

# The role of language and experience with nature in the development of reasoning about living kinds

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# Domain specific challenges

- Physics

Object properties, contact causality

- Psychology

Beliefs, desires, mental causality

- Biology

Diversity of life, internal causality

# The role of categories

- Organize experience
- Allow communication
- Help extend knowledge through inference.
  
- Inductive potential varies by domain and depending on hierarchy level.
- Category based inference particularly important within living kinds.

# Categorization - sources

- Perceptual

e.g. *cats* acquired by 3mos by mere exposure to a dozen instances (Quinn et al. 1993)

- Linguistic

Labels support categorization in infants. This support is 'smart'/selective. Superordinate categories acquired better when named with a noun, subordinates better when adjectives, no label effect for basic levels (Waxman et al..)

- Conceptual

Booth 2009 Conceptual (causal) information facilitates word learning/concept acquisition. Categorization sensitive to domain/property interaction Diesendruck & Perez, 2013

# Hierarchy

Fido is a

poodle → dog → mammal → animal → living thing

Inferences strongest at basic level

Superordinates most strongly 'conceptually loaded'  
& intertwined with domain theories

# Mature representation of *living thing*

- Explicitly categorize animals and plants as alive
- Represent commonalities between animals and plants (growth, reproduction, metabolism, responsiveness to environment etc.)
- Consider these commonalities as central in the biological domain
- Rely on *living thing* in induction to generate new knowledge

# When is *living thing* acquired?

- Animates singled out early (maybe at birth) on the basis of goal directed movement, biological motion, faces (Craighero et al. 2011; Simion et al., 2008; Johnson & Morton, 1991).
- Inclusive *living thing* (animals and PLANTS) acquired late (6-10 years) (Piaget, 1929; Laurendeau & Pinard, 1962; Hatano et al. 1993; Carey, 1985; Goldberg Thompson-Shill, 2009)

# Early foundations for *living thing*

- **Intentionality** (Carey, 1985)

Psychology as support biology, humans as prototypical living things =intentional beings

- **Teleological motion** (Opfer & Siegler, 2004).
- **Vitalism** (Inagaki & Hatano 2002). Organs need vital force from food, water, sun to support growth & live, prevent illness
- **Essentialism** (Gelman, 2003, Atran et al. 2001; Leddon et al., 2008) Living kinds share internal executive causes



	Explicit categorization as alive	Commonalities represented as central	Inductive power of <i>living thing</i>
Intentionality	no	--	no
Teleological motion	With knowledge of teleological motion	Teleological motion	?
Vitalism	Not necessary, depending on task	Body parts need vital force to support life, growth, prevent death & illness	Projections of known biological properties from animals to plants and not artifacts
Essentialism	Often impeded by language	Innate potential, inductive power, boundary intensification, immutability	High at basic level Not clear at superordinate level

# Variability in biological knowledge

- *Living thing* and language/cultural differences  
Anggoro et al. 2008; Hatano et al. 1993; Taverna et al., 2014
- Patterns of inductive inference  
Carey 1985 vs. Ross et al., 2003; Tarlowski, 2006; Inagaki, 1990; Coley, 2012

# Research questions?

- Do children rely on *living thing* in induction?
- Is experience with nature related to children's inferences?
- Is vocabulary size related to children's inferences?
- What is the place of humans in *living thing* concept?
- Is inductive inference related to categorization of living things?

# How to test for reliance on *living thing* in induction?

- Dogs/people have blicks inside.
- Do tulips have blicks inside?

# Category based induction (CBI)

- ‘Classical’ CBI task

*Dogs have spleen inside.*

*Do bicycles/flies/sparrows/worms/bears?*

Carey 1985; Ross et al. 2003; Inagaki & Hatano, 2002 etc.

- Triad induction task

Gelman Markman, 1986; Coley, 2012 etc.

