

# The function and mechanisms of teaching: an evolutionary perspective





*“Der Mensch ist das  
einzige Geschöpf, das  
erzogen werden muß”*

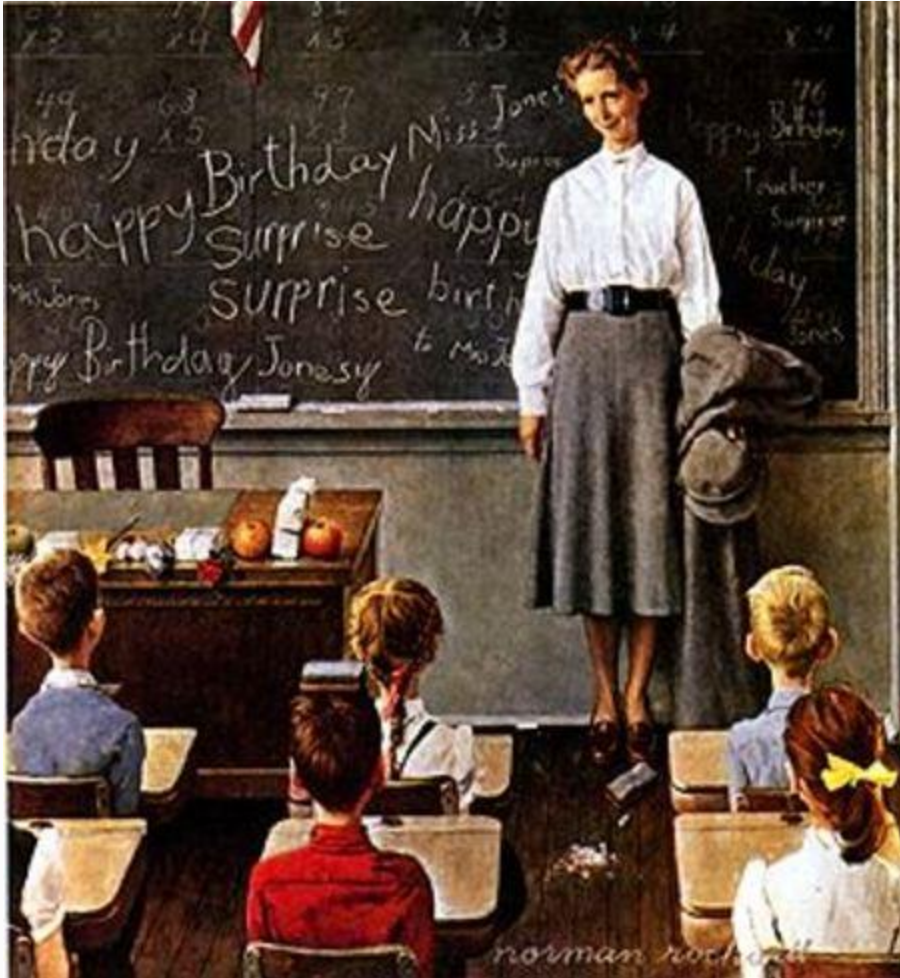
Man is the only being  
who needs education

Kant 1803



Was Kant right? It depends on your definition...

## Western Culture-centric



## Anthropocentric



# Definitions of teaching

## Western Culture-centric

- Unidirectional
- Formal
- “Marked”
- Explicit verbal instruction

Paradise & Rogoff (2009) *Ethos*

Lancy & Grove (2010) In: *The Anthropology of Learning in Childhood*

## Problems

- Subjective
- Excludes most human societies
- Useless for understanding how teaching evolved

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- Subjective
- Excludes most human societies
- Useless for evolution

## Anthropocentric

- Emphasises “intention” to teach
- Cognitive prerequisites:
  - Theory of Mind
  - Metacognition

Tomasello et al. (1993) *Behav. Brain. Sci.*

Strauss et al. (2002) *Cog. Dev.*

# Anthropocentric definitions: problems

## 1. Impractical

- Definitions based on unobservable cognitive mechanisms are of little use in allowing us to recognise teaching when it occurs

# Anthropocentric definitions: problems

## 2. Confuse function and mechanism



*“Why would you attempt to teach someone something unless you assumed that they did not know something?”*

Michael Tomasello

Quoted in:

Olson, D.R. 1996. Preface: *Handbook of Education and Human Development: New Models of Learning, Teaching and Schooling*



# Anthropocentric definitions: problems

## 2. Confuse function and mechanism



*“Why would you attempt to  
use a tool unless  
you understood how the tool  
works?”*



# Anthropocentric definitions: problems

## 3. Highly restrictive

- Excludes (almost?) all non-human animals
- Excludes many forms of human teaching



# Teaching: a Functional Perspective

## Key characteristics of teaching

1. it is a form of **cooperative behaviour** with response-dependent fitness payoffs
2. its **function is to facilitate learning** in others
3. it involves the **coordinated interaction** of a donor and a receiver of information



# Tinbergen's Four Questions



Tinbergen, 1963

## Function

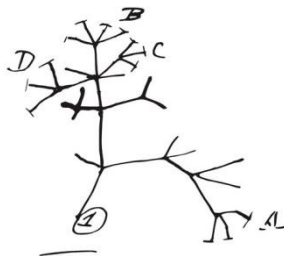
- *What is the behaviour for?*
- To promote learning in others

## Mechanism

- *How it is achieved?*
- Physiological, cognitive processes, etc

## Phylogeny

- *What is its evolutionary history?*



## Ontogeny

- *How does the behaviour develop across an individual's life?*

# Caro & Hauser's operational definition

1. Knowledgeable individual **modifies its behaviour** in the presence of naïve individual
2. Knowledgeable individual **incurs some cost/ derives no immediate benefit** by modifying its behaviour
3. **Naïve individual learns** as a result of knowledgeable individual's behaviour

