

# Unit 7B:

## Cognition: Thinking, Problem Solving, Creativity, and Language



# Thinking

- **Cognition**
  - mental activities associated with thinking, knowing, remembering, and communicating
- **Cognitive Psychologists**
  - study these mental activities
    - concept formation
    - problem solving
    - decision making
    - judgment formation

# Unit Overview

- [Thinking](#)
- [Language](#)
- [Thinking and Language](#)



Click on the any of the above hyperlinks to go to that section in the presentation.

# Introduction

- Cognition (thinking)
- Cognitive psychologists

# Thinking



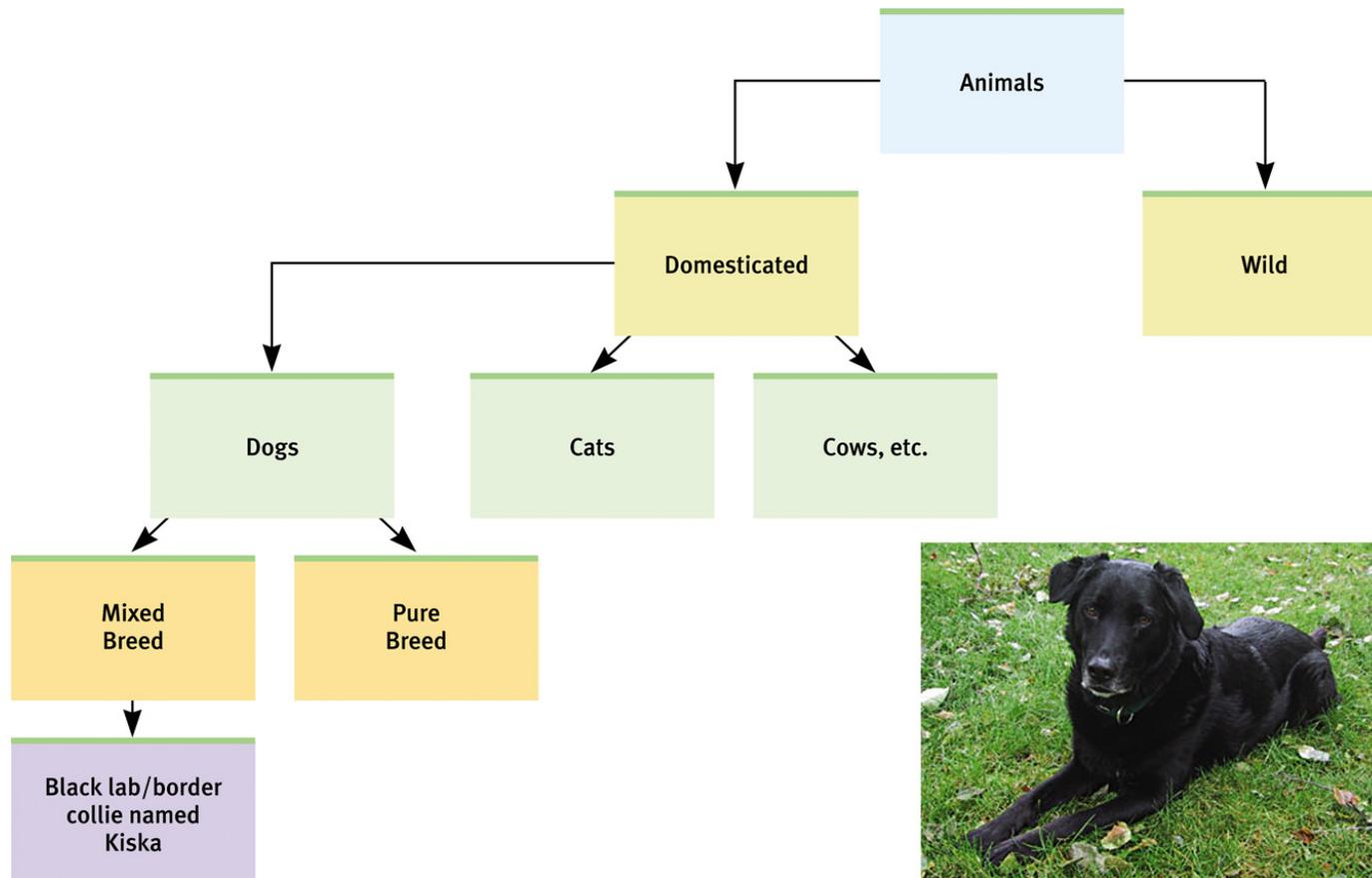
# Concepts

- Concepts
  - Category hierarchies
  - prototype



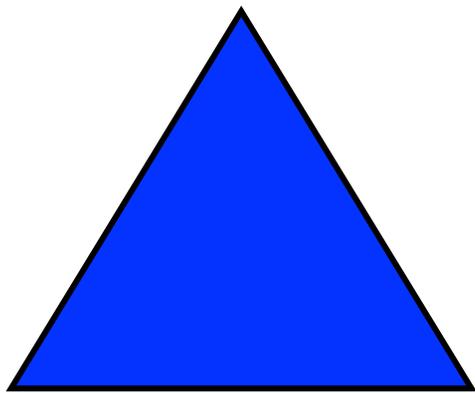
# Category Hierarchies

We organize concepts into category hierarchies.