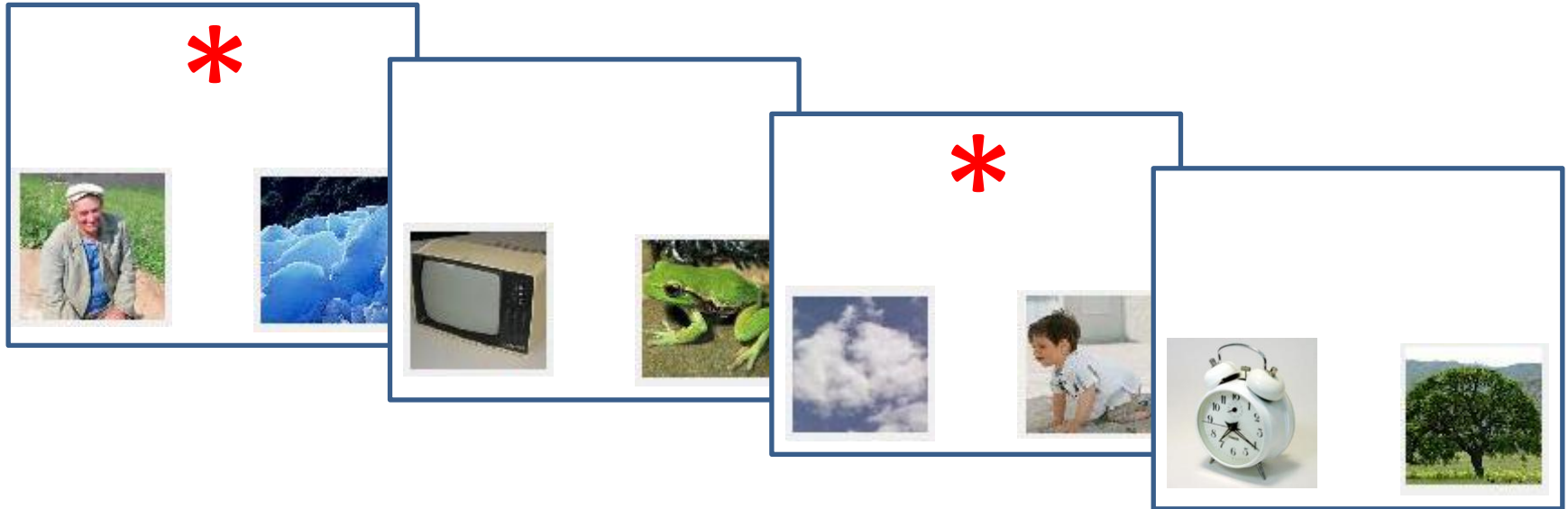
- category against similarity / thematic match

# Do children rely on living things in induction?

## Inductive learning task

- Mixture of 'classical' CBI and triad induction tasks
- Series of pairs of objects
- One object in a pair has the target feature
- Feedback given on training trials
- Performance on test trials indicates reliance on *living things*

# Inductive learning with feedback task



- Participants presented with a sequence of pairs of objects, for each pair they select one object that they think has the target feature and receive feedback on training (\*) trials.
- Test trial responses provide a measure of reliance on *living thing* in induction

	Task	population	Additional measures	Sample size and age
<b>Study 1</b>	Inference humans → living vs. artifacts	Urban and rural children		N=72 Age: 5; 8
<b>Study 2</b>	Inference animals → plants vs. artifacts	Urban and rural children		N=37 Age: 5;6
<b>Study 3</b>	Inference humans → Plants vs. artifacts	Urban and rural children	Vocabulary size	N=52 Age: 5;6
<b>Study 4</b>	Inference humans → plants vs. artifacts	Small town children	Categorization as alive	N=57 Age 6 - 8 years
<b>Study 5</b>	Free descriptions of living kinds	Urban and rural children		N=22 Age: 5-6 years
<b>Study 6</b>	Parental reports Activities and interests	Urban and rural parents		N=50 Parents



# Study 1

## Projecting from humans to living things

Human →

- Living kind (animals and plants)
- Artifact

# Details of the procedure

## Training trials

On each of the 12 training trials a human was pitted against water.






















Training trials always received feedback – the human had the feature.