# Teaching in animals?

- Many species are capable of learning by watching and interacting with others



- The wise do not change their behaviour to educate the naive
  - Teaching involves ACTIVE participation to help others learn

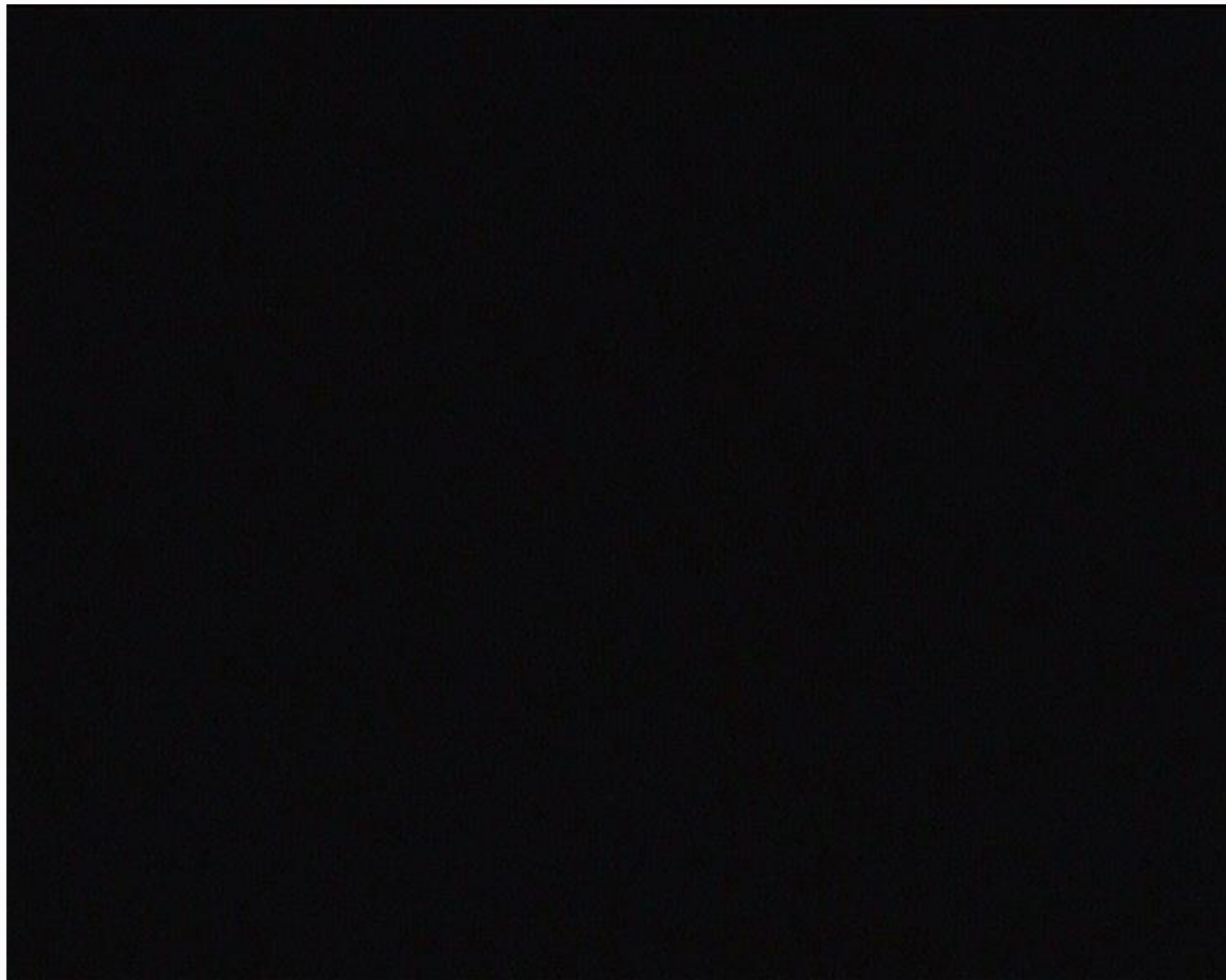


# Evidence: Meerkats

## 1<sup>st</sup> criterion

- Adults **gradually introduce pups to live prey**
- **Watch** pups handling prey
- **Nudge** prey if pups show no interest
- **Retrieve** prey that escapes
- **Further modify** it if pups struggle

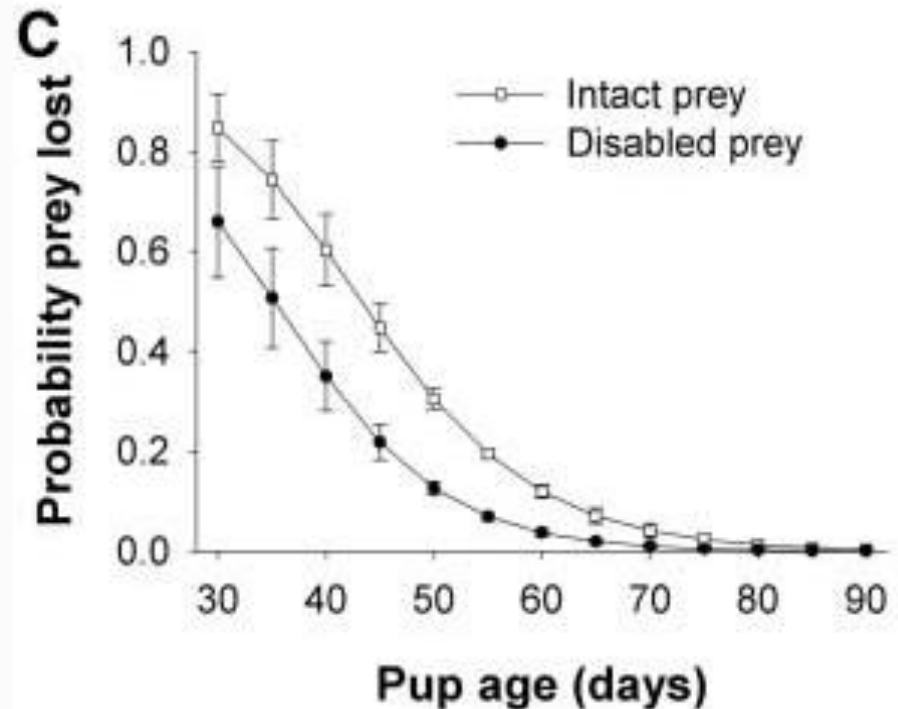




# Evidence: Meerkats

## 2<sup>nd</sup> criterion

- Giving away live prey is costly:
- More time spent monitoring pups
- Prey may escape  
    → lost investment
- Danger





