Children’s thinking and how to study it

Eve Kikas

Tallinn University

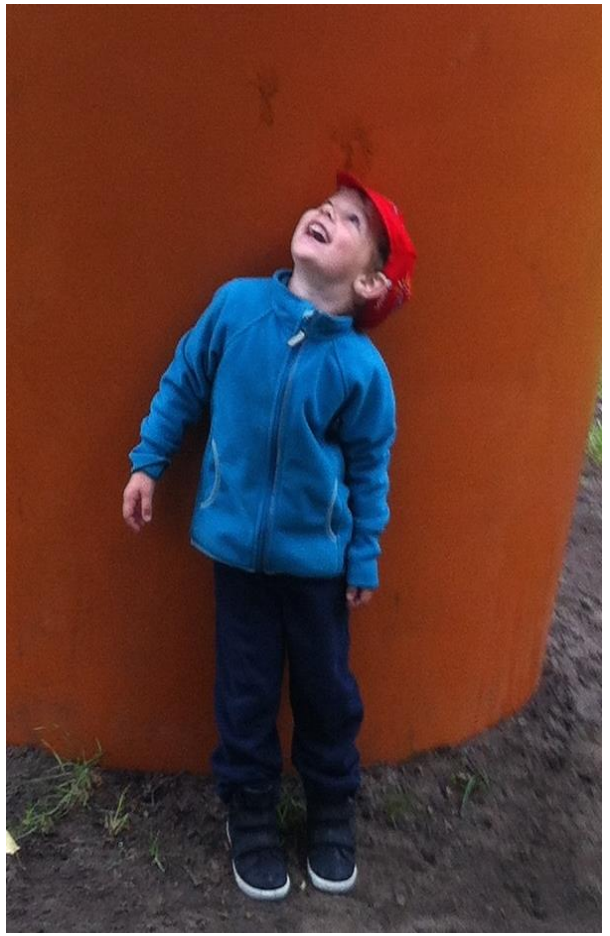
The boy fell down from the bicycle because he got hurt

Daughter:
Now I understand
why fire engines are always in such a hurry!

I: Why?

Daughter:
Of course, because otherwise
they reach the fireplace
when the fire has been already extinguished!

Look!
Chimney is
making clouds!



I How to study young (preschool) children's thinking

II How to study schoolchildren's thinking

Is there difference between studying preschool and schoolchildren?

I How to study young children’s thinking. What methods, how well-known the material should be for child?

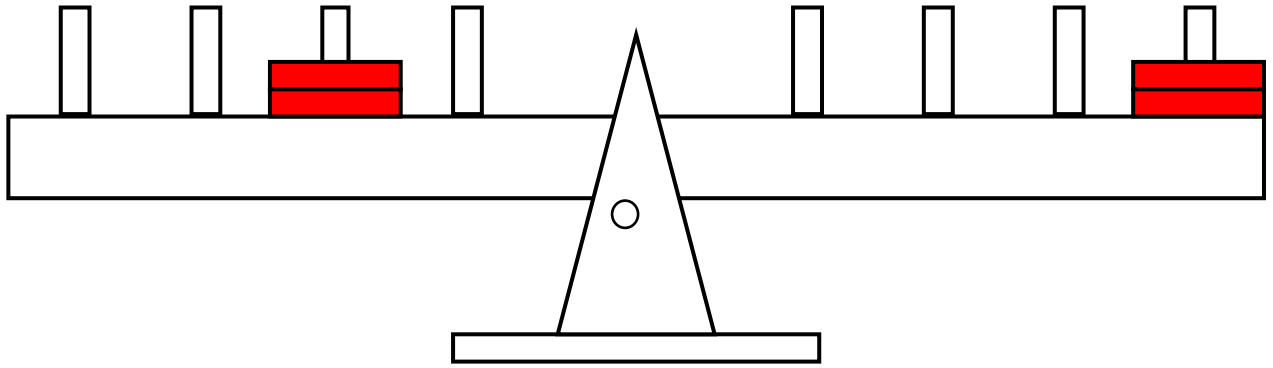
Jean Piaget and clinical method

- *The Child's Conception of the World* (1929):

Challenge of exploring cognition and thinking

in young children

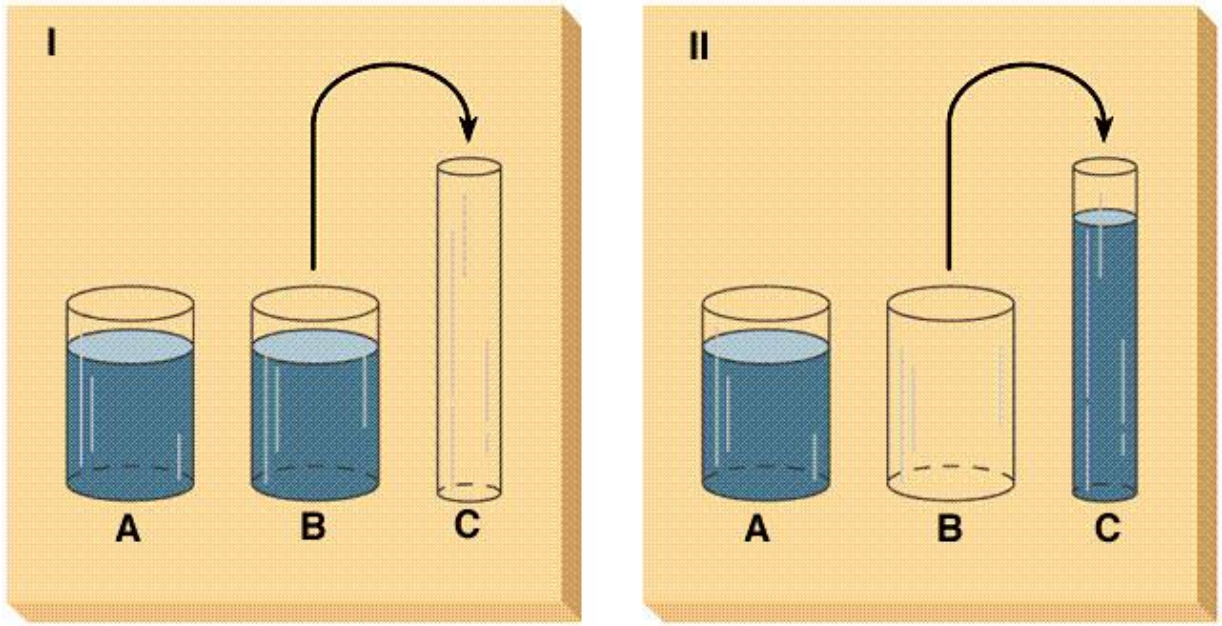
- **Clinical interview method:**
  - to investigate underlying patterns in children's thinking from behavior
  - influenced by the psychoanalytic movement and by Freud's approach
  - flexibility involving the interviewer as measuring instrument
  - non-standardized process, develops as the interview progresses
  - great sensitivity to and understanding of the *individual*
- Unfamiliar tasks to which a child has not learnt a standard procedure
- Piaget: to uncover peculiarities of cognitive stages