Example training items:



# Test Trials

## Living kinds

						Item number
						1
						2
						3
						4
						5
Category						
1	2	3	4	5	6	

Subcategory descriptions:

1. Mammals
2. Other vertebrates
3. Arthropods































4. Neither plants nor typical animals

5. Small plants

6. Trees

# Test Trials

## Artifacts

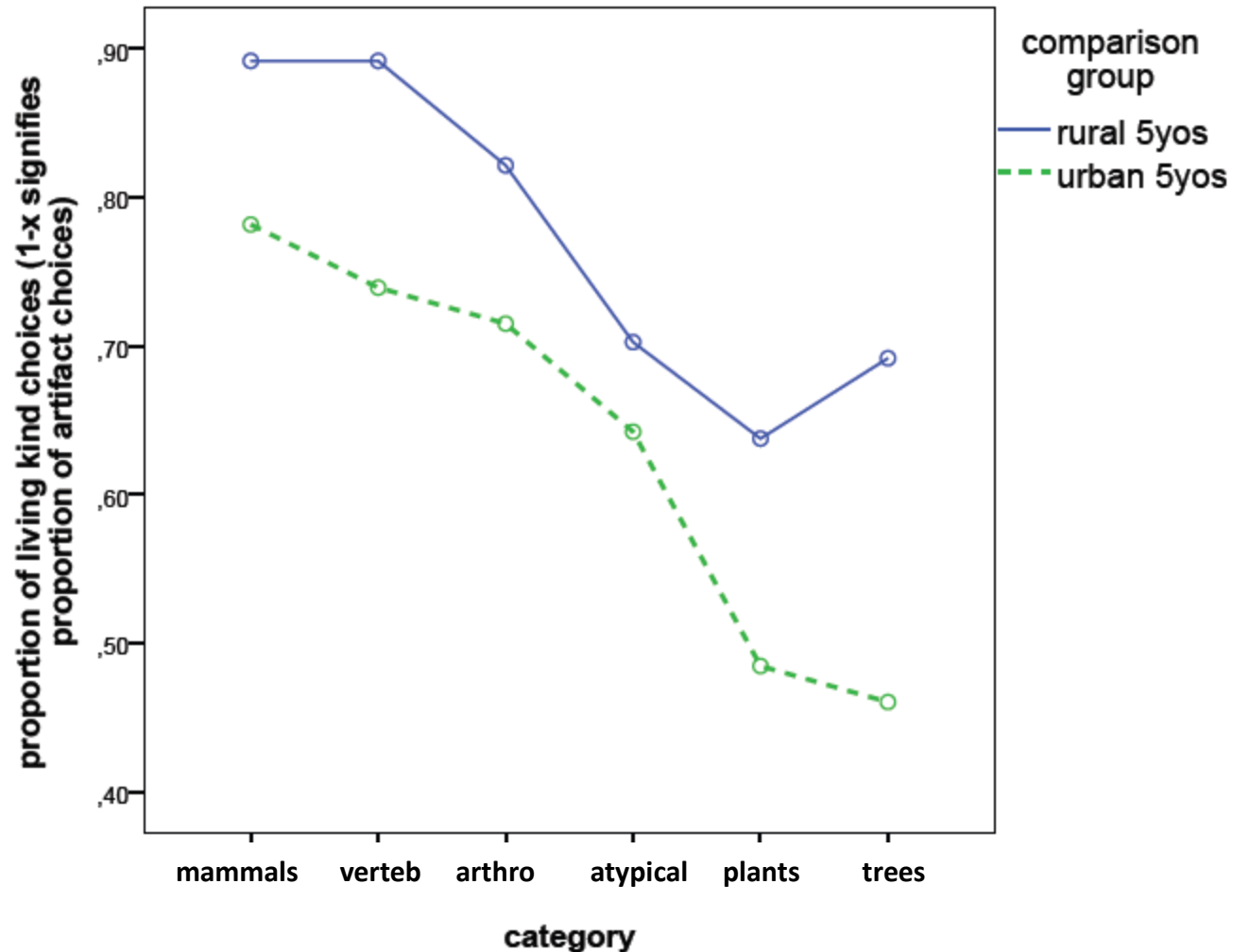
						Item number
1						
						2
						3
						4
						5
Category	1	2	3	4	5	6

