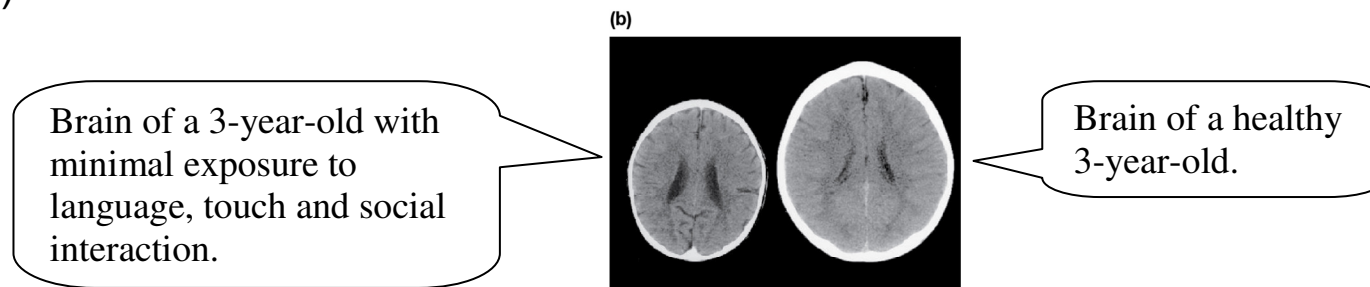


Brain Development

As infants and children mature, their brains change in two critical ways.

- First, myelinated axons form synapses with other neurons. The synaptic connections between neurons let regions of the brain communicate to process information and this growth gives the brain the chance to adapt to any environment.
- Second, over time and experience, synaptic connections change. Those that are not used are pruned and those that are used are strengthened.

Infants raised in environments that stimulate the brain, and are able to explore the external world, move, talk, and read, the brain develops. Poverty and the living conditions that come with it can impede brain development ([page 142 and 143](#)).



Cognitive development depends on the interaction of genetics, the environment and the social interactions that regularly occur.

Cognitive Development



Piaget was intrigued by the errors in thinking children made. To investigate how these errors and how thinking changes as we grow older, Piaget carefully observed his children's thinking and how their thinking changed as they grew. He observed four qualitatively different overlapping stages in thinking.



- Sensorimotor: Infants acquire information about the world through their senses and motor skills.
- Preoperational: Children think symbolically about objects, but they reason based on intuition and superficial appearances rather than logic.
- Concrete operational: Children begin to think about and understand logical operations, and they are no longer [less likely to be] fooled by appearances.
- Formal operational: People can think abstractly, and they can formulate and test hypotheses through logic.

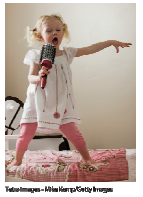


Image source (right) Schacter, Gilbert and Wegner

Although stages suggest that each stage is distinct from the other, the boundaries between the stages are “fuzzy”. Like the changes of the seasons, cognitive development is a continuous gradual process.

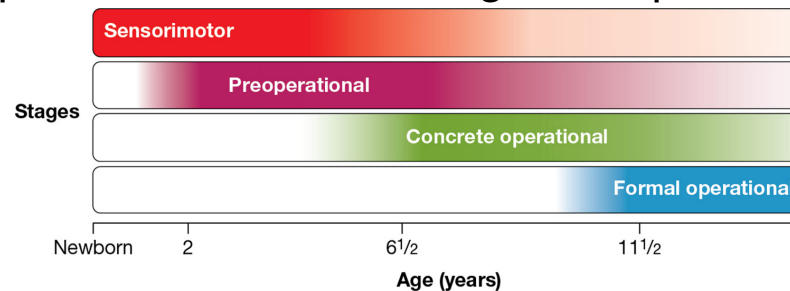


FIGURE 4.18

Cognitive Development





Stage	Characteristics
<p>1 Sensorimotor (birth–2 years)</p>	<ul style="list-style-type: none"> • Starts to mentally represent information acquired through the senses and motor exploration. • Begins to act intentionally—for example, pulls a string to set a mobile in motion or shakes a rattle to make a noise. • Achieves object permanence by realizing that things continue to exist even when they are no longer present to the senses. 
<p>2 Preoperational (2–7 years)</p>	<ul style="list-style-type: none"> • Learns to use language and to represent objects by images and words. • Thinking is egocentric, with the child having difficulty taking the viewpoint of others. • Can think intuitively but not logically. • Classifies objects by a single feature—for example, groups objects by color regardless of their shape. 
<p>3 Concrete operational (7–12 years)</p>	<ul style="list-style-type: none"> • Can think logically about concrete objects and events. • Achieves conservation of number, volume, mass, and weight. • Flexibly classifies objects by several features and can order them in a series along a single dimension, such as size. 
<p>4 Formal operational (12 years and up)</p>	<ul style="list-style-type: none"> • Can think logically about abstract propositions and test hypotheses systematically. • Becomes concerned with hypothetical issues, the future, and ideological problems. 