Limitations:

Novel tasks
One dimension clearly more visible than the other

Piaget's Conservation Task

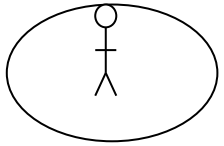


Stella Vosniadou et al.

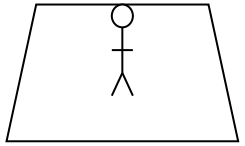
- Questions and drawing tasks
  - Factual questions, generative questions
  - Repetitive questions
- Examined the data for coherent patterns of responses and constructed from those a number of possible mental models
  - Three types of models—initial, synthetic, and scientific
  - Synthetic: Dual Earth, Flattened Sphere

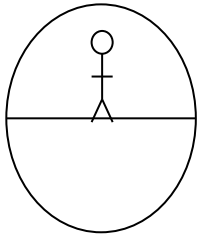
(1) Draw the Earth
(2) Draw where the sky and clouds go
(3) Draw some people to show where they live
(4) What is the shape of the Earth?
(5) Where is the sky?
(6) Where do people live?
(7) If you walked for many days in a straight line where would you end up?
(8) Is there an end/edge of the Earth?
(9) What is below the Earth?

Models of the Earth

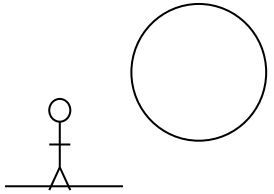


Tasapinnaline Maa

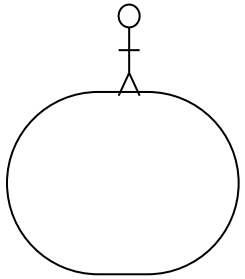




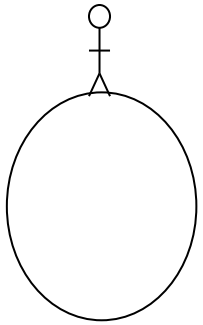
Seest tühi kera



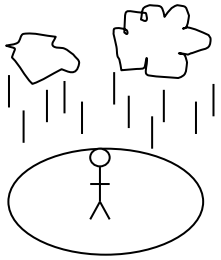
Kaks Maad Maad



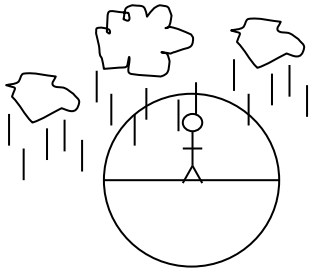
Lamendunud kera

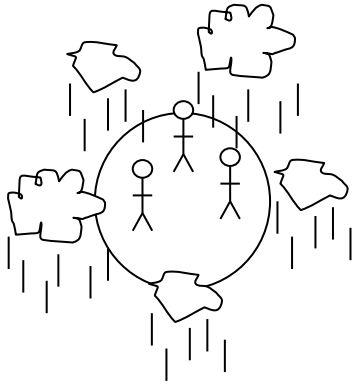


Teaduslik mudel

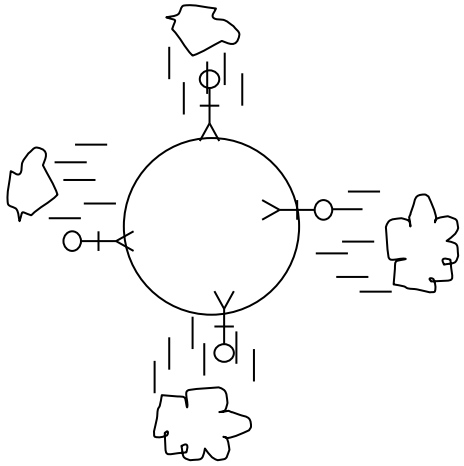


Kettakujuline Maa





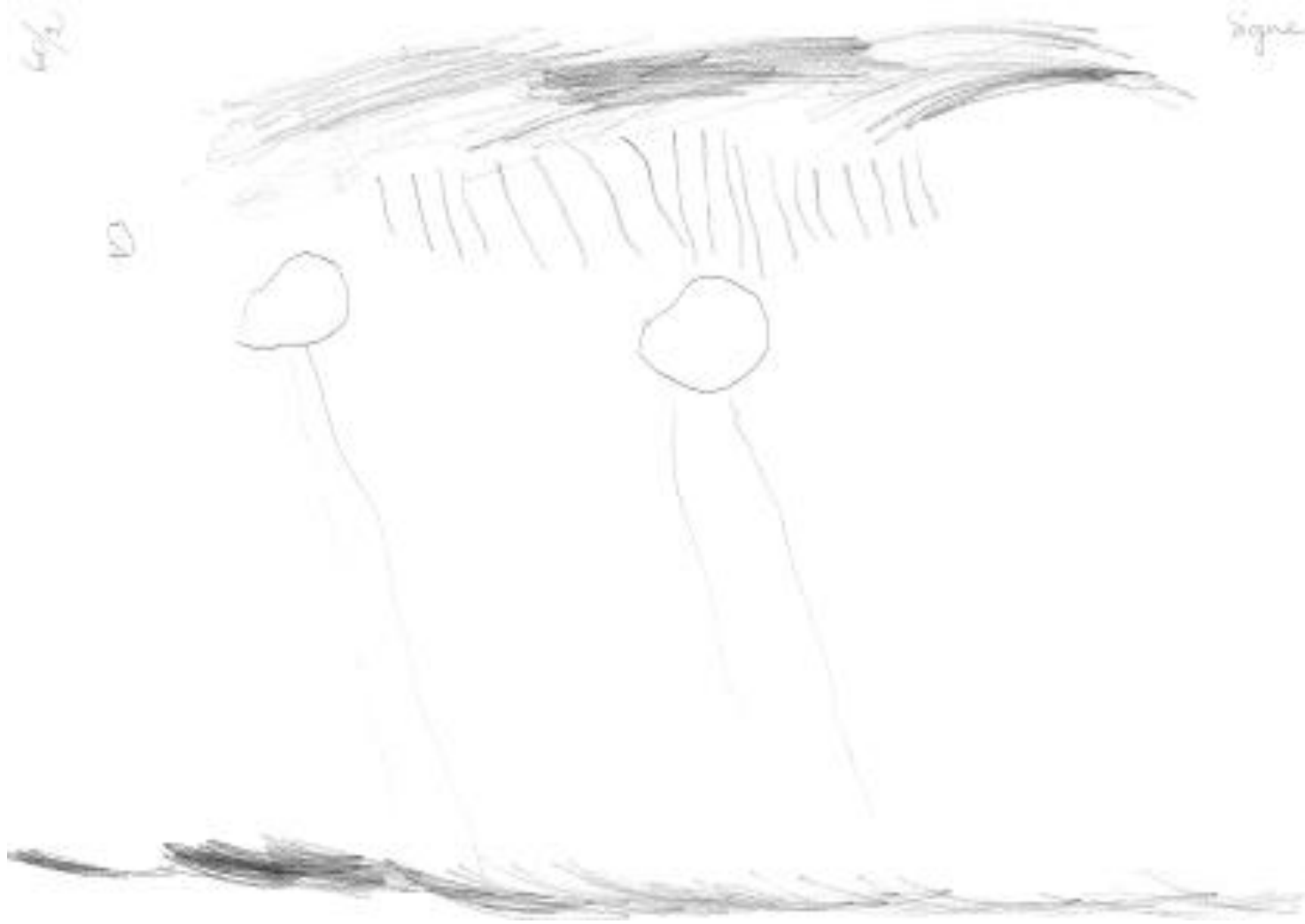
Ümmargune Maa. Pildist lähtumine

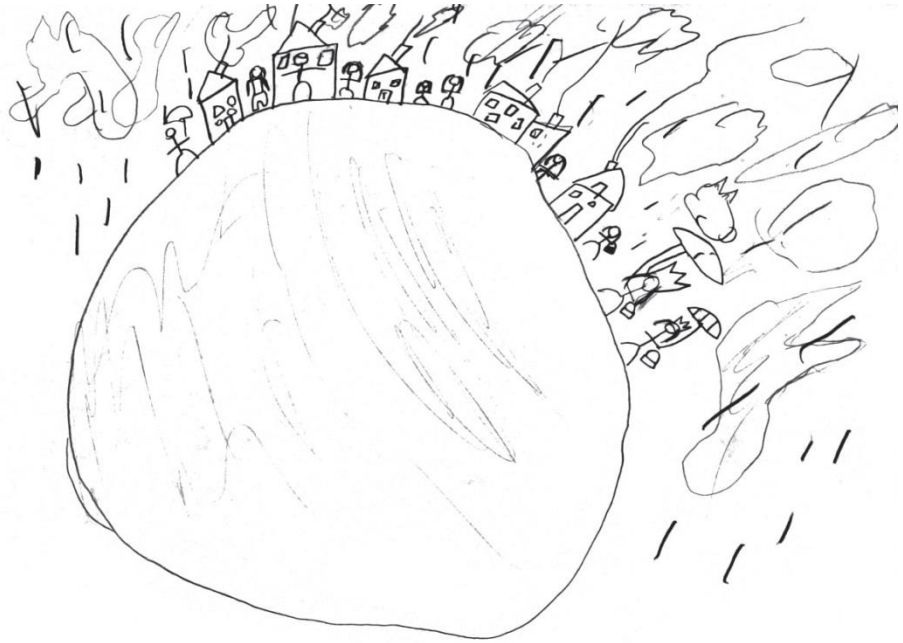


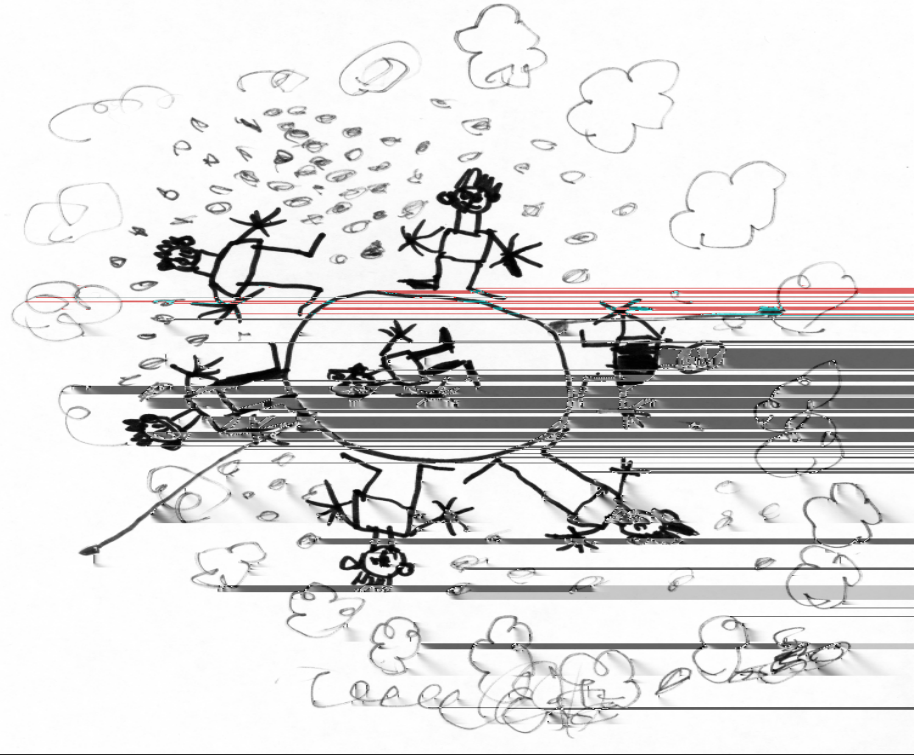