# Evidence: Meerkats

## 3<sup>rd</sup> criterion

- Opportunities to handle live prey **promote learning**
  - **Experiment:**

Treatment 1	Treatment 2	Treatment 3



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Live scorpions		



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# Evidence: Meerkats

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- Opportunities to handle live prey **promote learning**
  - **Experiment:**

Treatment 1	Treatment 2	Treatment 3
Live scorpions	Dead scorpions	Egg
TEST		

- Treatment 1 did best: Faster, less likely to lose the scorpion, less likely to get stung



# Further experimental evidence

## Tandem-running ants



Franks & Richardson (2006) *Nature*

## Pied babblers



Raihani & Ridley (2008) *Anim. Behav.*

## Superb fairy-wrens



Colombelli-Négrel et al. (2012) *Curr. Biol.*

Kleindorfer et al. (2014) *Behav. Ecol.*

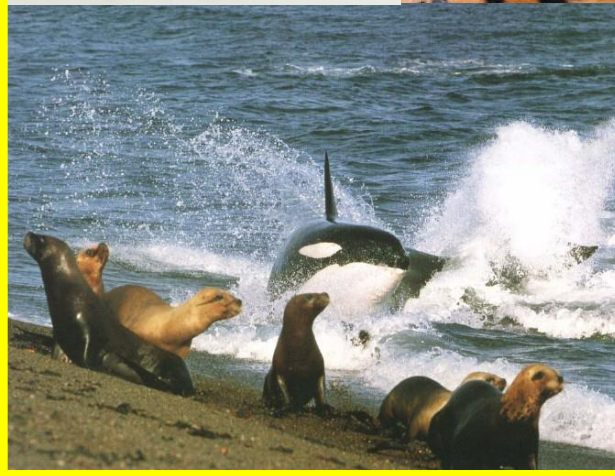








**How to hunt**



**What to eat**



**How to get around**



**How to court**

# Back to Tinbergen's 4 Questions

## Function

- *What is the behaviour for?*

## Mechanism

- *How it is achieved?*

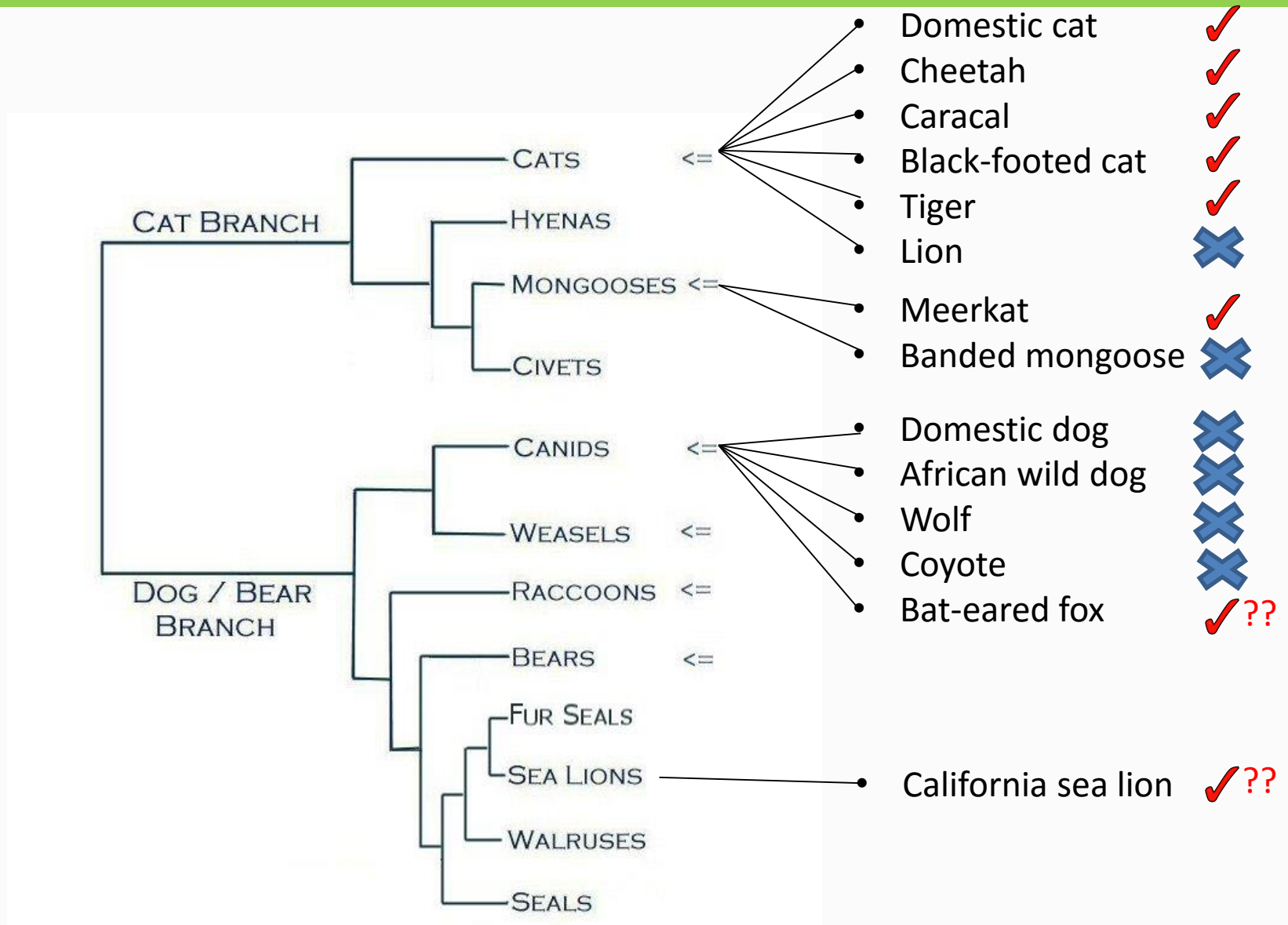
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## Ontogeny