Category descriptions:

1. Vehicles
2. Complex artefacts with some 'autonomous activity'
3. complex artefacts

4. Clothing and accessories
5. Containers
6. Simple metal artefacts

# Projections of internal property from humans to living kinds (contrasted with artifacts) by rural and urban 5-year-olds



ANOVA did not show an interaction between category and comparison group

# Conclusions

Rural children are more prone to rely on *living thing* in induction

How can the results be interpreted?

Compared to urban children

- rural children have better access to *living kinds* (humans, other animals and plants) and they use it in making inductive inferences
- rural children perceive animals and plants as more similar to humans
- rural children perceive artifacts as less similar to humans
- rural children like/prefer living kinds more or artifacts less

# Study 2

## Projections from animals to plants

Animals →

Plants

Artifacts (with autonomous motion e.g. laptop, washing machine, clock)

37 urban and rural children (mean age 5;5)

# Response patterns

- 12 test trials ( plant versus artifact)
- 9 + artifact selections – consistent artifact (p=0.07)
- 9+ plant selection – consistent plant (p=0.07)
- Other pattern – inconsistent



# Results

- No urban vs. rural difference in plant selections.
- 60% plants for rural and 61% for urban
- 16% children consistently artifact, 44% consistently plant
- Overall, significantly above chance  $t(35) = 2.36$   
 $p < 0.05$

## Conclusion

- Rural and urban children are equally disposed to expect internal commonalities between animals and plants

# Study 3

## Projections from humans to plants and vocabulary size

- Inductive inference task

Humans → Plants vs. Artifacts (with  
autonomous activity e.g. laptop, washing  
machine, clock)

- Vocabulary size

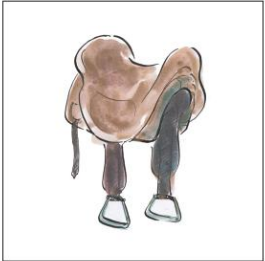



(Picture Vocabulary Task OTSR)

# OTSR Haman & Fronczyk, 2012





Simple questions (for nouns, verbs, adjectives) :

Where is x?  
Gdzie jest koń?

Who is y-ing?  
Kto siedzi?

