

Children's logic and learning

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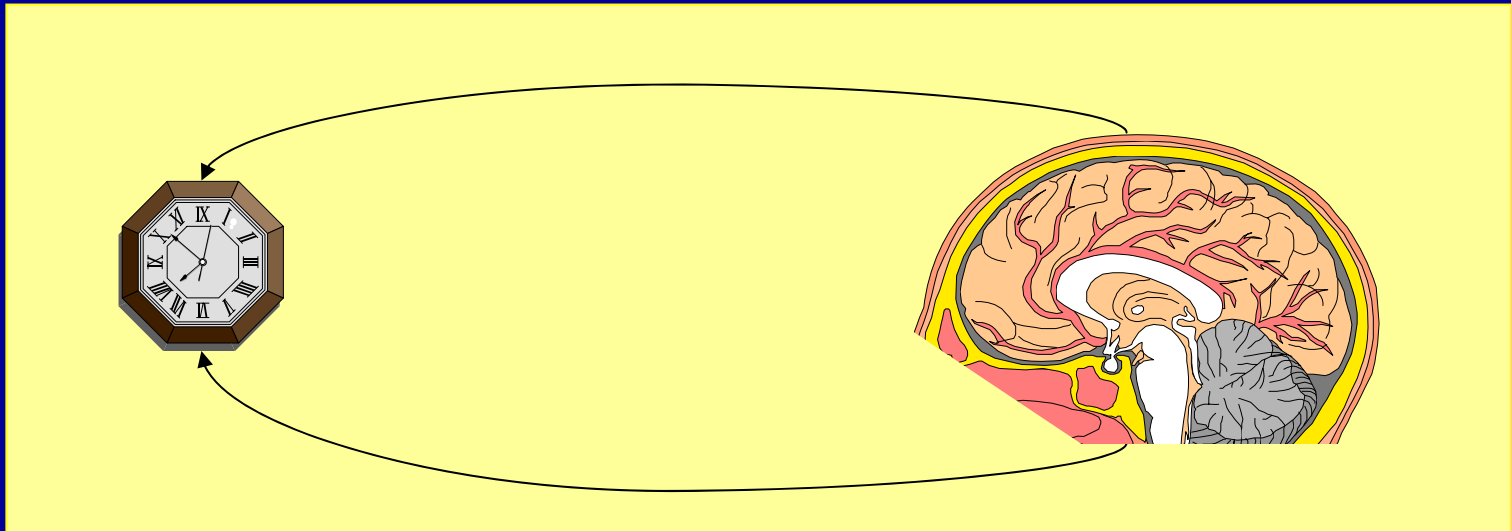
Outline

- Thinking about learning in a technological society
- Why logic and learning?
- How do we know which logical reasoning is necessary for each learning?
- And what if we don't do the learning in school?

Thinking about learning

What time is it?

- Your most likely reaction is to look at your watch in order to answer



How does this work?

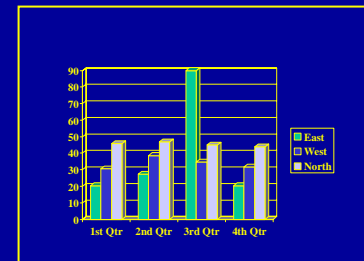
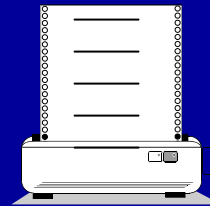
- Our knowledge of time is organised by a cultural artefact - the watch - and the knowledge that is part of using a watch
- We need to know about numbers
- We need to understand the connection between minutes and hours
- We need to know how to read the watch: number 1 means 'one' for hours and 'five' for minutes

A cultural tool for thinking

- The watch is a cultural tool for thinking and knowing about time: our thinking about time would be different without watches and clocks
- Much of our everyday knowledge is of this type because we need some form of knowledge to use the objects that surround us

A cultural tool for thinking

- Some of the knowledge might be very specific, like using a can opener
- Much of it will not be so specific because it involves systems that are used in different situations
 - writing
 - numbers
 - using computer menus



Why logic and learning?