- *How does it develop over an individual's life?*

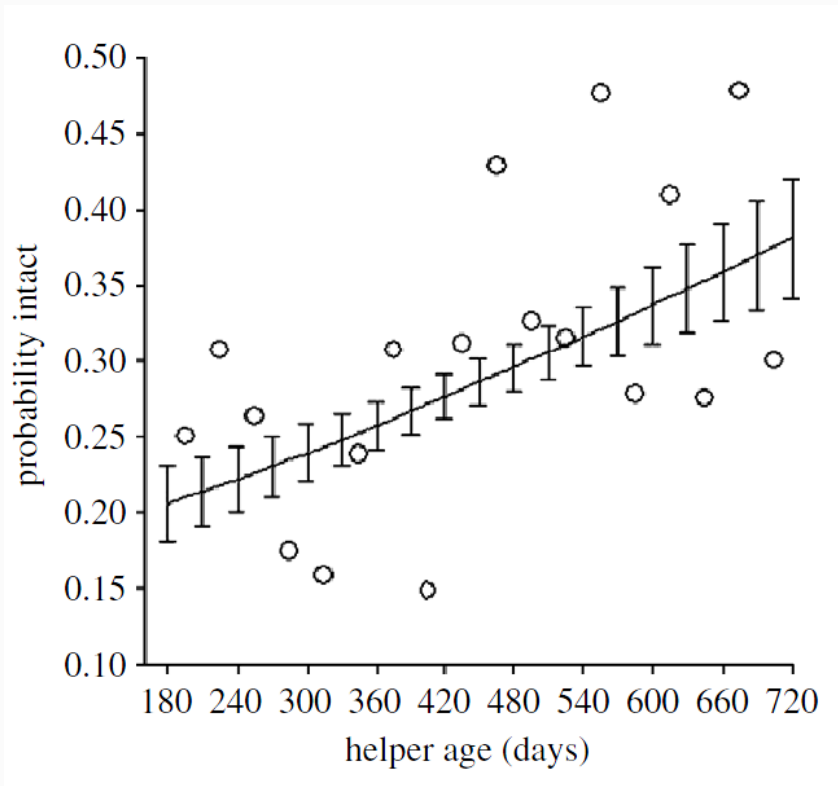
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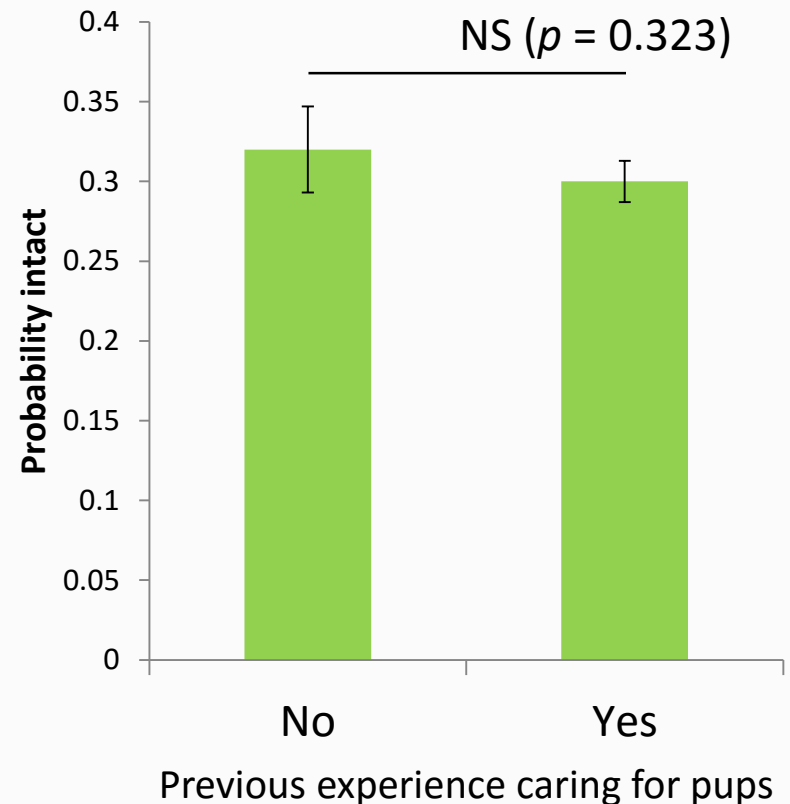