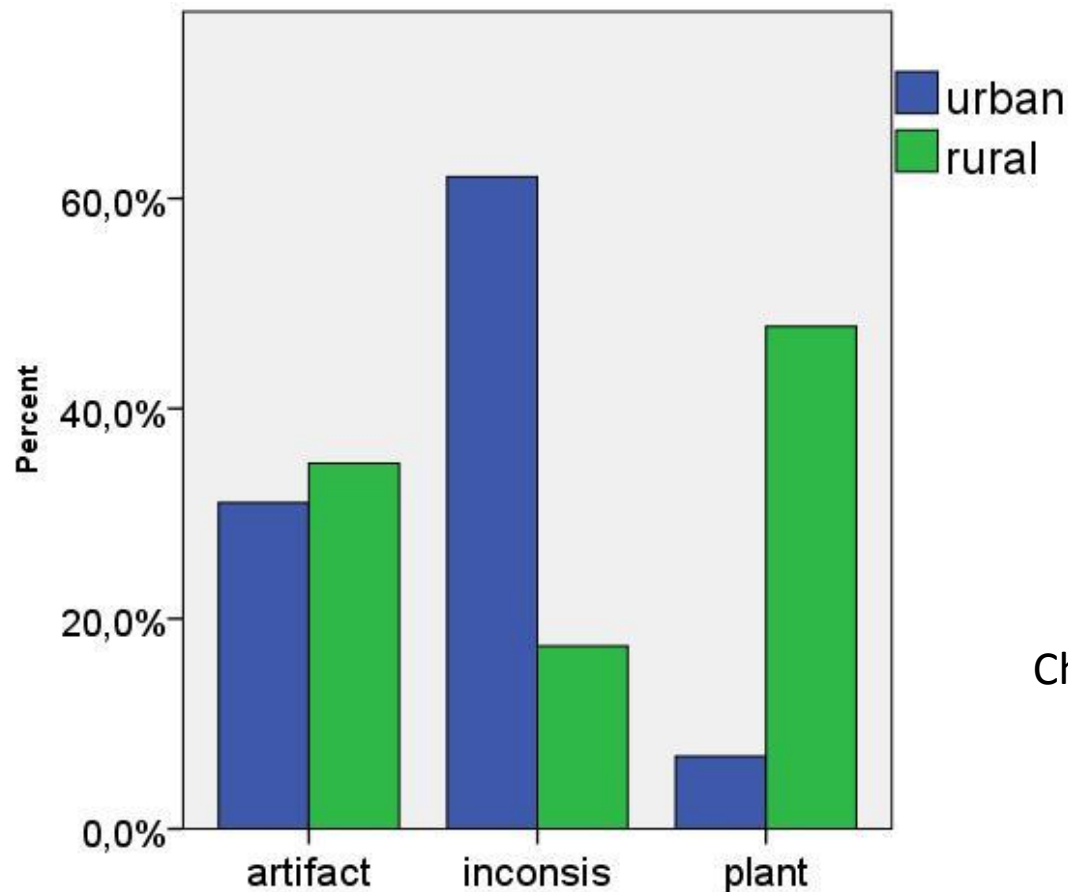
1		2	
3		4	

A-1

1		2	
3		4	

A-5

# Percent of children who chose plants/artefacts consistently or were inconsistent



Chi2(2)=11.1 p<0.01

# Correlations with vocabulary

Urban children

	Plants	Consistency
Vocabulary	-0.19 NS	0.44*

Rural children

	Plants	Consistency
Vocabulary	0.47*	0.14

# Reliance on superordinate categories in induction is facilitated by a combination of direct experience and conceptual factors

## Study 3

	Small vocabulary	Large vocabulary
Urban	--	--
rural	--	Rely on <i>living thing</i>

## Tarlowski 2006

	Lay parents	Biology expert parents
Urban	--	--
Rural	--	Rely on <i>animal</i>

# Conclusions

- Direct experience must be paired with conceptual development to facilitate acquisition of higher order categories
- The role of language - rich vocabulary = rich conceptual network
- Vocabulary size is an effect of rich conceptual input from caregivers