# Development of Concepts

We form some concepts with definitions. For example, a triangle has three sides. Mostly, we form concepts with mental images or typical examples (**prototypes**-- mental image or best example of a category). For example, a robin is a prototype of a bird, but a penguin is not.



Triangle (definition)



Bird (mental image)





















90% CA



80% CA



70% CA



60% CA



50%/50%



60% AS



70% AS



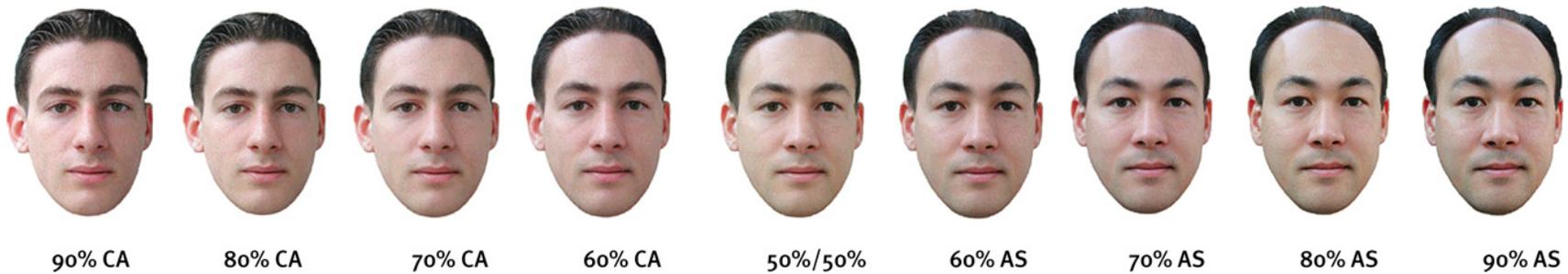
80% AS



90% AS

# Categories

Once we place an item in a category, our memory shifts toward the category prototype.



Courtesy of Oliver Cornelie

A computer generated face that was 70 percent Caucasian led people to classify it as Caucasian.



# Problem Solving

There are two ways to solve problems:

**Algorithms:** Methodical, logical rules or procedures that guarantee solving a particular problem.

# Algorithms

Algorithms, which are very time consuming, exhaust all possibilities before arriving at a solution. Computers use algorithms.

**S P L O Y O C H Y G**

If we were to unscramble these letters to form a word using an algorithmic approach, we would face 907,208 possibilities.

# Heuristics

Heuristics are simple, thinking strategies that allow us to make judgments and solve problems efficiently. Heuristics are less time consuming, but more error-prone than *algorithms*.



# Heuristics

Heuristics make it easier for us to use simple principles to arrive at solutions to problems.

**S P L O Y O C H Y G**  
**B B Y O M O C B G Y**

Put a Y at the end, and see if the word  
begins to make sense.