# Ontogeny

- Young helpers contribute relatively little



- No effect of prior experience



- Meerkats do not learn to teach



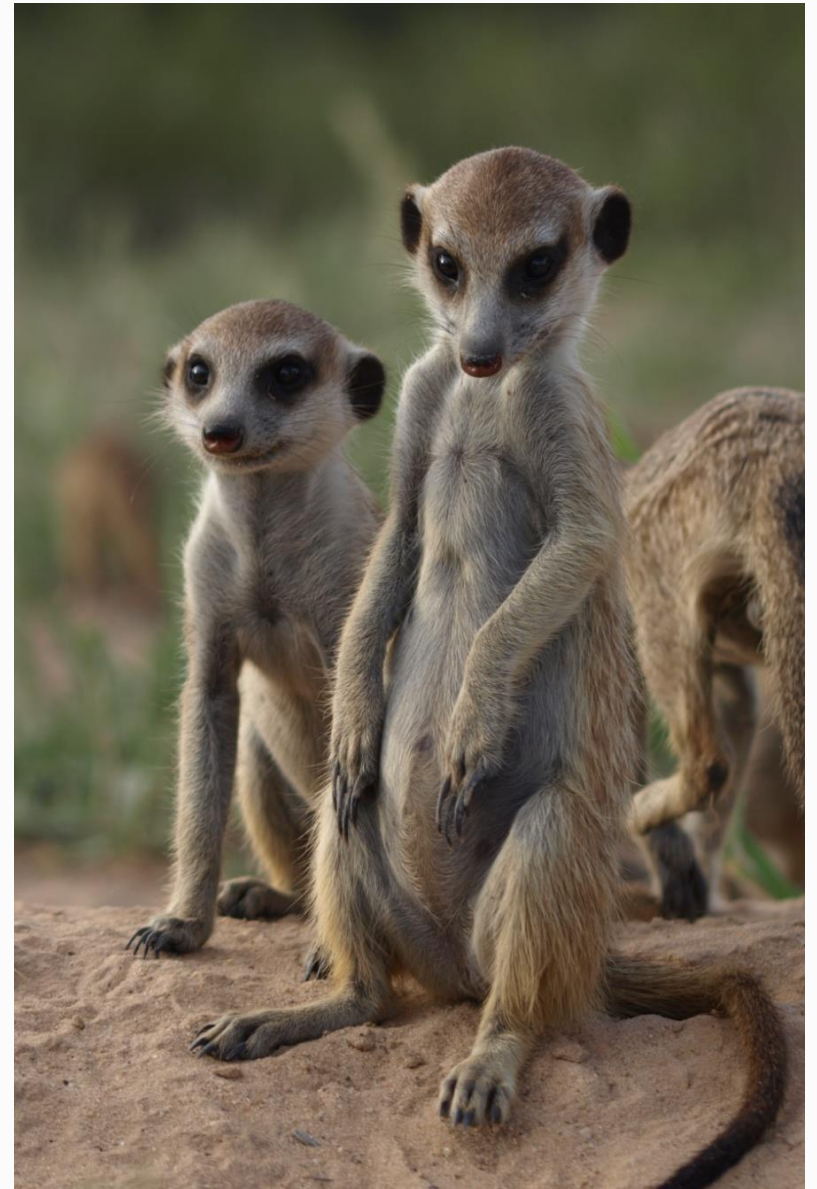
# Mechanisms

“...in order to teach, one needs to know when knowledge, beliefs, skills, etc. are missing, incomplete, or distorted, as well as how people learn”