FIGURE 4.15

Sally and Richard Greenhill/Alamy Stock Photo; Tom Mareschal/Alamy Stock Photo;
Ian Shaw/Alamy Stock Photo; Jon Feingersh/Getty Images
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Sensorimotor Stage (page 150)

Definition: Infants acquire information about the world through their senses and motor skills (page 150).

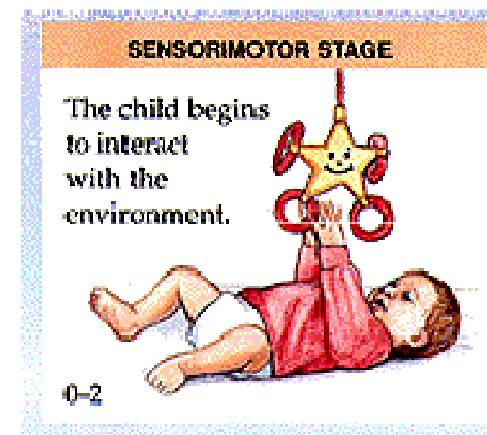


Image source: Hockenbury and Hockenbury (2005)

Image source: Lefton



Elie Bernager/Getty Images



Cognitive Development: Sensorimotor (Birth to 2 years old)

Typical behaviors of an infant in the sensorimotor stage:

During this stage,

- Infants acquire information and experience about the world through direct manipulation of objects using their motor skills and sensory experiences.
 - For example, they learn about rattles by grasping, shaking, and sucking it.
- Infants explore the cause-and-effect relationship. They begin to notice that their behavior can affect their world such as knocking a pile of blocks makes them crash or pulling the dogs tail makes it run away.

These activities (direct interaction and establishing cause and effect helps infants develop schemas or theories of how the world works.

Cognitive Development: Sensorimotor (Birth to 2 years old)

At the beginning of the sensorimotor stage, infants lack an understanding of object permanence. They don't understand that an object continues to exist even when it is not seen. It is believed that infants do not have a mental representation of objects yet. Objects are "Out of sight, out of mind".

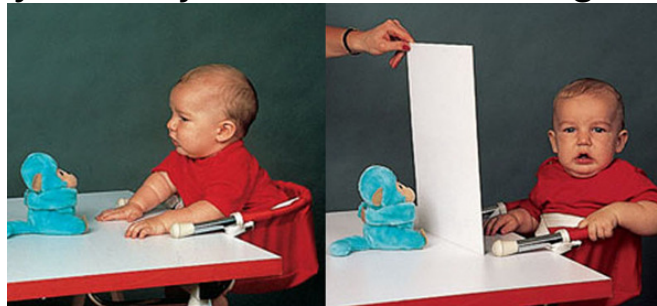


Image source: Carpenter and Huffman (), Visualizing Psychology

- At the end of the sensorimotor stage, infants understand that objects continue to exist even when it can no longer be seen. They gain object permanence. It is believed that infants start developing a mental representation of the world around them, which also begins with language development.



Image source: Myers, (), Psychology

Cognitive Development: Preoperational Stage (page 150-151)

Definition: Children think symbolically about objects, but they reason based on intuition and superficial appearances rather than logic (page 150).

When Piaget uses the word “operational”, “operations”, etc., he refers to logical, mental activities.

What kind of behaviors is typical of a child in the preoperational stage of cognitive development (approximate age range is 2 to 7 years old)?

- Symbolic thinking emerges. They start to use words, images, and symbols to represent their world. Such behaviors are characterized by
 - The use of language (the word “fly” represents an annoying, buzzing creature).
 - Using language (a symbolic system) to ask for a drink of water instead of walking to the sink and pointing to it.
 - Using a doll to represent a real baby.



Tetra Images - Mike Kemp/Getty Images

Cognitive Development: Preoperational Stage ([page 150-151](#))

Children often display:

- An inability to conserve quantities
- egocentrism

Preoperational Thinking: Inability to Conserve Quantity

Preoperational children lack the ability to understand the principle of conservation. The principle of conservation states that two equal quantities remain equal as long as nothing is added and subtracted, even though the form or appearance changes.