- Do we learn each item by itself or do we learn the *logic* of the system and then can construct and reconstruct the items using our understanding of the system

Learning to count in Japanese

-	10 ju	20 niyu	30 sanju
1 ichi	11 juichi	21 niyuichi	
2 ni	12 juni	22 niyuni	
3 san	13 jusan	23 niyusan	
4 shi			
5 go			
6 roku			
7 sichi			
8 hachi			
9 ku			99?

Why did you learn to count in Japanese so easily?

- You already had understood the logic of the English counting system
- English uses a base-ten system and so does the Japanese counting system
- When you learn to count in Japanese, you don't have to learn all the words
- You can construct some words from your knowledge of the system

What about children?

- Psychologists analyse what sort of logical moves are involved in children's learning
- Then we assess the children's understanding of these logical moves at different ages
- We also investigate what makes it easier or harder for them to make some of these moves

What is involved in learning the decimal system

- Units of different values: ones, tens, hundreds
- In everyday life we also work with other units of different values - coins and notes have different values
- If you have **one 10p** coin and **one 1p** coin, you have two coins but **11p**

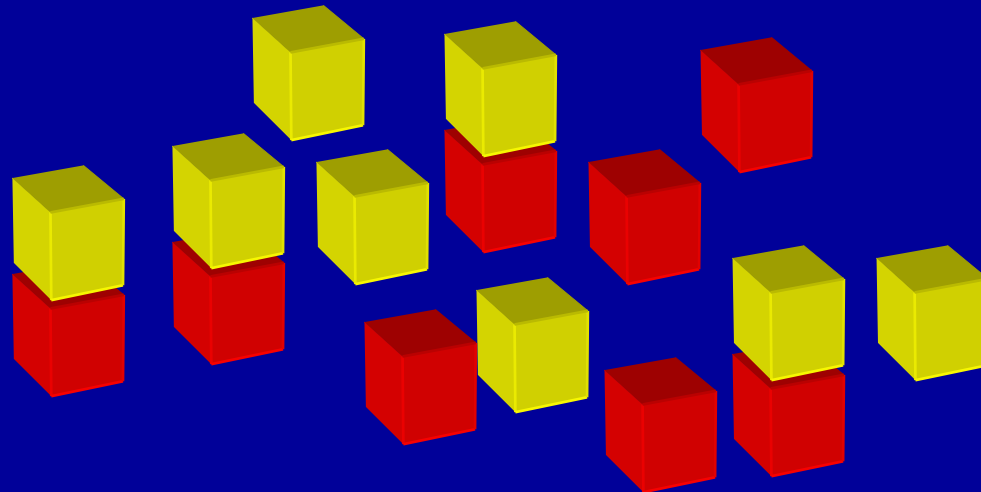
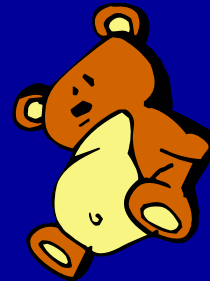
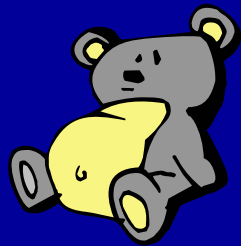
Is this difficult for children?

- Two types of situation
 - the ones within a unit can be identified
 - the ones within a unit cannot be identified