Strauss et al. 2002



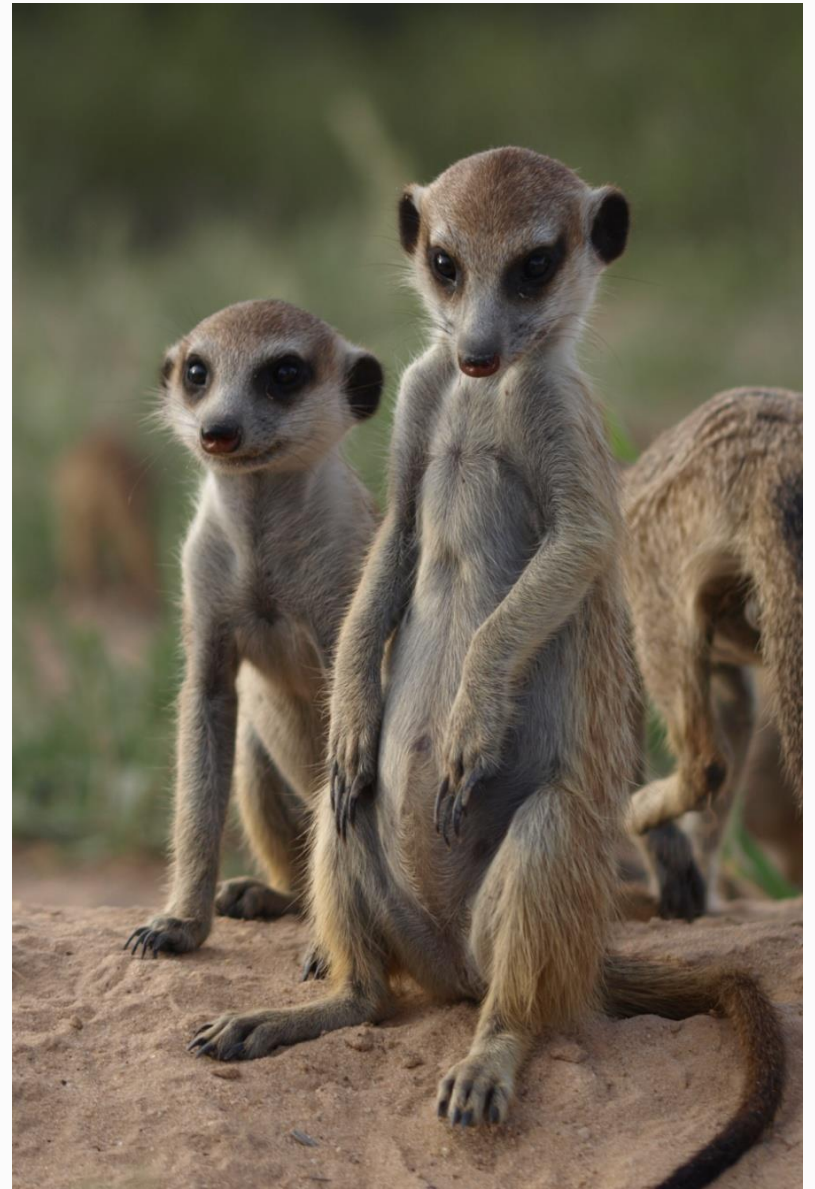
35 days old



85 days old

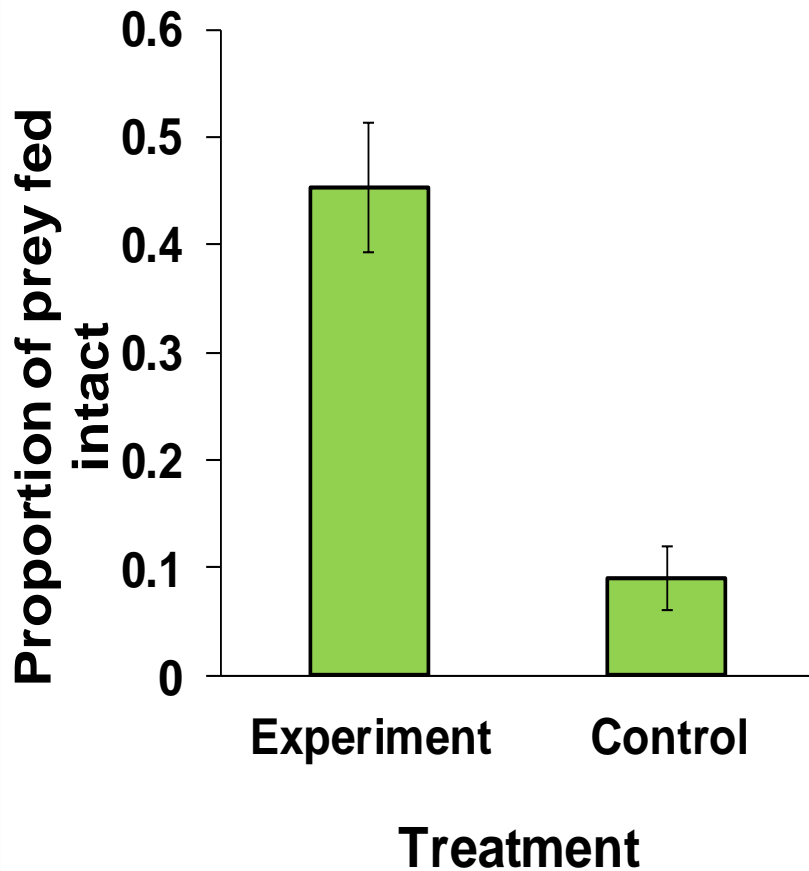


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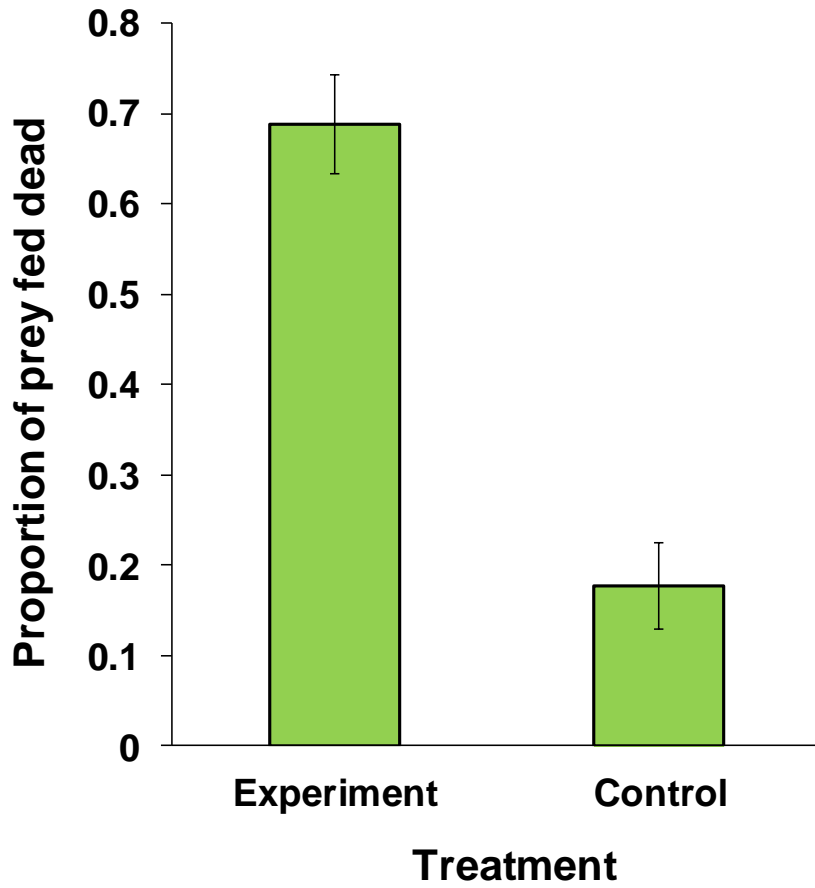
# Mechanisms



- Playing calls of old pups to groups with young pups causes adults to bring live prey