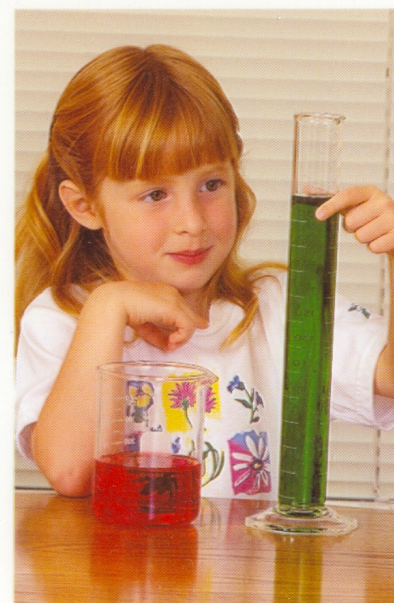


Image Source: Hockenbury and Hockenbury, 2008, Psychology



1 A young child believes that a tall 8 oz. glass contains more juice than a short 8 oz. glass.



2 Here, the child watches the juice being poured from the tall glass into a second short glass.



3 She is surprised to see that the short glass holds the same amount of juice as the tall glass.

FIGURE 4.17

Maya Barnes Johansen/TopFoto
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Preoperational Thinking: Inability to Conserve Quantity

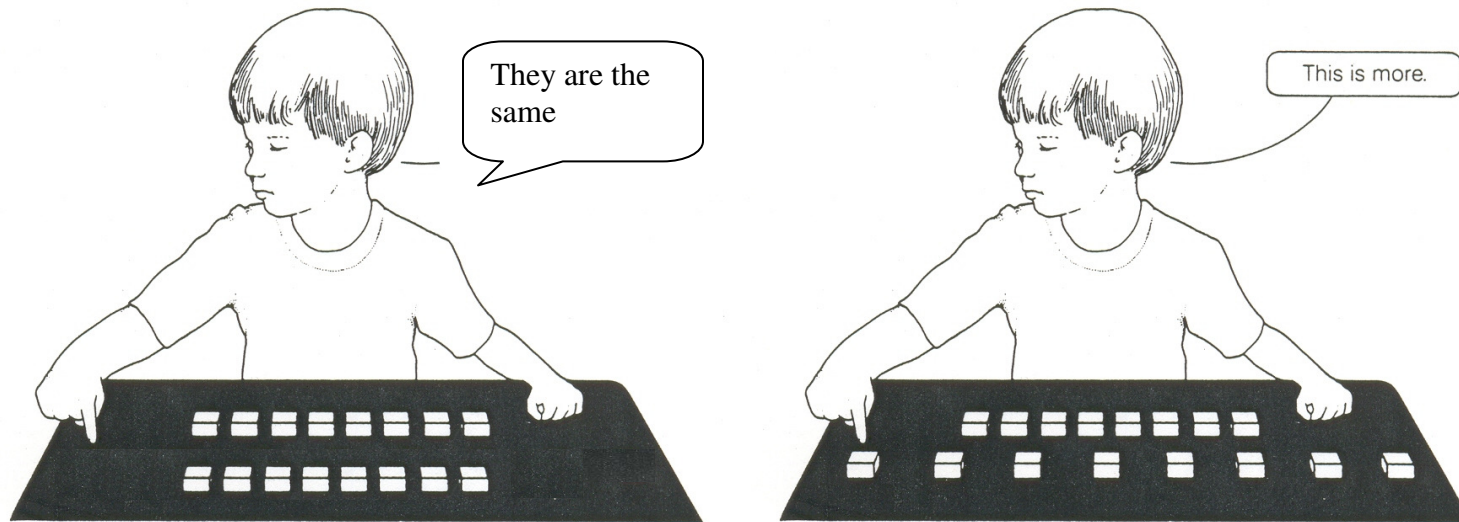


Image Source: Kalat, ()

1 A 4-year-old is shown two rows of marbles. Each row has the same number of marbles, but one row is spread out. When asked which row has more marbles, the 4-year-old says the longer row. In this case, he fails to show conservation of number.



2 However, when asked to count the marbles in each row, the 4-year-old counts correctly and states that the two rows have the same number of marbles. Now he does show conservation of number.

FIGURE 4.19

Preoperational Thinking: Inability to Conserve Quantity

A four-year old (who hates carrots) gets upset when a mother cuts the carrots into smaller pieces because the child thinks they have to eat more carrots.



Preoperational Thinking: Centration

The lack of understanding of conservation can be explained with centration.

Centration is the tendency to focus or center on one aspect of the situation and ignore other important aspects of the situation.

When determining which ball of clay has more, the child “centers” on surface area and ignores height at the preoperational level.

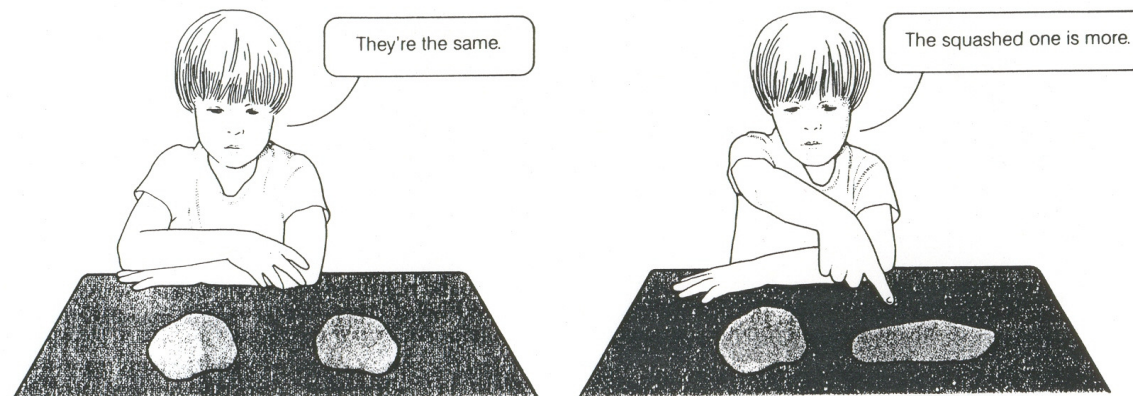


Image source: Kalat, (),

Preoperational Thinking: Centration

With the example of the graduated cylinder, they “center” on height and not on surface area.