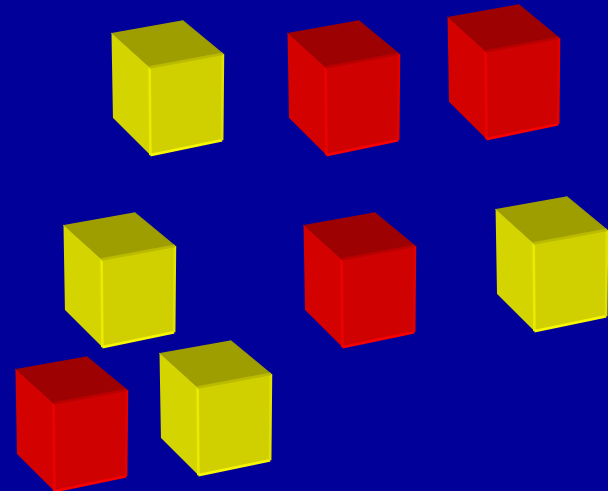
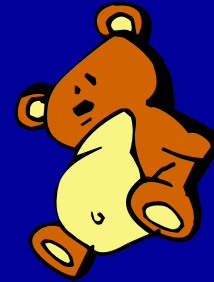
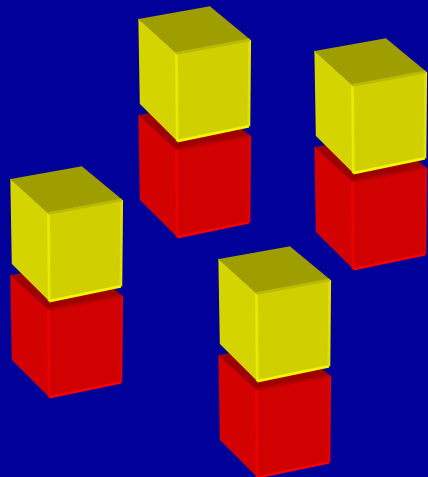
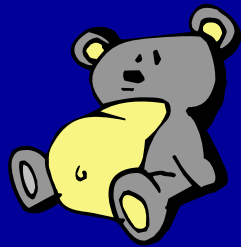
Sharing units of different value

- Peter Bryant (U. of Oxford) asked children to share fairly single and double sweets to two bears

Sharing units of different value



Sharing units of different value



Sharing units of different value

- We have developed a second task where the children share coins of different values
- The units cannot be identified within a coin
- Does this situation make the problem more difficult for children?

Sharing units of different value

- Only a few 4-year olds but the majority of 5 year olds can share fairly the sweets when the ones are of the same colour in the double sweets
- When the ones are of a different colour, many 4-year-olds succeed in the task
- Only a few 5-year olds succeed in sharing fairly 1p and 2p coins

Sharing units of different value

- We conclude that these tasks are easier when it is easier to identify the ones within a unit of a higher value
- The same logical move can be made more difficult or easier by changing the task
- Peter Bryant has shown that children can improve in harder tasks by practising with simpler tasks

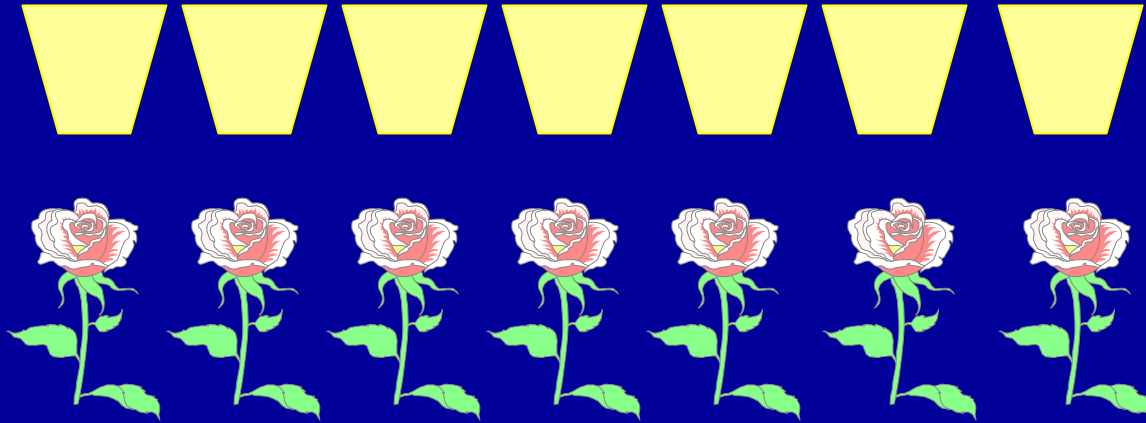
What is the logical move here?