Teaduslik Maa mudel

Limitations

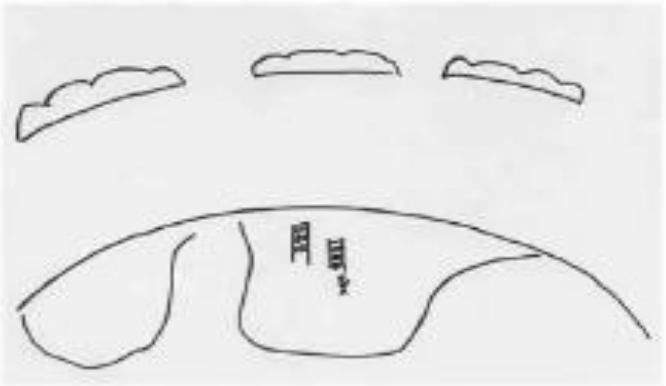
- Repeated questioning (i.e., rephrasing questions) might mislead children
- Relying too heavily on children's drawings might lead to misinterpretations of children's understanding
- Analysis of data that supports finding integrated models







(d)



Semicircular (P891)

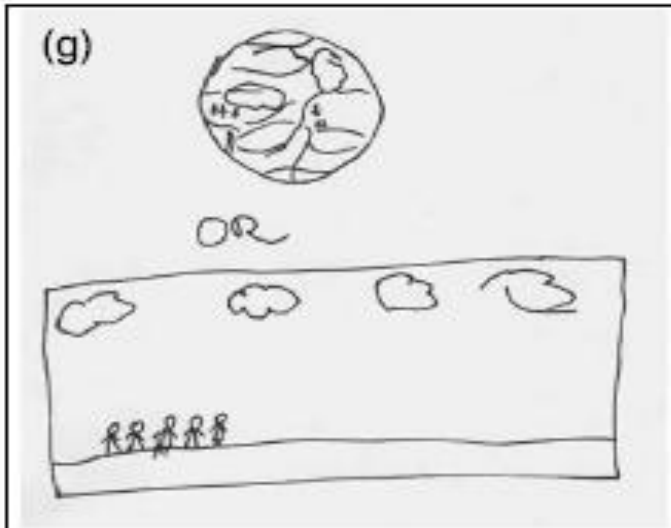
(e)

Flat Earth (P802)

(f)

f: Three pictures (P93)

(g)



Two pictures with 'or' (P22)

(h)

Dual Earth (P71)

(i)

Hollow Earth (P812)

Adults' representations of the Earth: Implications for children's acquisition of scientific concepts

Gavin Nobes* and Georgia Panagiotaki
University of East Anglia, UK

When I drew this I was thinking about only one place on the Earth. Wherever you are on the face of the Earth there is always the sky above you (P803, hollow)
I didn't continue my sky all around the little drawing of the Earth not just because I thought the sky only existed at the top of the world but because I just intended to represent it (P991, circular, sky on top).

This (circle) is the Earth. I've done the clouds here and the people here as a representation of where they would be, like all the way around (P148, hollow)

I'm thinking where the sky is. Everybody is seeing it, right? Is it like it's all around? I don't think I know. . . I just assumed that it's up there (P67, circular, sky on top)
I don't know actually, I would have thought the sky's on top (P807, hollow)
[Where would the sky and the clouds be with regards to this sphere?] I presume over England here. I suppose they are hovering over various . . . I don't know (P814, flat).

An important question when examining children's thinking is what kind of questions and tasks to give to children.

Should these be novel
or base on their earlier experience and context?

As soon as we modify the method we get different results.

So – when can we learn how children REALLY think?

After graduating, Siegler enrolled in the State University of New York at Stony Brook's graduate program in clinical psychology. By the end of his first year, however, he had decided to focus on cognitive development. The decision was made when his advisor Robert Liebert and he tried to teach a five-year-old liquid quantity conservation through modeling of correct answers and explanations. Siegler went into the experiment convinced that he would demonstrate that this kook, Piaget, was dead wrong: Of course a five-year-old would know that pouring water into a different shaped glass did not change the amount of water. Siegler was surprised when the little girl said that the tall thin glass had more water, but he was shocked when the girl maintained her stance despite Liebert—a large, imposing man with a deep booming voice—repeatedly telling her that she was wrong. At this point, Siegler's career path was set; anything that could motivate a five-year-old to defy Bob Liebert merited serious study.