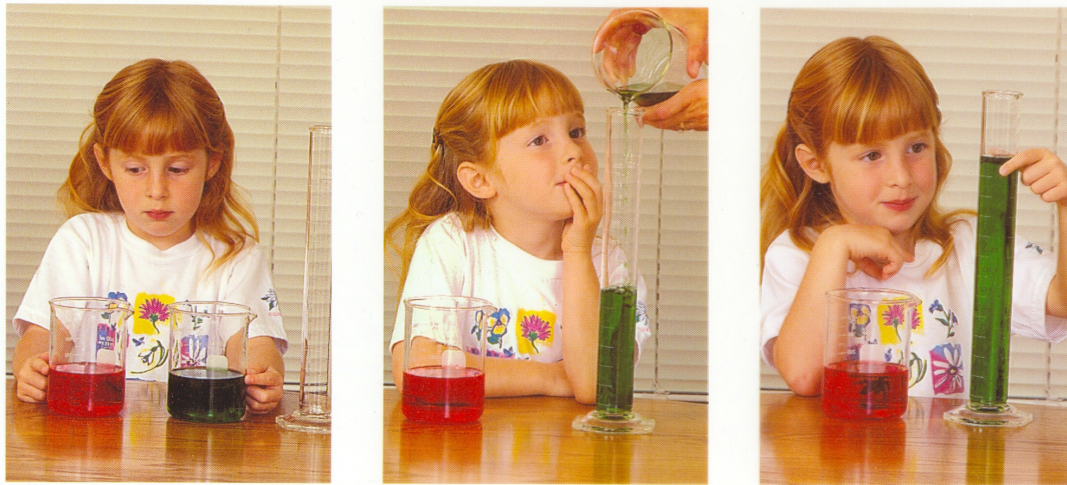
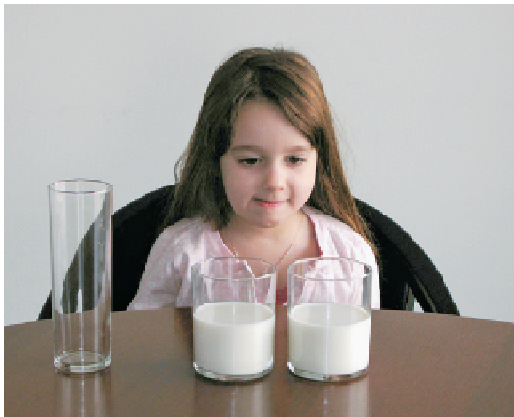


Image Source: Hockenbury and Hockenbury, 2008, Psychology



Bianca Moscatelli/Worth Publishers

Preoperational Thinking: Egocentrism

Egocentrism: The tendency for preoperational children to have difficulty viewing the world from someone else's perspective or point of view. Psychologists are NOT using egocentrism to mean selfishness or conceit as social psychologists use the word.

Concrete operational response (age 7+)

What does the doll see?

Preoperational response (age 2-7)

Image source: Lahey, ()

In response to the question “What does the doll see?”, an egocentric child picks the bottom set of triangles.

Cognitive Development: Concrete Operational Stage (page 151-152)

Definition: Children begin to think about and understand logical operations, and they are ~~no longer~~ [less likely to be] fooled by appearances.

A child in the concrete operational stage of cognitive development (approximate age range is 7 to 12 years old):

- is less egocentric in their thinking.
- can focus on two aspects of a problem.
- thinks and use of logic tends to be limited to concrete concepts (concepts and events that are tangible and can be related to their own experience and actual events).
- can classify and organize concrete objects (eg. oaks as trees), but not abstract ideas.
- has explanations that are concrete and tangible.
 - “friendship is when someone plays with me”.
 - when asked “What can be done to end world hunger?”, children at concrete operations have answers such as “drop food from parachutes” or “grow more food”.

Cognitive Development: Formal Operations ([page 152](#))










An adolescent at formal operations is able to think logically even when dealing with abstract concepts or hypothetical situations.