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# Teaching



Motherese



Scaffolding

Natural  
pedagogy

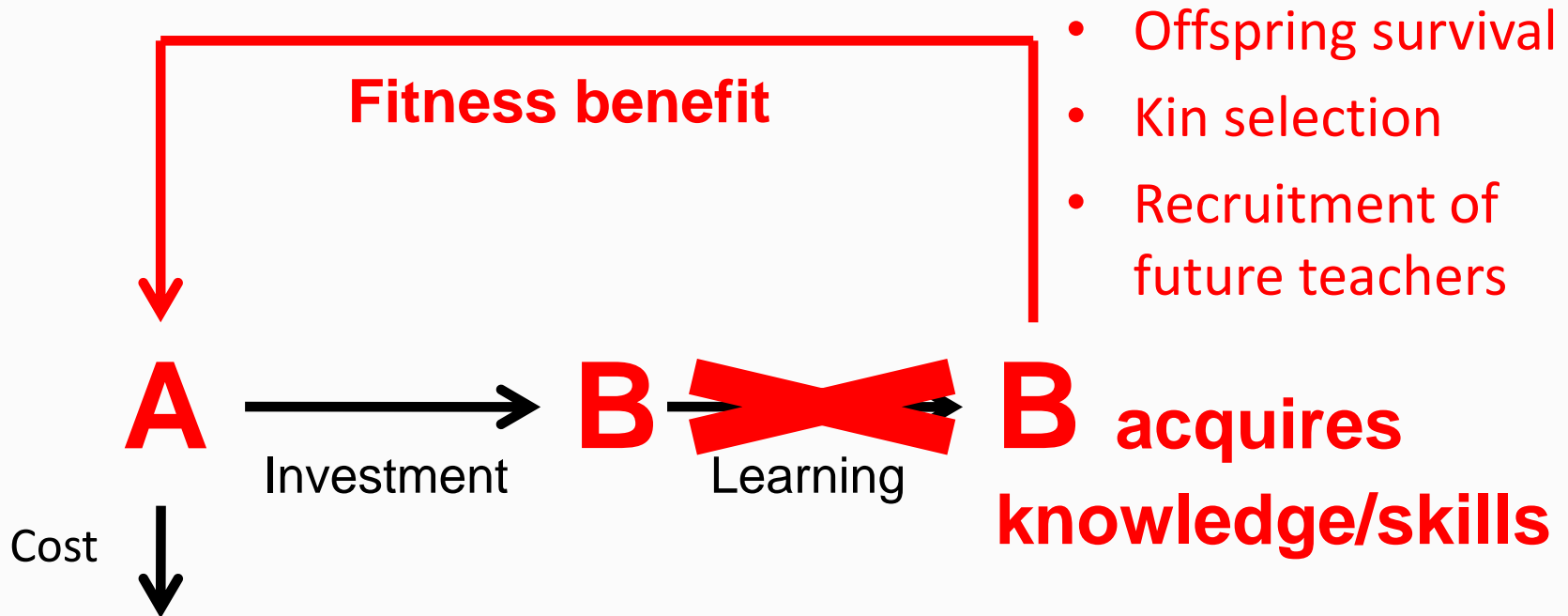


Teaching by  
people with  
autism

# ToM

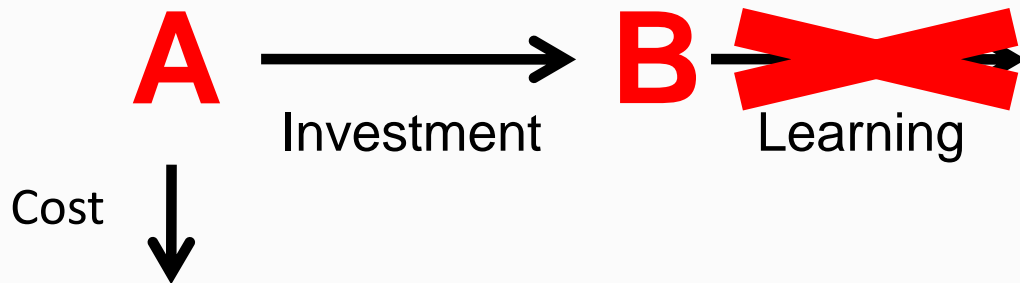
# Function: Why teach?

Teaching is a form of cooperation



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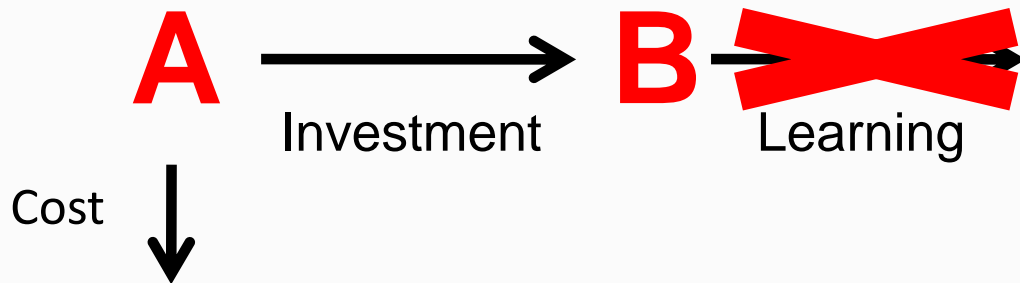
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# Function: Why teach?

Teaching is a form of cooperation



# Conditions for the evolution of teaching

## 1) High **fitness value** of information



- Mobile prey account for  $> 50\%$  of diet

Thornton & Raihani (2008) *Anim. Behav.*

Fogarty et al. (2012) *Evolution*

# Conditions for the evolution of teaching

## 2) High **utility** of information

- Few opportunities/high costs for individual and social learning



- Observing others is ineffective
- Pups rarely find mobile prey
- Incompetent attempts may be dangerous

# Conditions for the evolution of teaching

## 3) **Benefits** for teachers

- Reduced period of pup dependence
- Kin-selected benefits
- Direct benefits of group augmentation