Robert Siegler and microgenetic method

- Study the progress in explanations
- First: the first answer that comes to the mind
- Last: learnt ways of solving problem
- Middle: several strategies, not only one
- Gave children same tasks in several sessions and observed for changes

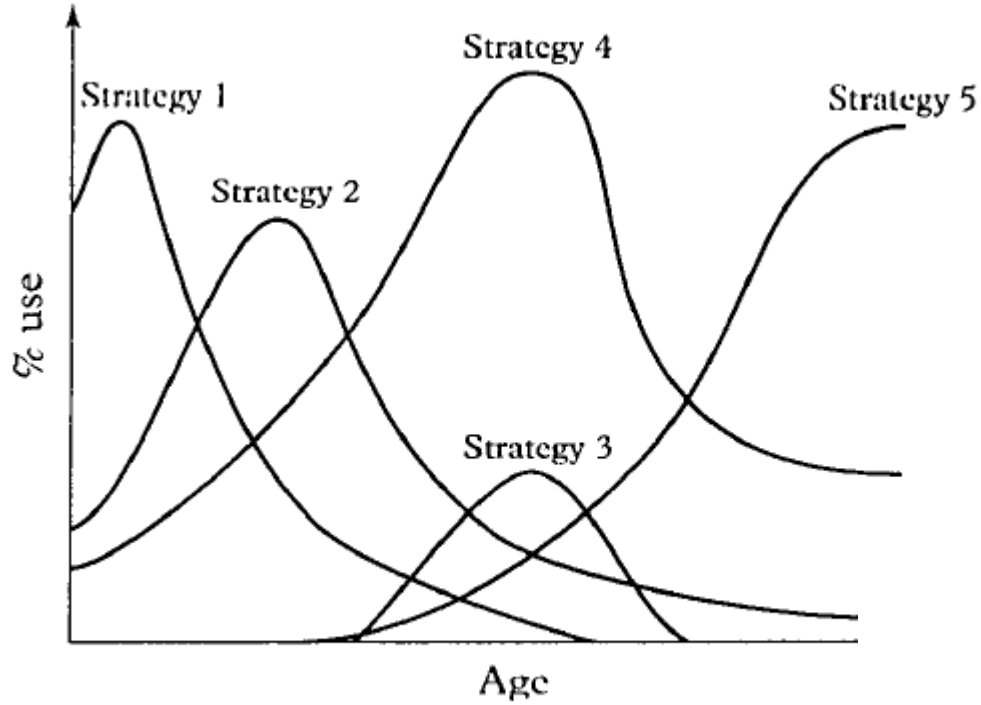


Figure 1.2 The overlapping waves model.

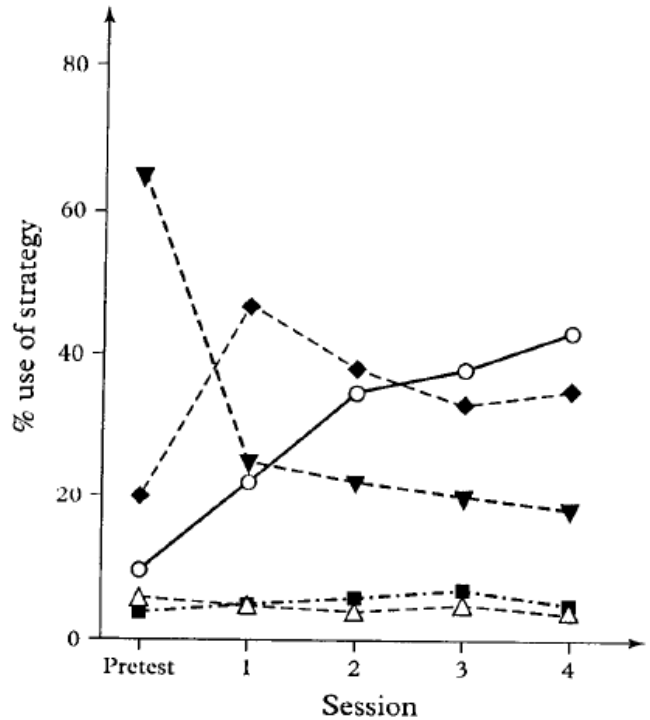


Figure 1.3 Percent use of five types of explanations on the number conservation task. -○-, Type of transformation; --▼--, Length; ----△----, Counting; --■--, Back and forth; --◆--, Don't know.

TOPICS
TOPICS IN COGNITIVE SCIENCE

Topics in Cognitive Science 8 (2016) 118–137

ISSN:1756-8757 print / 1756-8765 online
DOI: 10.1111/tops.12174

Tensions Between Science and Intuition Across the Lifespan

Andrew Shtulman, Kelsey Harrington

Department of Psychology, Occidental College

Received 30 June 2014; received in revised form 11 February 2015; accepted 20 February 2015

Abstract

The scientific knowledge needed to engage with policy issues like climate change, vaccination, and stem cell research often conflicts with our intuitive theories of the world. How resilient are our intuitive theories in the face of contradictory scientific knowledge? Here, we present evidence that intuitive theories in 10 domains of knowledge—astronomy, evolution, fractions, genetics, germs, matter, mechanics, physiology, thermodynamics, and waves—persist more than four decades beyond the acquisition of a mutually exclusive scientific theory. Participants (104 younger adults, M_{age} = 19.6, and 48 older adults, M_{age} = 65.1) were asked to verify two types of scientific statements as quickly as possible: those that are consistent with intuition (e.g., "the moon revolves around the Earth") and those that involve the same conceptual relations but are inconsistent with intuition (e.g., "the Earth revolves around the sun"). Older adults were as accurate as younger adults at verifying both types of statements, but the lag in response times between intuition-consistent and intuition-inconsistent statements was significantly larger for older adults than for younger adults. This lag persisted even among professional scientists. Overall, these results suggest that the scientific literacy needed to engage with topics of global importance may be constrained by patterns of reasoning that emerge in childhood but persist long thereafter.