- Explanations tend to be more global and abstract.
 - When explaining friendship, a formal operations thinker will explain it in terms of
 - mutual trust,
 - empathy,
 - loyalty,
 - consistency and shared beliefscompared to a concrete operations thinker who explains it as “friendship is when someone plays with me”.
- Thinking abstractly continues through adulthood and varies individually.
 - Abstract thinking tends to be limited to one’s area of expertise or special interest.
 - The more diverse knowledge you have, it increases the likelihood you will think abstractly in different domains.

Cognitive Development: Formal operational stage (page 152)

Definition: People can think abstractly, and they can formulate and test hypotheses through logic.

- When solving problems, the person is much more systematic and logical than the concrete operational child.
- If a child was asked to determine which factors influence the speed of a car:









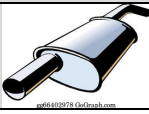
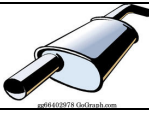
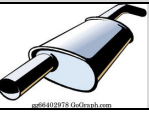
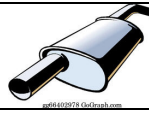








• engine size* (small vs. large),		
• wheel size* (small versus large),		
• muffler* (present/absent),		
• color, or		
• tail fins (present/absent)		

At formal operations stage, a child would change one variable at a time to see what the effects are, while at concrete operations, a child would change multiple variables.

Concrete Operations vs. Formal Operational stage

When solving problems,

- concrete operational children change more than one variable at time,
- where formal operational children change one at a time.

	Concrete Operations		Formal Operations	
	Before	After	Before	After
• engine size* (small vs. large),				
• wheel size* (small versus large),				
• muffler* (present/absent),				
• color, or				
• tail fins (present/absent)				
	Change the engine size, tire size and remove the tail fins		Change only the tire size	

Abstract Thinking

One way to prepare for your economic future is to use compound interest. Compound interest is more abstract than simple interest, which makes compound interest difficult to comprehend, apply and use.

Investments that yield a gain of 10% each year (this is a bit high, but makes the math easier) doubles about every 7.2 years. Therefore, an investment of \$1000 will yield about \$16,000 in about 28.8 years.

	Starting Balance	10% gain	Ending Balance
year 1	\$1,000.00	\$100.00	\$1,100.00
year 2	\$1,100.00	\$110.00	\$1,210.00
year 3	\$1,210.00	\$121.00	\$1,331.00
year 4	\$1,331.00	\$133.10	\$1,464.10
year 5	\$1,464.10	\$146.41	\$1,610.51
year 6	\$1,610.51	\$161.05	\$1,771.56
year 7	\$1,771.56	\$177.16	\$1,948.72
year 8	\$1,948.72	\$194.87	\$2,143.59

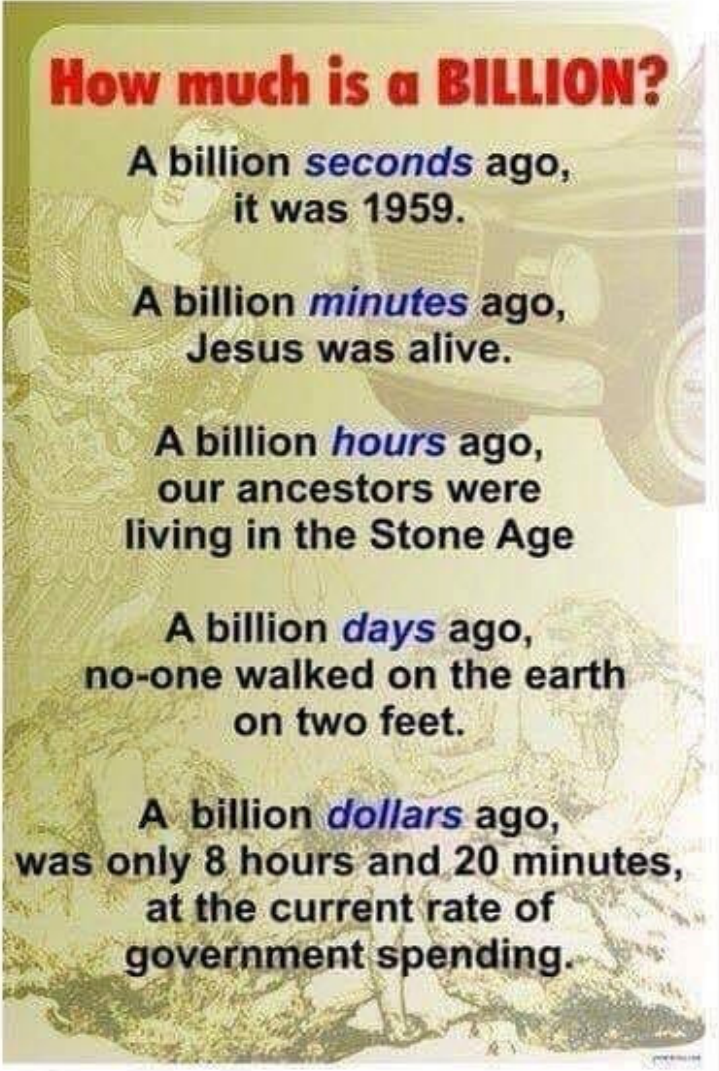
However, if we look at loans, instead of savings, compound interest is an easy way to stay in debt.