- Costs distributed among multiple helpers



# Adaptive benefits of human teaching?



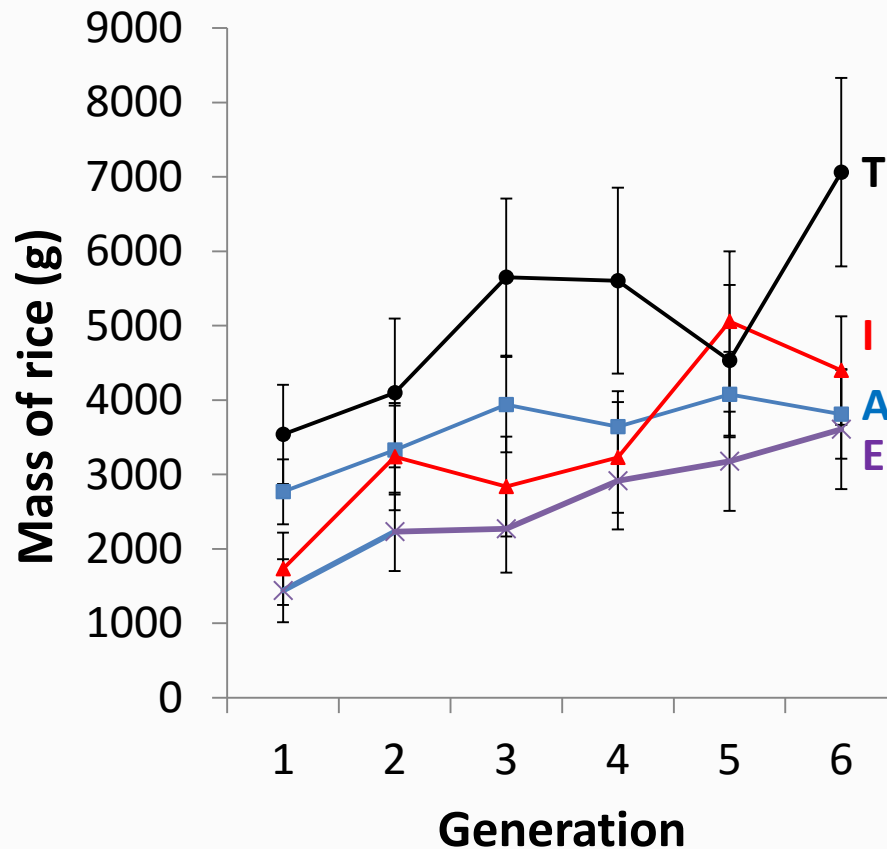
## Transmission chain experiment

- Asocial learning
- Emulation
- Imitation
- Teaching



# Adaptive benefits of human teaching?

- Teaching is not strictly necessary to generate cumulative improvements

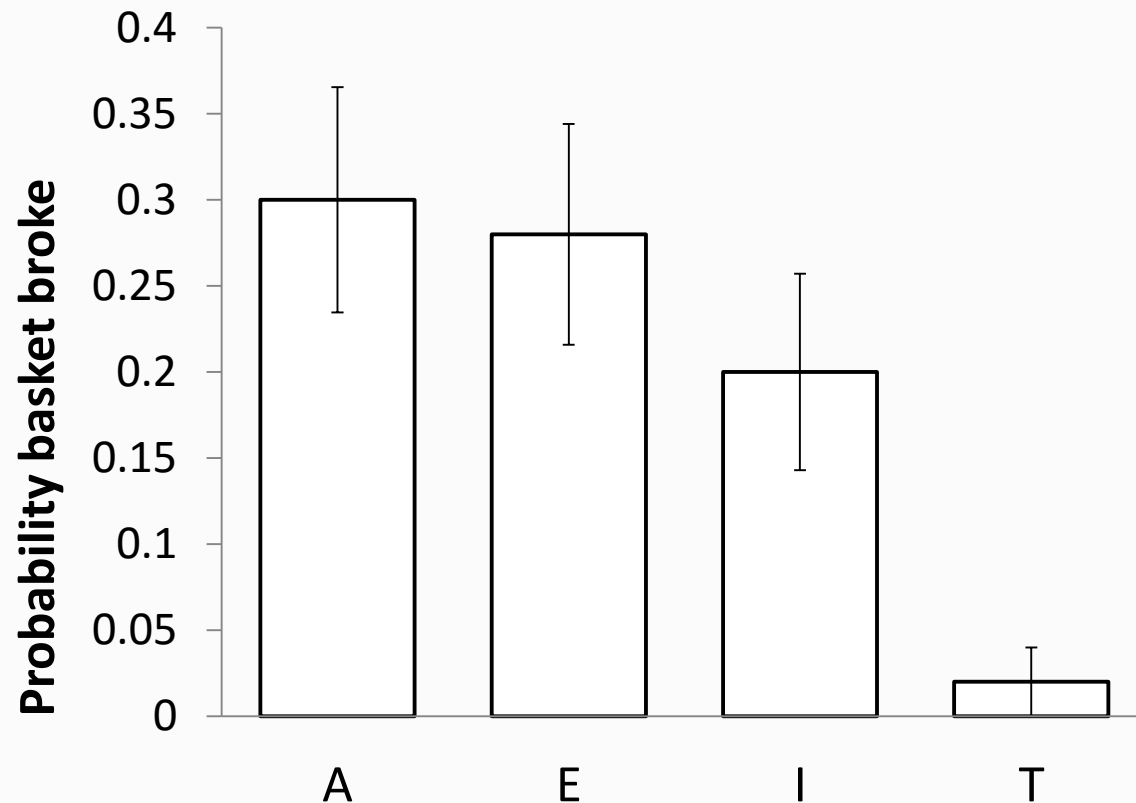


GLMM

- Generation:  $p < 0.001$
- Treatment:  $p = 0.74$

# Adaptive benefits of human teaching?

- Teaching baskets are more durable







# Thanks!

Katie McAuliffe



Nichola Raihani



[www.wildcognitionresearch.com](http://www.wildcognitionresearch.com)

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