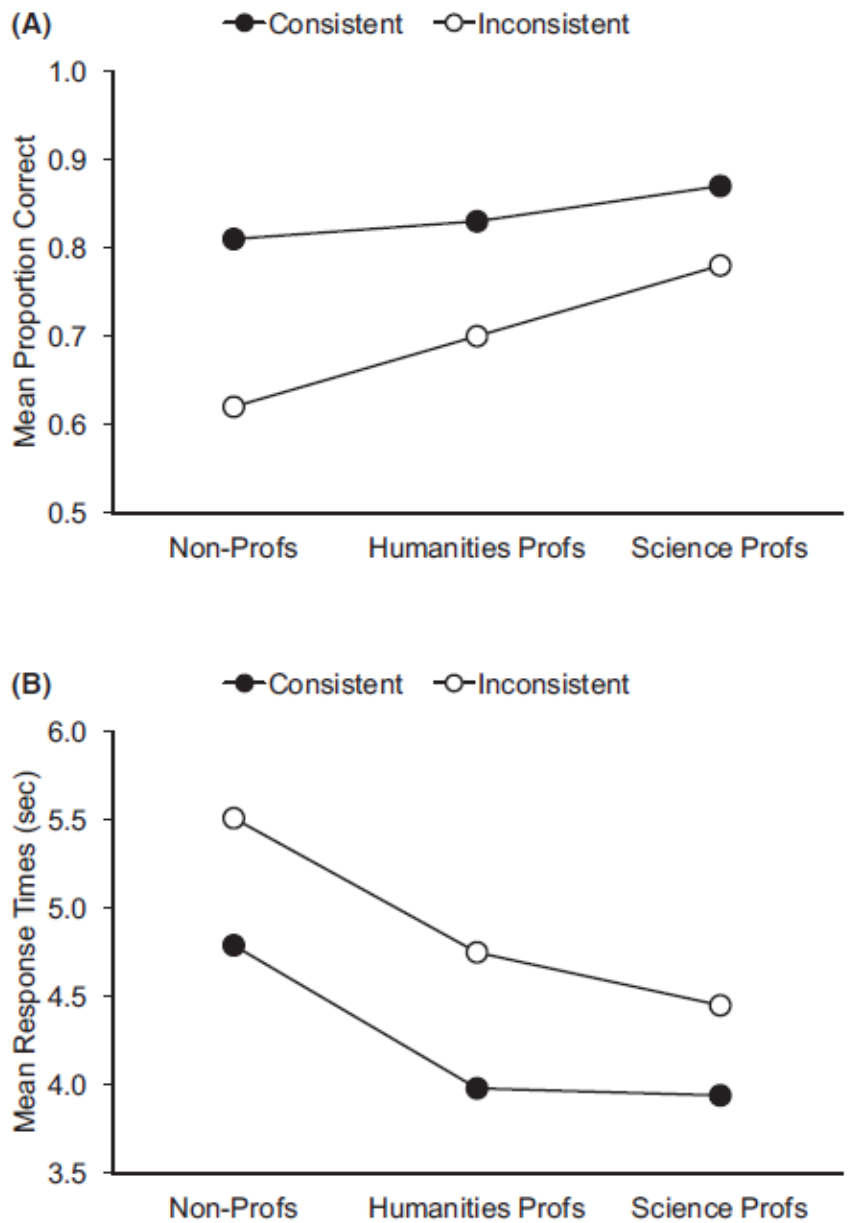


Fig. 2. Mean proportion of correct verifications (A) and mean response times (B) as a function of statement type (intuition-consistent vs. intuition-inconsistent) and occupation (non-professors, humanities professors, science professors) for the older adults; all $SE < 0.03$ for (A) and all $SE < 0.035$ for (B).

II Difficulties with studying school-aged children.

Differences from young children.

Learning about thinking of schoolchildren

- Piaget was not interested in studying children's understanding of material learnt at school because It shows the extent schoolchildren have acquire what has been taught by teachers and thus does not show children's true way of thinking
- It is not correct!
- Children construct their knowledge from experience and also books, teachers' talk
- They always know something about the topic they start to learn about
- This earlier knowledge guides how they interpret new knowledge

Examples of scientifically-looking answers

- **What is water cycle?**
- Water cycle is water moving around because of temperature differences
- **What is condensation?**
- Gathering of water vapour on to something because it becomes thicker

- Scientific: Water cycle is a process where water evaporates, then clouds form and after some time it rains down again

- Scientific: Condensation is water in a liquid state

- Differently from preschool and young schoolchildren, older students are more afraid of giving stupid answers and they better say simply that they do not remember, do not know.
- In school, children learn *through language but also to use language*.
  - one right answer
  - use special kind of language – scientific language
  - What is scientific language?
    - Scientific for scientist – to use logical deductions, abstract schemas, base on principles, that characterize the subject (e.g., physics).
    - Children – use abstract terms, terms also for logical argumentations (because).
  - It means, scientists use scientific language but children base on its everyday, perceptual features.

Examples of scientifically-looking answers

- What is water cycle?
- Water cycle is water moving around **because** of temperature differences
- What is condensation?
- Gathering of water vapour on to something **because** it becomes thicker

- Scientific: Water cycle is a process where water evaporates, then clouds form and after some time it rains down again

- Scientific: Condensation is water in a liquid state

Pay attention to wrong answers!

- These answers show how children really think!
- And more – ask to explain these answers
- It is a good way of learning

- Robert Siegler: children learn the most if they have to explain both their wrong answers and (teacher's) right answer!

Wrong answers from test. What do they mean?