Concrete Thinking

When thinking about economically preparing for the future, using concrete operation thinking, one might be more likely to think that winning the lottery, one big score, one big bonus, one big deal, etc. is a way to wealth.

People can rely on concrete strategies such as winning the lottery, though winning the lottery is unrealistic. We tend to overestimate the likelihood of winning the lottery due to hearing about the winners, but not the losers (see availability heuristic) and difficulties comprehending large probabilities in the millions.

Making the Abstract Concrete



How much is a BILLION?

A billion *seconds* ago,
it was 1959.

A billion *minutes* ago,
Jesus was alive.

A billion *hours* ago,
our ancestors were
living in the Stone Age

A billion *days* ago,
no-one walked on the earth
on two feet.

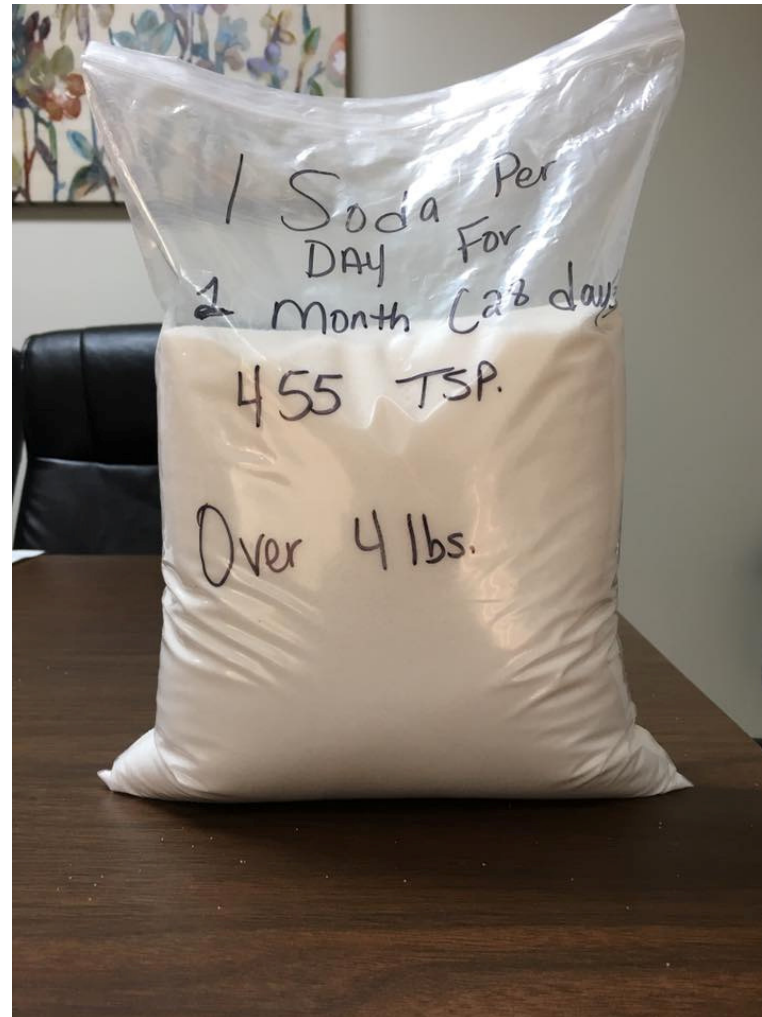
A billion *dollars* ago,
was only 8 hours and 20 minutes,
at the current rate of
government spending.

The infographic features a background collage of historical and modern imagery, including a woman in a dress, a car, and a stone-age figure. The text is presented in a clear, bold font with the word 'BILLION' in red and the unit of measurement in blue italics.

