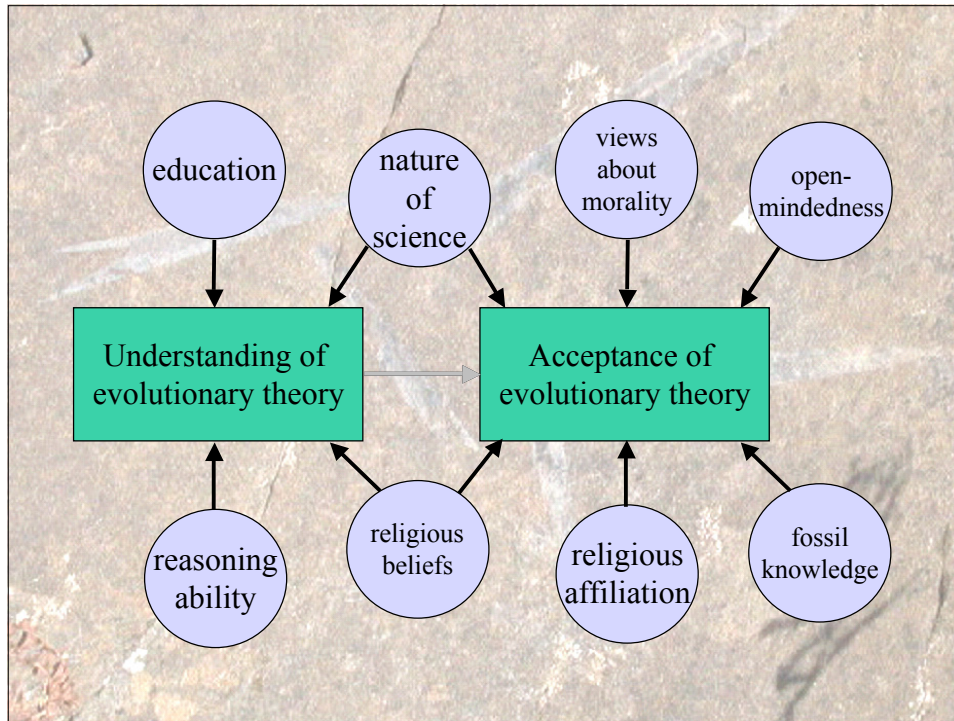
Tania Lombrozo  
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UC Berkeley



## The Psychology of Evolution and Intelligent Design

Tania Lombrozo  
Department of Psychology  
UC Berkeley





**Part I: Understanding**

How well is evolution understood?  
 Are there systematic misconceptions?  
 Why?

**Part II: Acceptance**

What leads some people to accept evolution while others favor creationism?

**Part III: Why creationism?**

What makes us the sorts of creatures who prefer creationism?



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## Misconceptions about natural selection

- Species change in response to need
- All individuals “adapt” simultaneously
- Population changes because individuals’ traits change, not because *proportion* of individuals with traits changes
- (“Adaptation” occurs within an individual’s lifetime and is passed on to offspring)

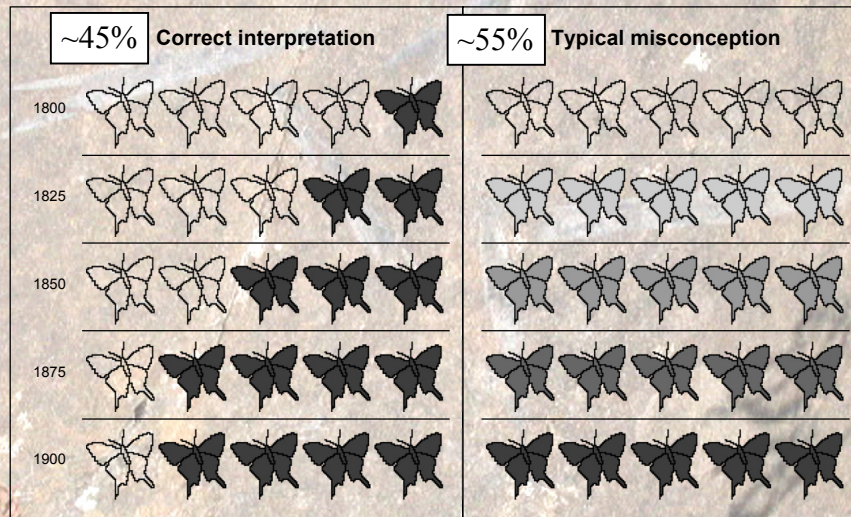
**Correct view?**

**High School: < 30%**

**College: < 50%**



## An example



(Shtulman, 2006)

