SCIENTIFIC REASONING

Definition: thinking in terms of abstractions or symbols, being able to think about many variables or dimensions at the same time, being able to think in terms of probabilities and proportions.

Systematic hypothesis-testing is the heart of scientific thinking.

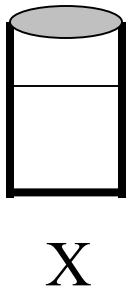
***** Most science textbooks (high school and college) assume that students are capable of scientific thinking**

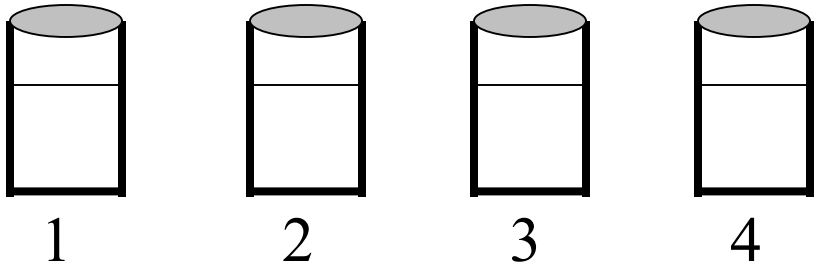
Classic Problem

Jean Piaget: Mixing Colors Problem

- 1,2,3,and 4 contain colorless, odorless liquids.
- X contains an “activating solution”.
- Some combination of liquids (always including X) will give a YELLOW color.
- How can you find the combination that makes YELLOW?

Jean Piaget (1896-1980)
Children’s Cognitive Development
University of Geneva





Classic Problem

Jean Piaget: Mixing Colors Problem

1+x	1+2+x	1+2+3+x	1+2+3+4+x
2+x	1+3+x	1+2+4+x	
3+x	1+4+x	1+3+4+x	
4+x	2+3+x	2+3+4+x	
	2+4+x		
	3+4+x		

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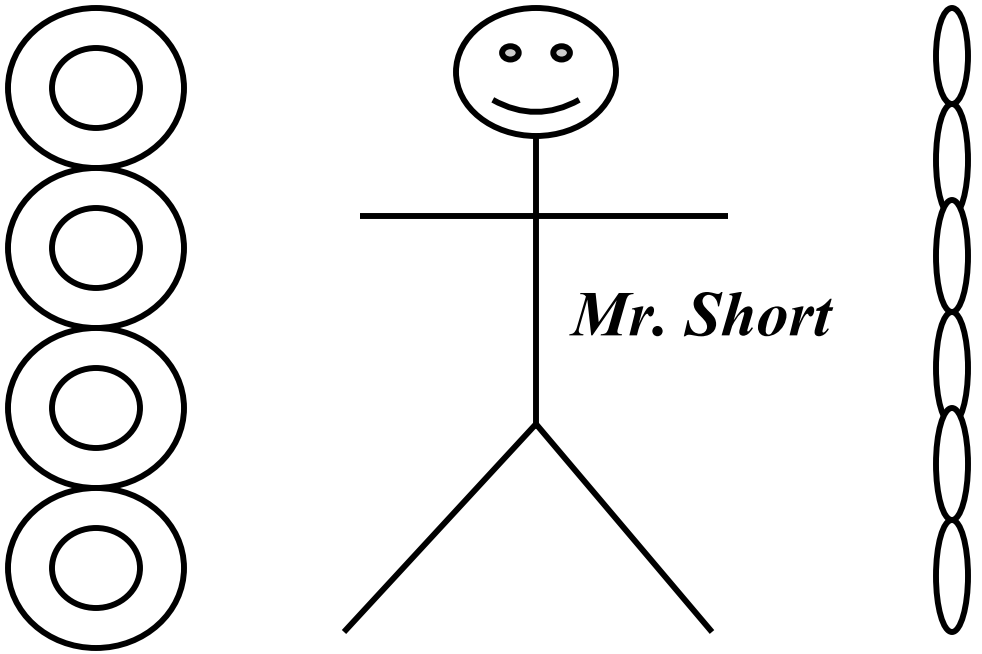
PROPORTIONAL REASONING IN ADOLESCENTS

Sample Problem:

Mr. Tall is 6 buttons tall. Mr. Short is 4 buttons tall. Now measure Mr. Short with paper clips. He is 6 paper clips tall. What is Mr. Tall's height in paper clips?



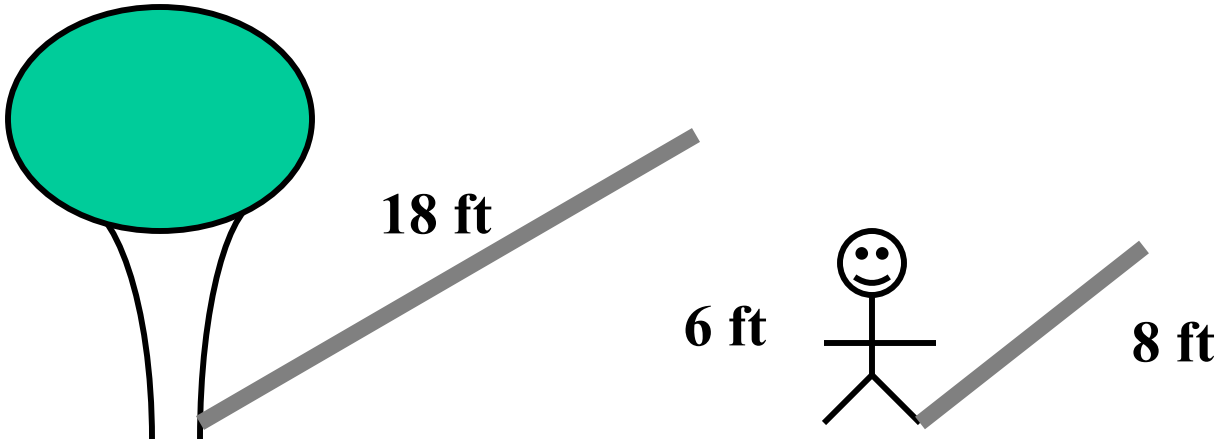
PROPORTIONAL REASONING IN ADOLESCENTS: THE MR. TALL/ MR. SHORT PROBLEM

Intuitive	**do not use all of data, or used illogically *("just added the 6 & 4" "just doubled 6 buttons")***	**38%**
Additive	**uses a single difference, uncoordinated with other differences** ***"If Mr. Tall is 6 buttons and Mr. Short is 4 buttons, that is a difference of 2. Now Mr. Short is 6 paper clips, so I took the 2 and added it to 6 and got 8."***	**28%**
Transitional	**partial ratio**	**18 %**
Ratio	**correct procedure**	**16%**

PROPORTIONAL REASONING IN COLLEGE STUDENTS

Sample Problem:

Walking back to my room after class yesterday afternoon, I noticed my 6 foot frame cast a shadow 8 feet long. A rather small tree next to the sidewalk cast a shadow 18 feet long. My best guess of the height of the tree would be _____



PROPORTIONAL REASONING IN COLLEGE STUDENTS: THE TREE/ SHADOW PROBLEM

Intuitive	**students either give no response or guess *("Can't tell. I'm not good at numbers")***	**8%**
Additive	**the student finds the difference between the two numbers and adds this value to a number** ***"8 is to 6 as 18 is to 16."***	**22%**
Transitional	**partial ratio** ***"6/8 is 3/4 but I didn't know how to find the height of the tree."***	**12 %**
Ratio	**correct procedure**	**58%**