Making the Abstract Concrete

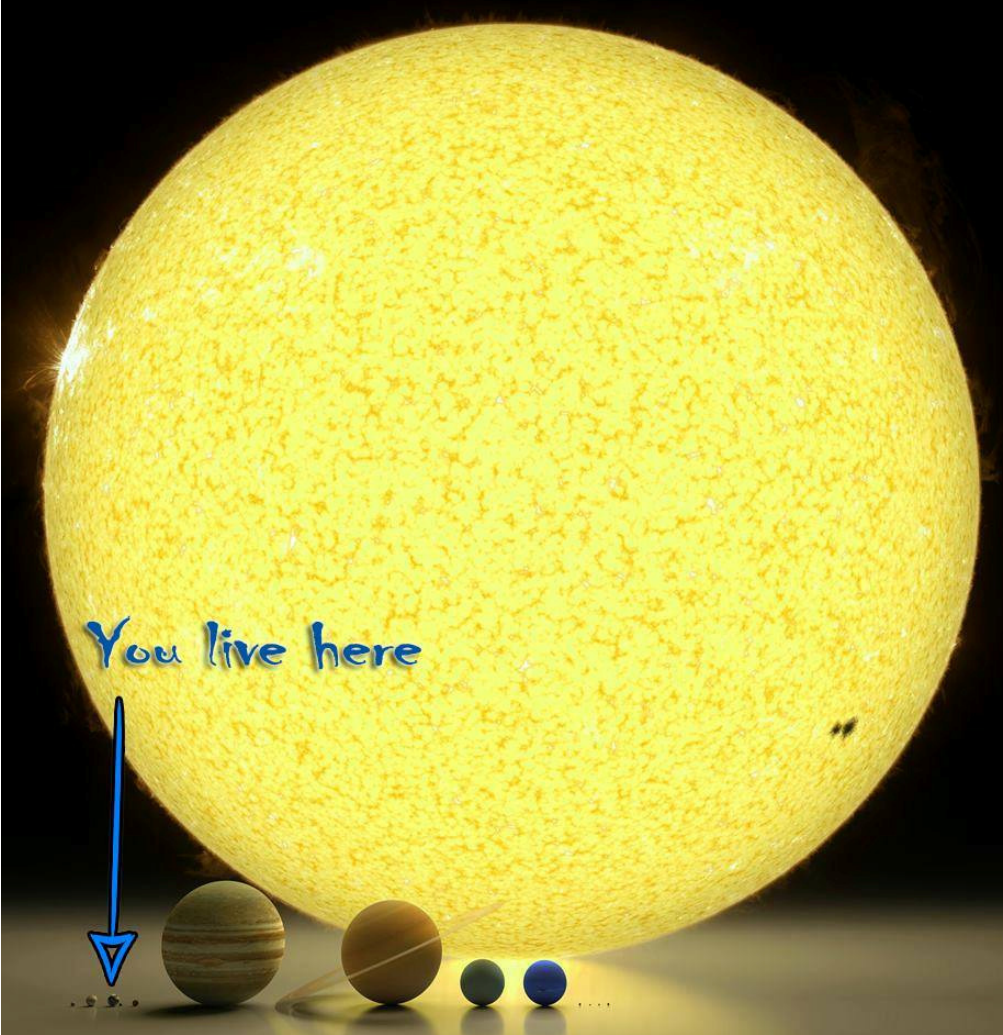


Making the Abstract Concrete



(My math comes to 2.41 pounds of sugar from Dr. Pepper with 39 grams per serving in a 12 ounce can, which is 1.092 kg or 2.41 pounds)

Making the Abstract Concrete

Concrete	Abstract
 <p data-bbox="321 979 657 1036">You live here</p>	<p data-bbox="1465 418 1709 459">Diameter of</p> <p data-bbox="1350 529 1829 1174">Sun = 864,340 mi Mercury = 3,031.9 mi Venus = 7,520.8 mi Earth = 7,917.5 mi moon = 2,158.8 mi Mars = 4,212.3 mi Jupiter = 86,881 mi Saturn = 72,367 mi Uranus = 31,518 mi Neptune = 30,599 mi Pluto = 1,476.8 mi</p>

In addition, we have a poor grasp of trillions of dollars (the U.S. total national debt) or large distances (the distance from the Sun to Earth is 93 million miles and the average distance from the Earth to Mars is 140 million miles—the farthest is 34 million miles and the closest is 250 million miles)