## Consequences:

- Evolution as “march of progress” (Harrold & Eve, 1995)
- No role for variation
  - <10% mention on free response (Dagher & Boujaoude, 1997)
  - <20% recognize it precludes NS (Lombrozo, 2006)
- Macroevolution complicated
  - E.g. “Dinosaur essentialism,” 23% of 3<sup>rd</sup> & 5<sup>th</sup> graders (Samarapungavan & Wiers, 1997)
- Extinction not inevitable (Poling & Evans, 2004)
- Sources of evolutionary evidence opaque
  - E.g. variation, differential reproduction/fitness, < 50% recognize NS requires differential reproduction (Lombrozo, 2006)



## The standard misconceptions

- **Very consistent pattern across studies**
  - (Brumby, 1979, 1984; Clough & Wood-Robinson, 1985; Lawson & Thomson, 1988; Bishop & Anderson, 1990; Greene, 1990; Settlage, 1994; Jensen & Finley, 1995, 1996; Dagher & Boujaoude, 1997; Sinclair et al., 1997; Southerland, 2001; Shtulman, in press; Lombrozo, 2006...)
- **Individuals relatively internally consistent**
  - (Ferrari & Chi, 1998; Shtulman, 2006)
- **Remarkably impervious to instruction**
  - **Learning:** Brumby, 1979, 1984; Bishop & Anderson, 1990; Jensen & Finley, 1995; Settlage, 1994
  - **No learning:** Sinclair et al., 1997; Demastes et al. 1995; Lawson & Worsnop, 1992; Pederson & Hallden, 1994

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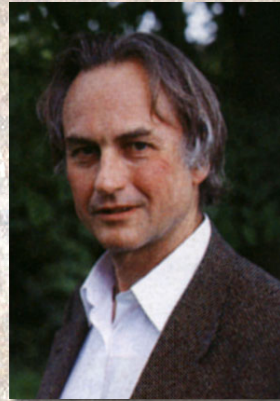
What makes us the sorts of creatures who prefer creationism?



## Why the misconceptions?

“It is almost as if the human brain were specifically designed to misunderstand Darwinism, and to find it hard to believe.”

**Richard Dawkins**



## Possible sources:

- (1) Difficult conceptual prerequisites
  - (time: Dodick & Orion, 2003; randomness: Kahneman & Tversky, 1972, exponential growth: Anderson et al., 2002)





## Source 1: Conceptual Prerequisites

- Poor understanding of geological time (Dodick & Orion, 2003)
- Poor understanding of randomness and probability (Kahneman & Tversky, 1972)



## Possible sources:

- (1) Difficult conceptual prerequisites
  - (time: Dodick & Orion, 2003; randomness: Kahneman & Tversky, 1972, exponential growth: Anderson et al., 2002)
- (2) Misleading language
  - (Brumby, 1979; Clough & Wood-Robinson, 1985; Bishop & Anderson, 1990; Tamir & Zohar, 1991; Pederson & Hallden, 1994; Abrams et al., 2001)



## Source 2: Language

- “Adapt”/adaptation (Brumby, 1979; Bishop & Anderson, 1990; Pederson & Hallden, 1994)
  - Deliberate process
  - Within individual lifetime
- “Fitness” (Bishop & Anderson, 1990)
  - Intuitively good properties, not good enough/better
- Teleological language
  - Suggests change induced by need (Clough & Wood-Robinson, 1985; Tamir & Zohar, 1991)
  - De-emphasizes “how”/causal mechanism (Abrams et al., 2001)

## Possible sources:

- (1) Difficult conceptual prerequisites
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- (2) Misleading language
  - (Brumby, 1979; Clough & Wood-Robinson, 1985; Bishop & Anderson, 1990; Tamir & Zohar, 1991; Pederson & Hallden, 1994; Abrams et al., 2001)
- (3) False analogies
  - (Ferrari & Chi, 1998; Evans, 2001)