# Study 4.

## Inductive inference and categorization as alive

- Intuitive inference task

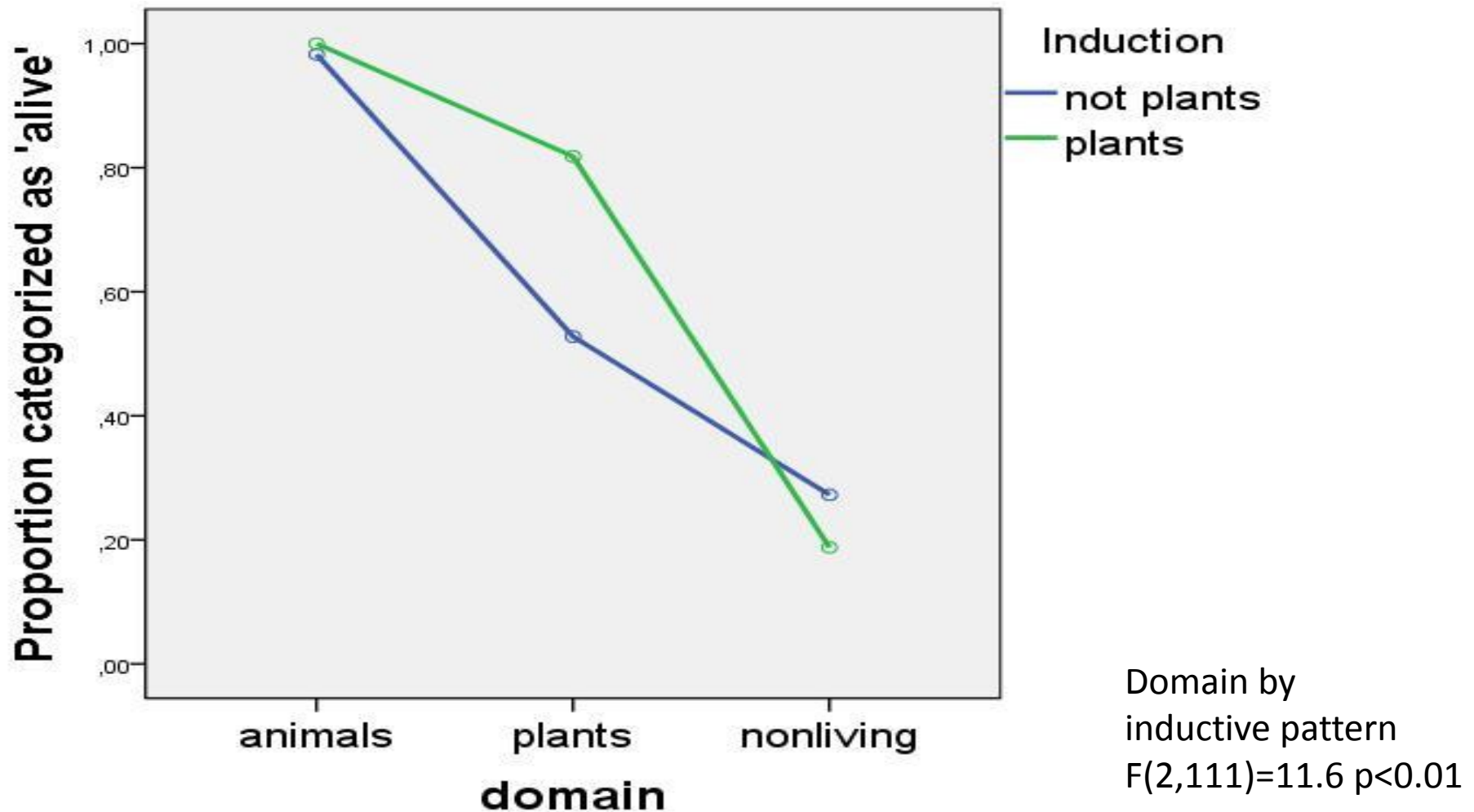
Humans → plants vs. artifacts

and

- Categorization as alive (18 pictures of animals, plants, nonliving things)



# Categorization as alive by children who systematically chose plants in inductive task and those who did not



# Conclusion

- Children who rely on living thing in induction also categorize both and only plants and animals as alive.

How are rural and urban children  
different?

# Study 5

## Children's descriptions of animals

- Urban and rural children talked about various living kinds. They were encouraged to share their experiences and everything they knew about the living kinds. They were shown 7 sets of 6 photographs and they talked about 2 of each set. The choice was up to them.
- The sets included (various living kinds: domestic animals, small animals, prey wild animals, predators, birds, tropical animals)