- 72 + 12 = 84 +
- 88 + 11 = 99 +
- 71-15 = 54 -
- 76 – 5 = 71 +
- 92-13 = 75 -
- 63 + 12 = 75 +
- 63 – 16 = 41 -

Adding and subtraction strategies

- 71 + 15 = 70 + 10 + 1 + 5 = 86

- 71 – 15 = 70 – 10 – 1 – 5 = 54
- 92-13 = 90 – 10 – 2 – 3 = 75
- 63 – 16 = 60 – 10 – 3 – 6 = 41

Follow discussions in groups

Example of our study
on how children explain why we have winter and summer
Why seasons change

British Journal of Educational Psychology (1998), **68**, 505–516 *Printed in Great Britain*

Pupils' explanations of seasonal changes: age differences and the influence of teaching

Eve Kikas*
Department of Psychology, University of Tartu, Estonia

Background. Pupils have consistent everyday astronomical explanations, some of which, e.g., distance theory, are very resistant to change. The reasons why everyday explanations are not replaced by scientific ones have been connected with teaching methods used in school.

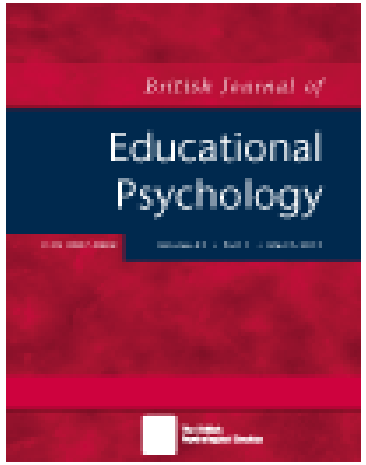
Aims. The developmental differences in explaining seasonal changes and the reasons why school teaching fails in changing distance theory are studied.

Samples. The 112 schoolchildren participating in the study were: 32 pupils from each of grade 3 (age 9–10), grade 5 (age 11–12) and grade 7 (age 13–14) (half of them from a state school, others from Waldorf school) and 16 pupils from grade 9 (age 15–16). Half of the pupils were boys. The participants were divided into groups of four same-sex and same-grade pupils (i.e., into 28 groups).

Methods. Guided peer discussions in foursomes are used. Explanations of pupils of different ages and from two schools with different teaching methods are compared.

Results. The sources of references on which pupils based their explanations were divided into five categories: everyday, distance-theory, incomplete, exact rules and authoritative. It is shown that younger pupils refer more frequently to everyday perceptible data and older ones more to knowledge taught in school but using distance theory does not change with age. Differences between schools were determined.

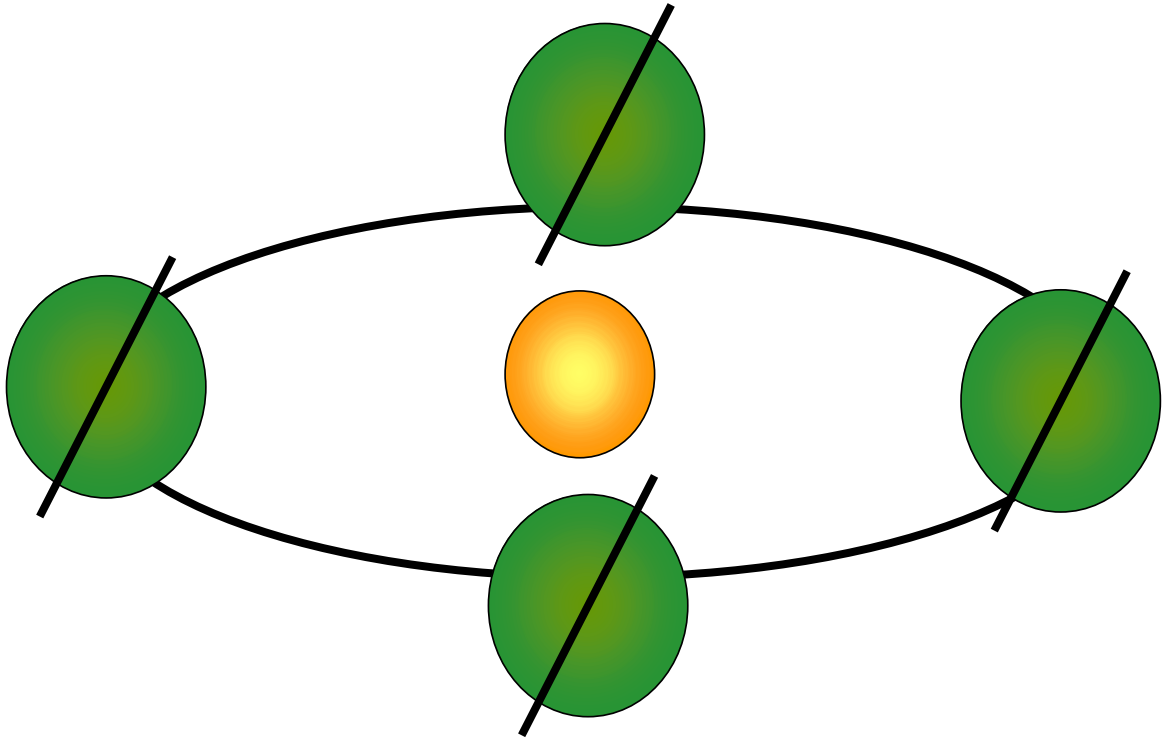
Conclusions. Such an everyday explanation as distance theory is very vital as it is drawn from several everyday experiences with heat sources. It is used to explain seasonal changes as far as scientific explanations learnt in school have not been well understood or have been forgotten.