## Source 3: False Analogies

- “Apparent design” is like intentional design (Evans, 2001)
  - Change based on need
- Biological inheritance is like cultural “inheritance” (Evans, 2001)
  - Inheritance of acquired characteristics

## Possible sources:

- (1) Difficult conceptual prerequisites
  - (time: Dodick & Orion, 2003; randomness: Kahneman & Tversky, 1972, exponential growth: Anderson et al., 2002)
- (2) Misleading language
  - (Brumby, 1979; Clough & Wood-Robinson, 1985; Bishop & Anderson, 1990; Tamir & Zohar, 1991; Pederson & Hallden, 1994; Abrams et al., 2001)
- (3) False analogies
  - (Ferrari & Chi, 1998; Evans, 2001)
- (4) Psychological essentialism
  - (Gelman, 2003; Medin & Atran, 2004)



## Source 4: Psychological Essentialism

- Assumption that the outward appearance of a species is determined by a hidden cause or “essence” shared by all species members (Gelman, 2003; Medin & Atran, 2004)
- Species defined by common essence
  - variation is “noise,” deviation, unimportant
- Species change is essence change
  - essence changes in every individual
- Essence can’t change “kind”
  - no macroevolution

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What makes us the sorts of creatures who prefer creationism?



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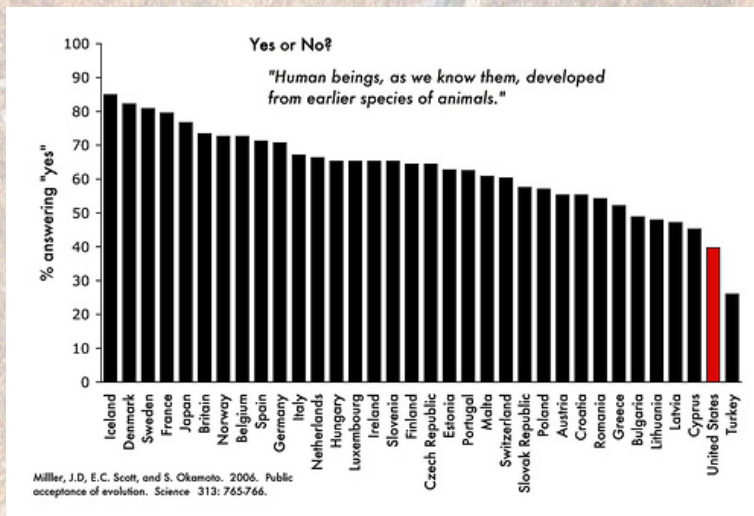
## Part II: Acceptance

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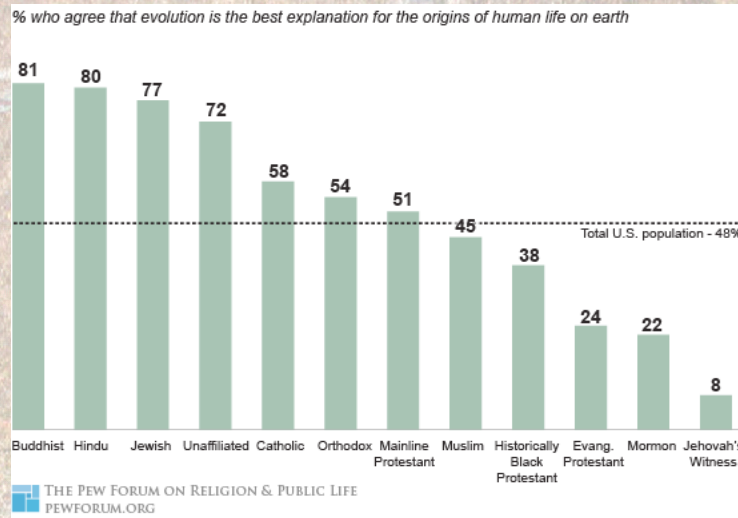
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## Acceptance in US