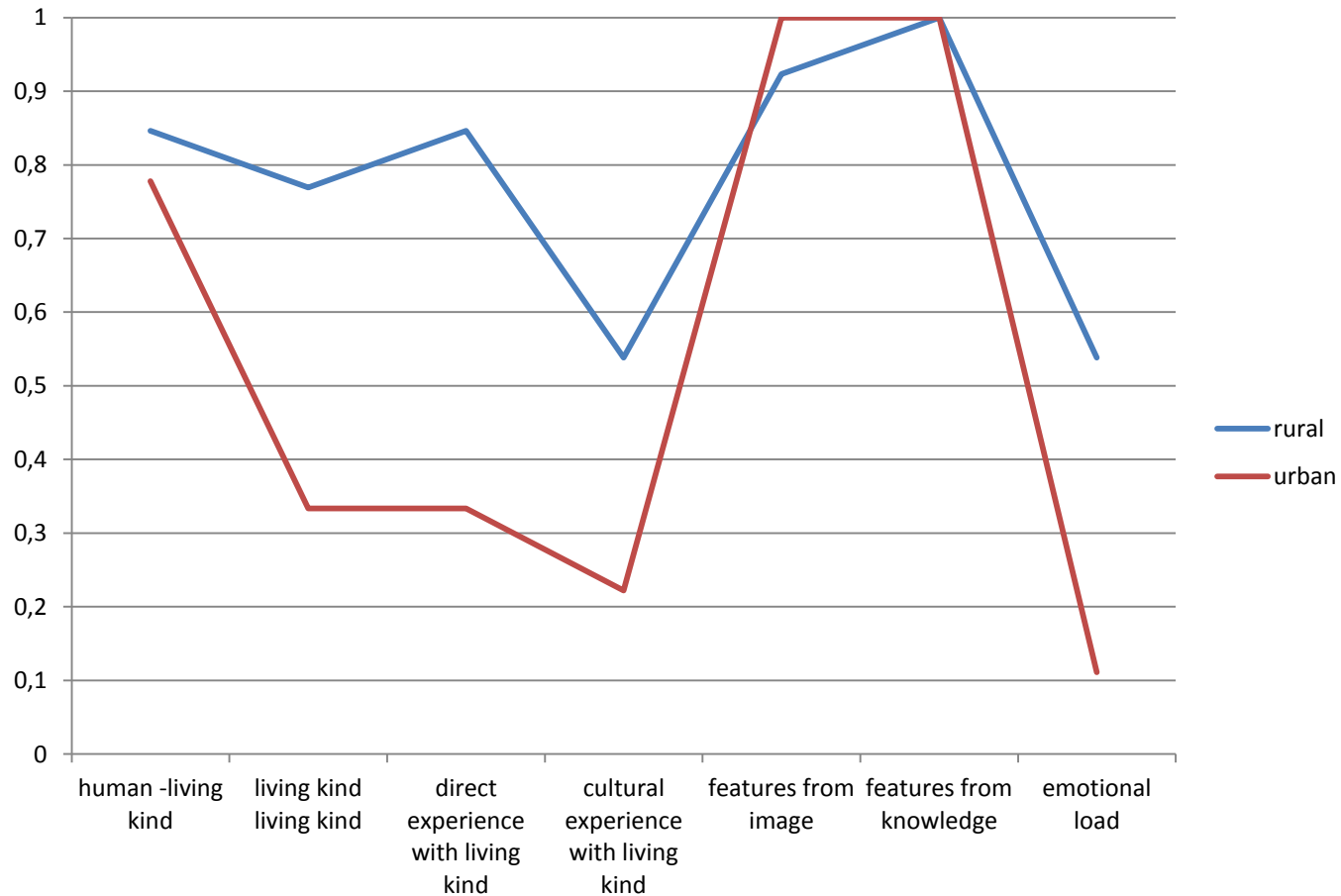
# Analysis of children's descriptions

Responses were coded into 7 categories:

- Relationship between a human and a living thing
- **Relationship between a living thing and other a living thing**
- **Direct experience with a living thing**
- Cultural experience with a living thing
- Description based on what can be seen in the image
- Description based on knowledge
- Emotional evaluation

Child's description of each living thing could contain more than one coding category.

# Proportions of children that were scored the category at least once



# Conclusions

- Rural children mention direct experiences, and living kind-living kind relationships more often in their descriptions than urban children do.

# Study 6

## Parental reports on children's activities and interests

- Internet survey
- Various fields of interest probed, e.g. nature related (animals & plants) conceptual, artistic (e.g. music & maths), entertainment (games, TV...)
- Proportion of time spent in rural environment correlates with the role nature plays in children's activities and interests  $r=0.4$   $p<0.05$



# Overall conclusions

- Reliance on living thing in induction begins to develop at age 5-6 years
- It is facilitated by direct experiences with nature but it's development requires conceptual foundation (rich network of concepts – rich vocabulary)

# Future directions

- Multivariate tests
- Testing sources of biological knowledge  
(e.g. parent child conversations, nature walks)
- Interventions

# Thank you

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