- Reasoning by correspondences
- Young children (age 4 and 5) are relatively good at reasoning about one-to-one correspondence
- Reasoning about one-to-many correspondence is more difficult but more than half of the 5-year olds succeed in the easier tasks

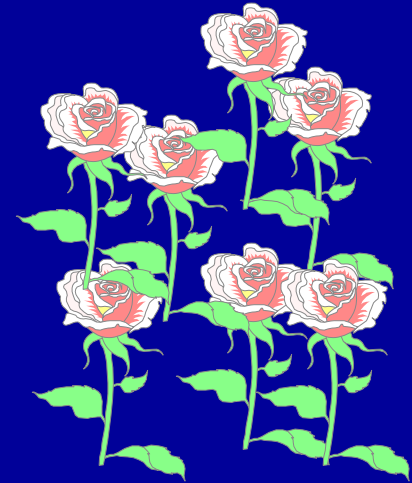
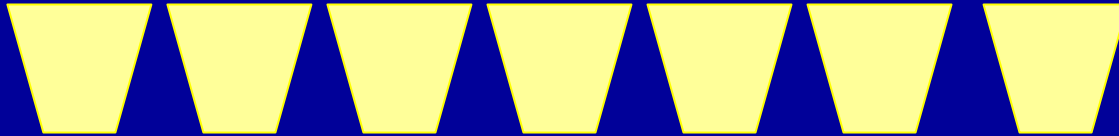
One-to-many correspondence

- The Swiss researcher Jean Piaget started the investigations on correspondences

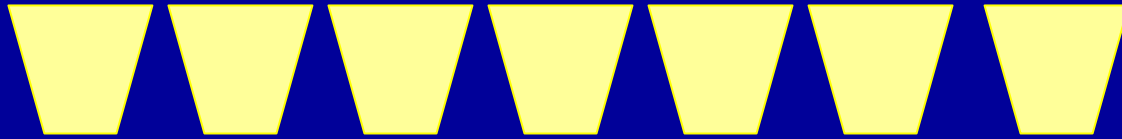
Take one red flower for each vase



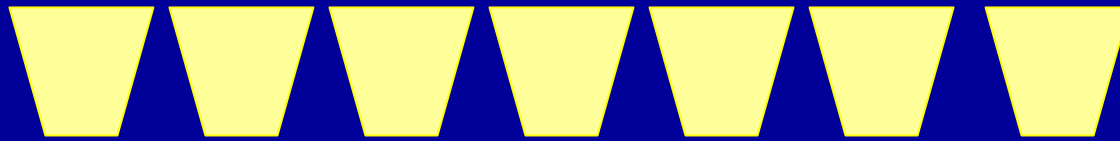
Take one yellow flower for each vase



If you put the same number of flowers in each vase, how many flowers will you have in each?



In each straw you can only fit one flower.
Pick up the exact number of straws you
need in order to put each flower in a
straw.



Two flowers per vase.

To take the same number of tubes, I will take two tubes per vase.



Results

- Piaget observed that many 5-year olds succeeded in making this logical move.
- Understanding the one-to-one correspondence was a necessary condition for understanding the one-to-two correspondence.

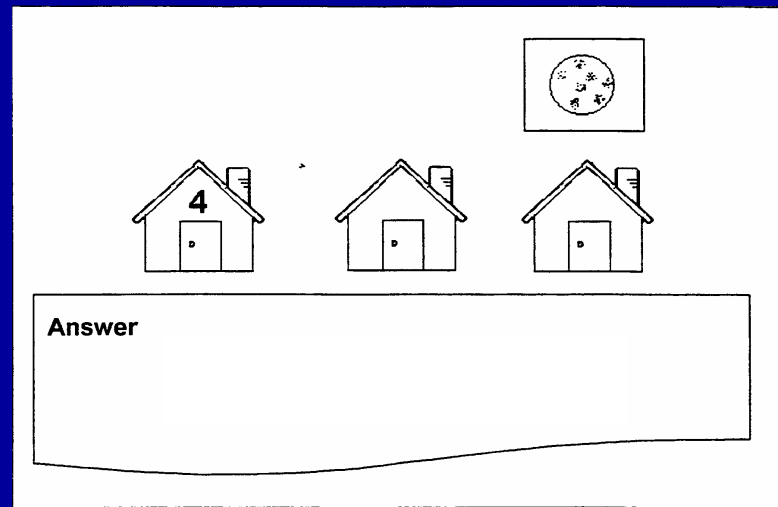
In each house in this street live 3 dogs. Write down the number of dogs that live in this street.