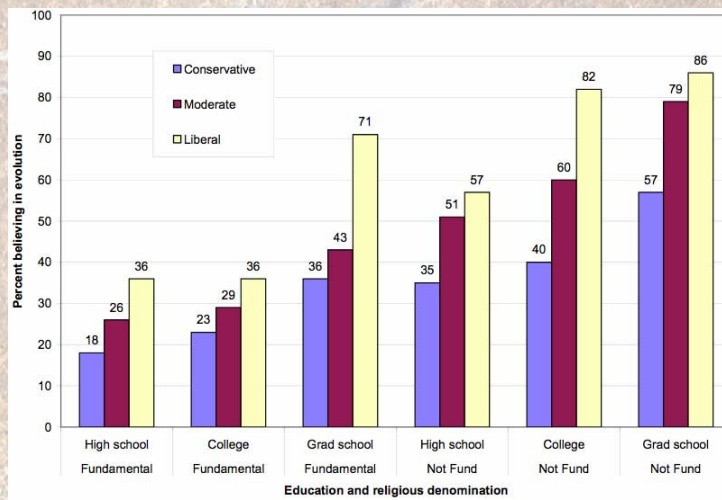


## Acceptance by religion



(Pew, 2009)

## Acceptance by affiliation & education



(Mazur, Science, 2007)



## Influences on belief

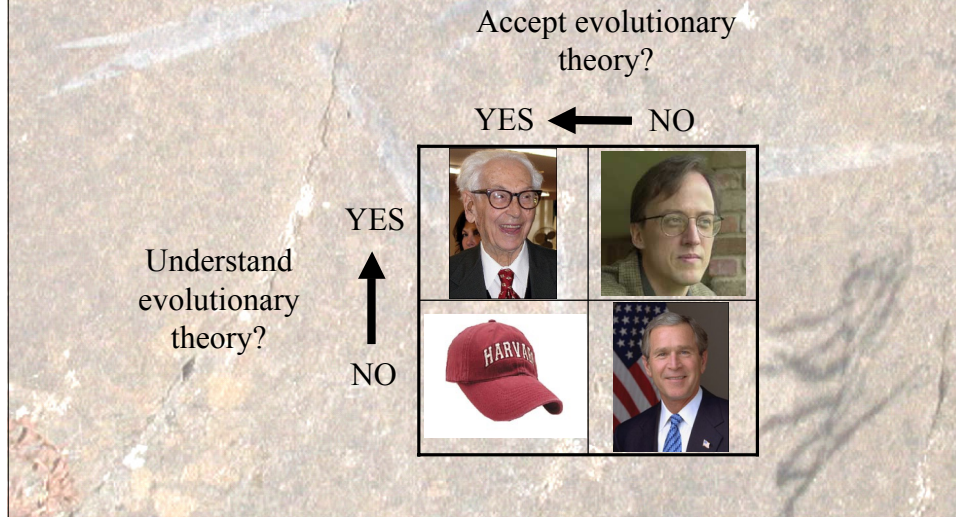
- • Cognitive biases
  - Lack of understanding, poor reasoning
- Exposure
  - School, media
- Sociocultural factors
  - Religious and moral commitments

## H1: Understanding

- Hypothesis 1:
  - People don't accept evolution because they don't understand it.
- Predictions:
  - (a) Many people don't understand evolution.
  - (b) Understanding correlated with acceptance.
- Data:
  - Resounding support for (a) (Every study ever conducted!)
  - Poor evidence for (b) (Bishop & Anderson, 1990; Demastes et al., 1995; Sinatra et al., 2003; Brem et al., 2003; Shtulman, 2006; Shtulman, 2008)



## Understanding vs. Acceptance



## Influences on belief

- Cognitive biases
  - Lack of understanding, poor reasoning
- Exposure
  - School, media
- Sociocultural factors
  - Community support, religious comfort

### No support:

- Understanding evolution

### Some support:



## H2: General Reasoning

- Hypothesis 2:
  - People don't accept evolution because they are bad at reasoning in general.
- Predictions:
  - (a) Many people are bad at reasoning.
  - (b) Reasoning correlated with acceptance.
- Data:
  - Support for (a)
  - Mixed support for (b) (Lawson & Worsnop, 1992; Eve & Harrold, 1995)

## H3: Scientific Reasoning

- Hypothesis 3:
  - People don't accept evolution because they are poor at scientific reasoning.
- Predictions:
  - (a) Many people are bad at scientific reasoning.
  - (b) Scientific reasoning ability correlated with acceptance.
- Data:
  - Resounding support for (a) (Lawson & Thomson, 1988; Lawson & Worsnop, 1992; Dagher & Boujaoude, 1997; Sinclair et al., 1997)
  - Some evidence for (b) (Sinatra et al. 2003; Harrold & Eve, 1995)