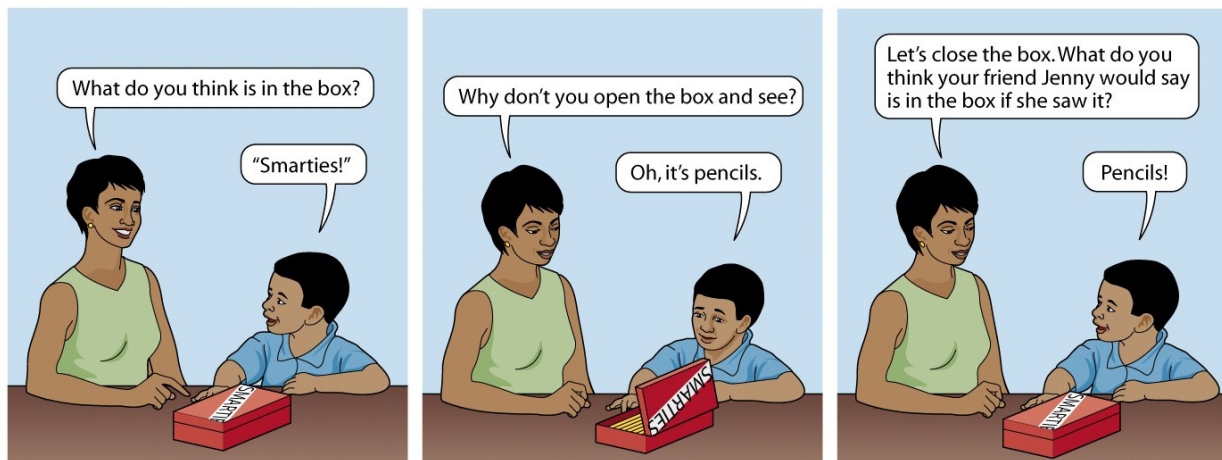
Piaget Stages of Cognitive Development	Monopoly Game	Guidelines for Parents
Sensorimotor Stage: The stage which sensory input and motor responses become coordinated.	The child puts houses, hotels, and dice in her mouth and plays with “Chance” cards.	Active play with a child is most effective at this stage. Encouraging explorations in touching, smelling, and manipulating objects. Peekaboo is a good way to establish the permanence of objects.
Preoperational Stage: The period of cognitive development when children begin to use language and think symbolically, yet remain intuitive and egocentric.	The child plays Monopoly, but makes up her own rules and cannot understand instructions.	Specific examples and touching or seeing things continue to be more useful than verbal explanations. Learning the concept of conservation may be aided by demonstrations with liquids, beads, clay and other substances.
Concrete operational Stage: The period of cognitive development during which children begin to use concepts of time, space, volume, and number, but in ways that remain simplified and concrete.	The child understands basic instructions and will play by the rules but is not capable of hypothetical transactions dealing with mortgages, loans, and special pacts with other players.	Children are beginning to use generalizations, but they still require specific examples to grasp many ideas. Expect a degree of inconsistency in the child’s ability to apply concepts of time, space, quantity and volume to new situations.
Formal operational Stage: The period of intellectual development marked by a capacity for abstract, theoretical, and hypothetical thinking.	The child no longer plays the game mechanically; complex and hypothetical transactions unique to each game are possible now.	It is now more effective to explain things verbally or symbolically and to help children master general rules and principles. Encourage the child to create hypotheses and to imagine how things could be.

Theory of the Mind

The understanding that people have mental states (feelings, desires, beliefs and intentions) and that these states underlie and help to explain their behavior (Segelman and Rider).

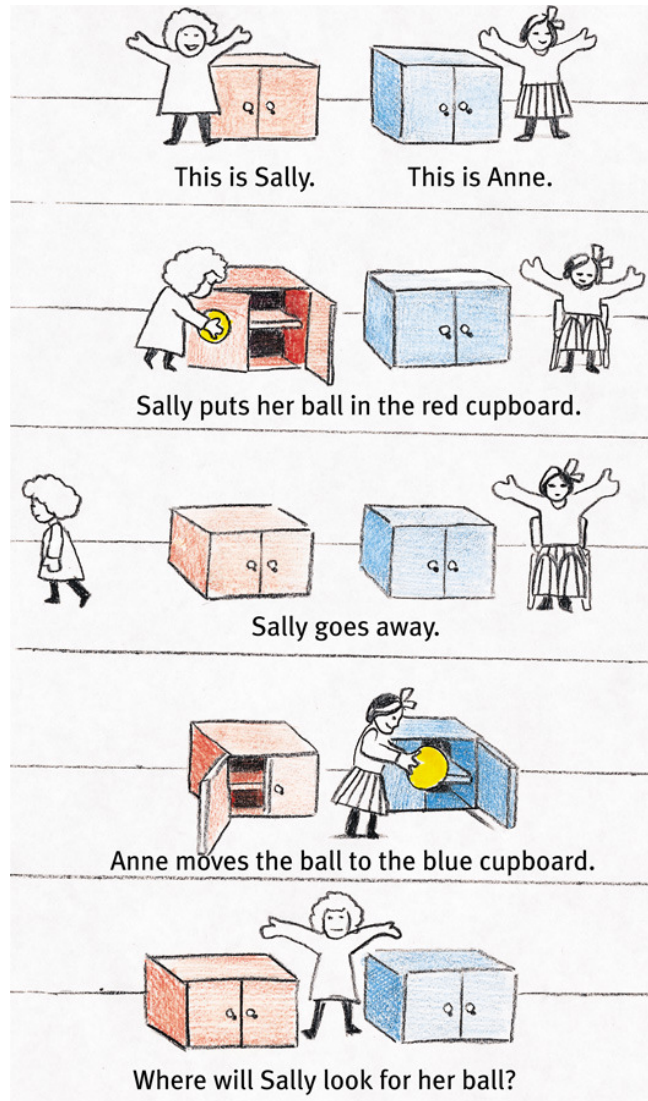
Young children have a difficult time understanding that others don't perceive their world in the same way they do.

Young children (see image below) would make the mistake of thinking that Jenny would know what they know—that a box labeled Smarties would have pencils in it because that is what they know.



(image source: unknown)

Theory of the Mind



(image source: Myers, Psychology 8th edition)

Theory of the Mind

Children with autism and deaf children whose parents do not know sign language develop the theory of the mind at a later age compared to those children without autism and whose parents know sign language.