Results

- Even children who have not been taught about multiplication can solve this type of problem using correspondence reasoning

A problem with paper and pencil

- In each house live four rabbits; draw the number of carrot biscuits you need to give one to each rabbit



Percentage of children drawing the correct number of biscuits



Nunes & Bryant, 2000 & Watanabe et al, 2000

What happens if the children do not attend school?

- Unfortunately in many parts of the world not all children attend school
- We have studied the mathematical reasoning of young people and adults in Brazil who either dropped out of school very early (after only one to four years) or did not go to school at all

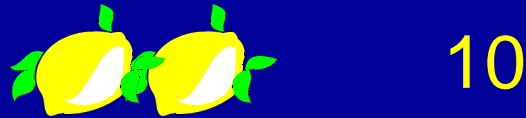
Mathematics in the streets

- Many children work in the streets in a variety of ways: selling small items, cleaning cars
- In their everyday lives, they have to use reasoning about multiplication but they have not attended school or left too early to have been taught about multiplication

Nunes, Schliemann, & Carraher
(Mathematics in the streets and in
schools, Cambridge University Press)

MD, 9 years, was selling lemons for Cr\$5
(five cruzeiros) each. I want 12 lemons.

MD (separates two lemons at a time as she counts out loud):



10



20



30



40



50



60

Mathematics in the streets and in school

- Many of the children we interviewed could solve multiplication problems using correspondence reasoning but could not solve a written multiplication sum
- When they were taught multiplication, they were not taught in a way that helped them see the connection between their reasoning and the sum

Mathematics in the streets and in school

$$\begin{array}{r} 12 \\ \times 5 \\ \hline \end{array}$$

Mathematics in the streets and in school

$$\begin{array}{r} 12 \\ \times 5 \\ \hline 0 \end{array}$$

Mathematics in the streets and in school

$$\begin{array}{r} 1 \\ 12 \\ \times 5 \\ \hline 0 \end{array}$$

Mathematics in the streets and in school

$$\begin{array}{r} 1 \\ 12 \\ \underline{\times 5} \\ 100 \end{array}$$

What is the message about children's logic and learning?

- Much of our learning involves the use of tools
- In order to use these tools, we must learn the logic of the systems embedded in the tools

What is the message about children's logic and learning?

- We don't learn examples one by one: we learn the logic that allows us to reconstruct examples we have seen and construct others we have not seen
- After we have understood the logic of one system, it is relatively easy to learn to use other tools based on the same logic

What is the message about children's logic and learning?

- But it is essential that we make a connection between what we are learning and the logic used
- Without using the logical principles to organise what we learn, we have to learn each item on its own

What is the message about children's logic and learning?

- Differences in the learning situations can make the same logic more difficult or easier
- Young children reason well about one-to-one correspondence but not as well about one-to-many correspondence

What is the message about children's logic and learning?

- They reason well when the ones in a composite unit can be identified but not when they cannot be identified
- We can use this simpler situation, where the logic of correspondence is clear to them, to help them learn in more difficult situations related to the same logic

What is the message about children's logic and learning?

- Finally, the logical moves we learn as children remain important for our reasoning throughout our life
- Correspondence reasoning is useful all the way through school for learning multiplication and later for learning about functions and graphs

What is the message about children's logic and learning?

- Schools must make sure they invest in children's reasoning so the children relate their own way of thinking – their logic - to what they are being taught
- If they fail to do so, the children's logic and their school learning do not become connected

What is the message about children's logic and learning?

- We have a sense that we do not understand the mathematics that we learned in school and do not feel confident with it
- At the same time, we solve problems using quite complex mathematical reasoning outside school without even knowing that we are using complex mathematical ideas