## Influences on belief

- • Cognitive biases
  - Lack of understanding, poor reasoning
- • Exposure
  - School, media
- Sociocultural factors
  - Religious and moral commitments

### No support:

- Understanding evolution
- General intelligence

### Some support:

- Understanding of science

## H4: Exposure

- Hypothesis 4:
  - People don't accept evolution because they haven't been properly exposed to evolution (school & media).
- Predictions:
  - (a) Many people haven't been properly exposed.
  - (b) Acceptance correlated with instruction/media.
- Data:
  - Support for (a) (e.g. Harrold & Eve, 1995)
  - Some support for (b) (Lawson & Worsnop, 1992; Demastes et al., 1995; Harrold & Eve, 1995; Brem & Ranney, 2001)
    - Quantity versus valence of exposure



## Influences on belief

- Cognitive biases
    - Lack of understanding, poor reasoning
  - • Exposure
    - School, media
  - • Sociocultural factors
    - Religious and moral commitments
- No support:**
- Understanding evolution
  - General intelligence
- Some support:**
- Understanding of science
  - Quantity of exposure
  - Valence of exposure

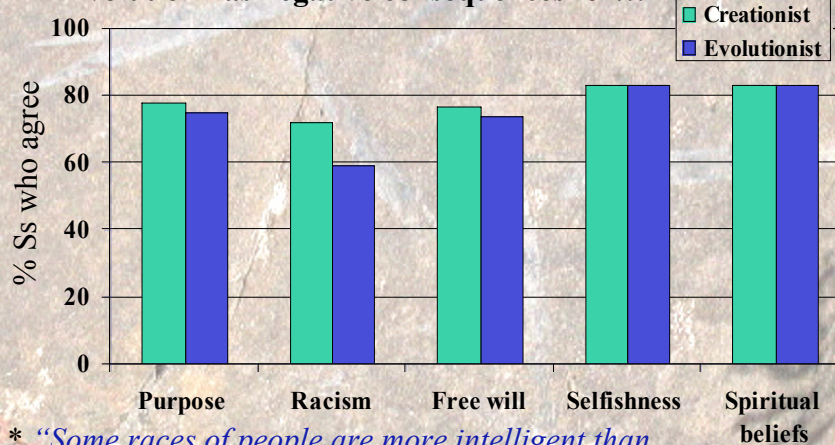
## H5: Perceived Consequences

- Hypothesis 5:
  - People don't accept evolution because they believe it has negative consequences.
- Predictions:
  - (a) Many people believe evolution has negative consequences.
  - (b) These beliefs correlate with acceptance.
- Data:
  - Support for (a) (Brem et al., 2003)
  - Rejection of (b) (Brem et al., 2003)



## Brem et al. (2003)

### Evolution has negative consequences for...



\* *“Some races of people are more intelligent than others” correlated w/creationism!* (Harrold & Eve, 1995)

## Influences on belief

- Cognitive biases
  - Lack of understanding, poor reasoning
- Exposure
  - School, media
- • Sociocultural factors
  - Religious and moral commitments

### No support:

- Understanding evolution
- General intelligence
- Perceived consequences

### Some support:

- Understanding of science
- Quantity of exposure
- Valence of exposure





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## Explanatory preferences

- People prefer simpler explanations (Lombrozo, 2007)
- People value broadly-applicable explanations (Preston & Epley, 2005)
- Default preference?
  - Innate biases (Kelemen, 2004; Kelemen & DiYanni, 2005)
  - Natural view given environment (Evans, 2001)

## Explanatory defaults

- **Strategy:** investigate children as a source of underlying cognitive bias still present in adults
  - Untutored creationism (Evans, 2000, 2001)
  - Promiscuous teleology (Kelemen, 1999; Kelemen, 2004)



## Untutored Creationism

<b>Age</b>	<b>Fundamentalist parents</b>
<b>5-7</b>	<i>Creationism</i>
<b>8-10</b>	<i>Creationism</i>
<b>10.5-12</b>	<i>Creationism</i>
<b>Adults</b>	<i>Creationism</i>

Evans (2001)

## Untutored Creationism

<b>Age</b>	<b>Fundamentalist parents</b>	<b>Non-fundamentalist parents</b>
<b>5-7</b>	<i>Creationism</i>	<i>Creationism &amp; Spontaneous generation</i>
<b>8-10</b>	<i>Creationism</i>	<i>Creationism</i>
<b>10.5-12</b>	<i>Creationism</i>	<i>Creationism &amp; Evolution</i>
<b>Adults</b>	<i>Creationism</i>	<i>Creationism &amp; Evolution</i>

Evans (2001)



## Promiscuous teleology

### Biological Property:

Why do you think *Cryptoclidus* had such long necks?