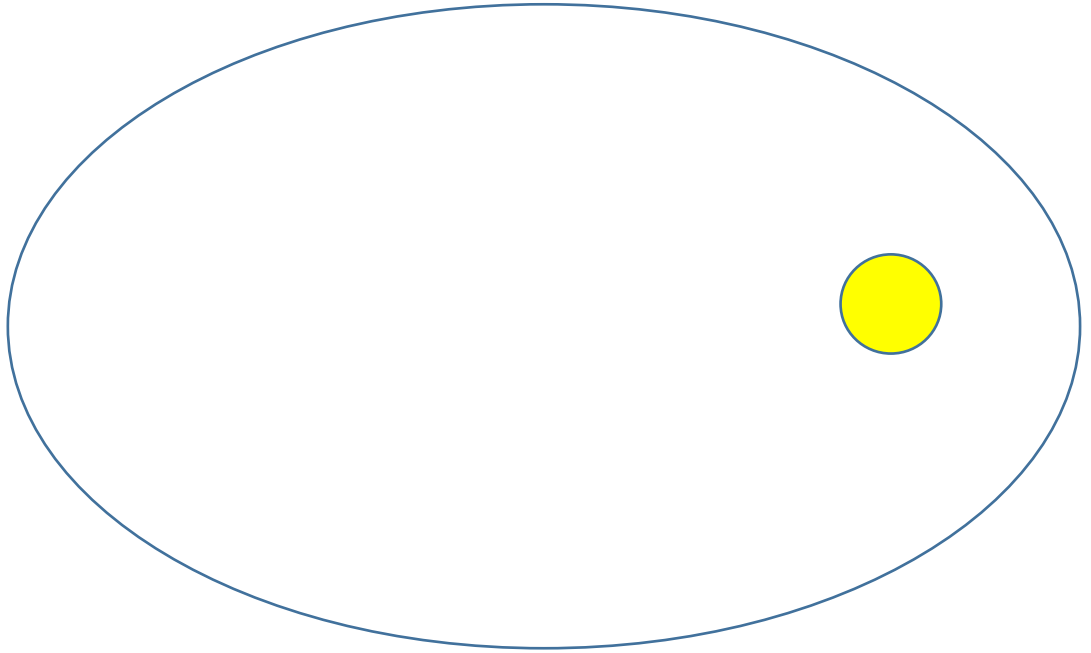


THE DEVELOPMENT OF CHILDREN'S KNOWLEDGE: THE SKY, THE EARTH AND THE SUN IN CHILDREN'S EXPLANATIONS

Eve Kikas

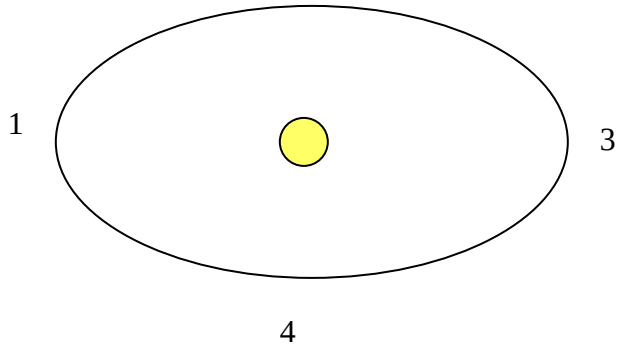
http://www.folklore.ee/folklore/vol31/kikas.pdf



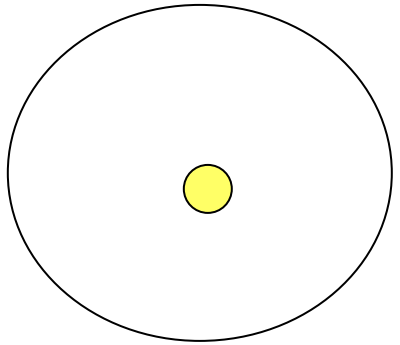


Which one in the Earth’s orbiit?

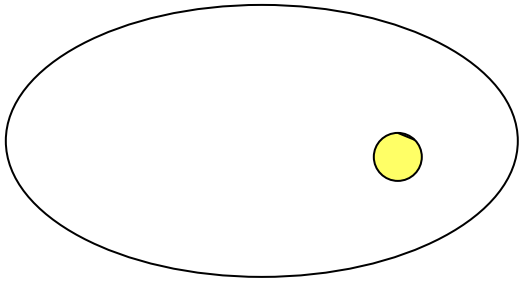
Where is summer where winter? 2



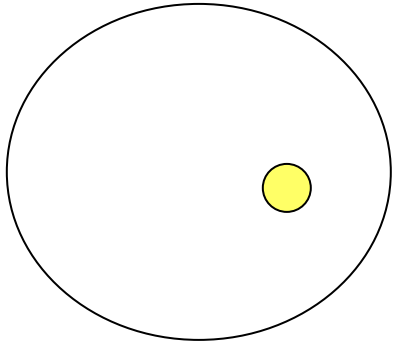
(a)



(b)



(c)



(d)

Pille: I think it should be that one (a).

Malle: Why, why should it be so irregular?

Pille: Because this is how it was on the picture, because this is how it was on the picture.

Malle: Why would it go further away from the sun… if it already has an orbit why would it go further away?

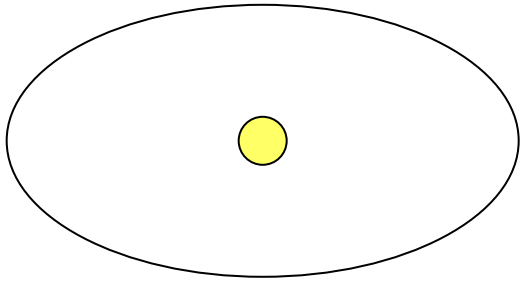
Pille: I don't know, I've always had the impression that it is not altogether round, its journey–

Ragne: I think so, too (a)–

Jana: I think, too (a)–

Malle: Well, I still think that if they already have certain orbits then their position relative to the sun should always be the same.

....



Conclusions

- Studying children' thinking is challenging
- It should be complex – with different methods, different reporters, context

- Another challenge for us as researchers and test developers

- Teachers would expect quick answers which is impossible !

THANK YOU!