### Nonliving Item's Property:

Why do you think the rocks were so pointy?



Kelemen (1999)

## Being teleological about teleology

“...human causal understanding evolved first in the social domain to comprehend others as intentional agents... many of the people of the world, when they are in doubt as to the physical cause of an event, often invoke various types of animistic or deistic forces to explain it; perhaps this is **the default approach**.” (Tomasello, p. 24-25)

“...the tendency to view objects as designed for purposes develops as part of our ability to view intentional agents as having purposes... **because of the way our minds are designed, intention-based teleological explanations come easily to us**. One consequence of this is that we might overzealously apply teleological reasoning to inappropriate domains unless we have learned not to.” (Kelemen, 1999, p. 287)



### Part I: Understanding

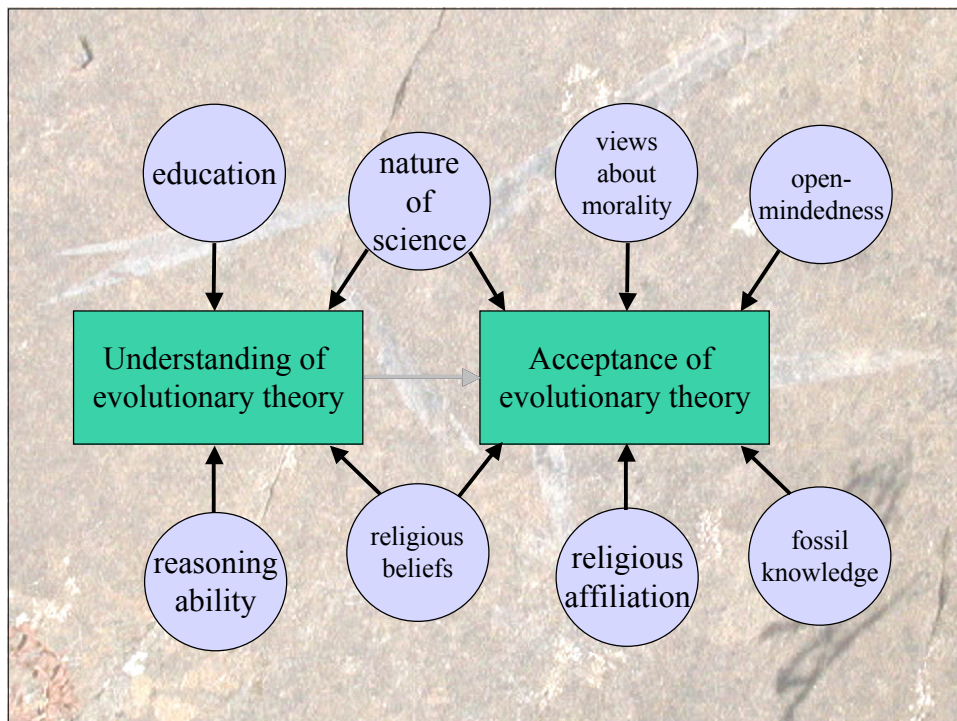
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## ID vs. Old-School Creationism

- Poor understanding of mechanism → poor ability to assess evidence (e.g. variation)
- Poor understanding of science → poor ability to evaluate scientific status
- May seem like a compromise position that sidesteps science/religion conflicts

**“Plenty of scientific evidence for creationism”**

20-40% agree! (Harrold & Eve, 1995)

## Take-Home Messages

- Systematic misunderstanding of evolution
  - Especially topics requiring “population-level” thinking, like variation and macroevolution
- Understanding and acceptance not correlated!
  - Increasing understanding ≠ increasing acceptance
- Evolution should be considered in a broad context
  - Views about the nature of science
  - Perceived moral and social consequences





The End!

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