# Thinking

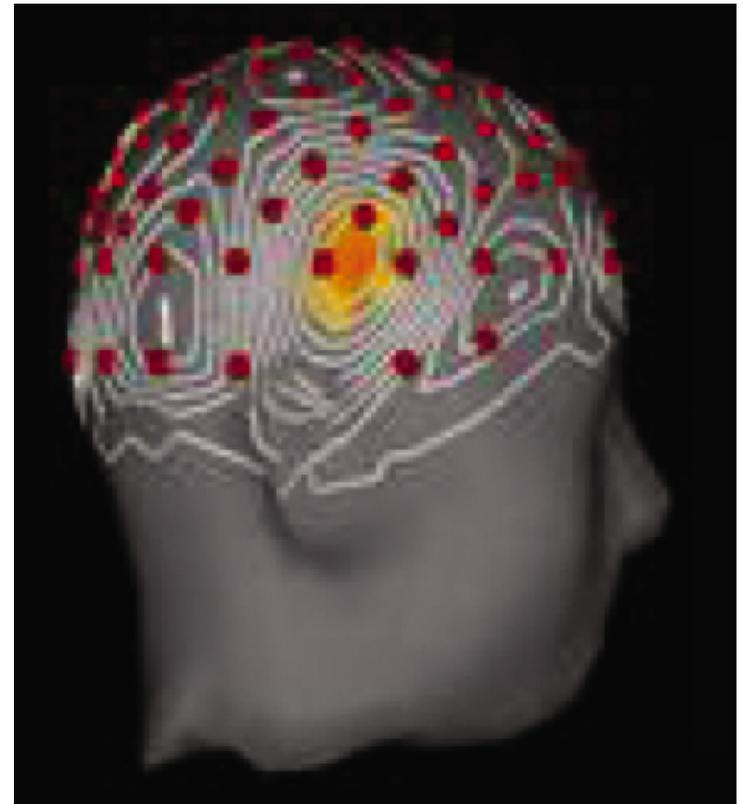
Unscramble

**S P L O Y O C H Y G**

- **Algorithm**
  - all 907,208 combinations
- **Heuristic**
  - throw out all YY combinations
  - other heuristics?

# Thinking

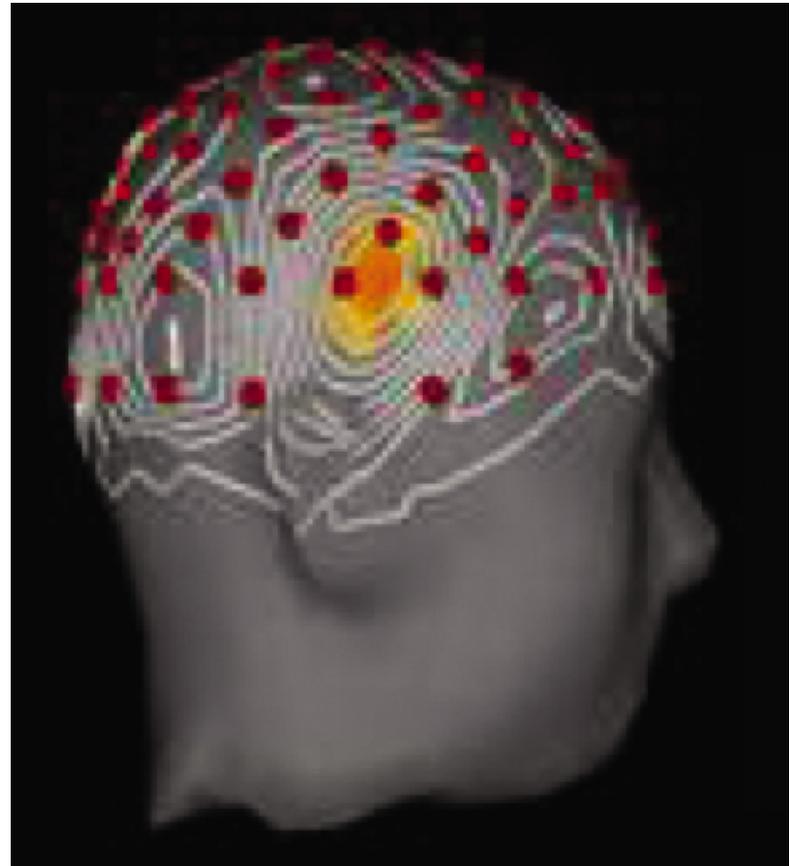
- **Insight**
  - sudden and often novel realization of the solution to a problem
  - contrasts with strategy-based solutions



The Aha! moment

# Insight

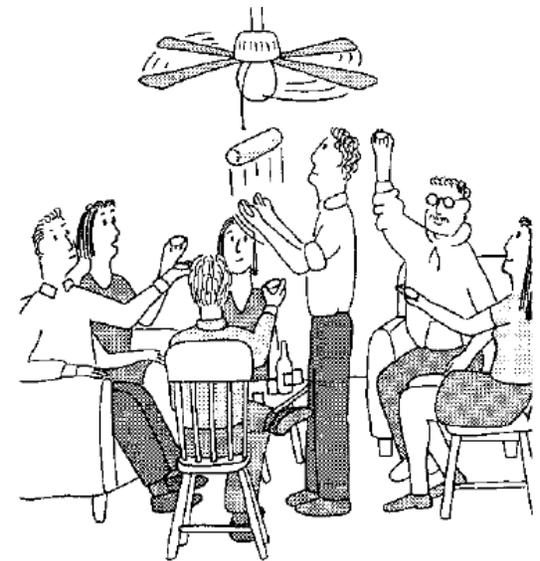
Brain imaging and EEG studies suggest that when an insight strikes (the “Aha” experience), it activates the right temporal cortex (Jung-Beeman, 2004). The time between not knowing the solution and realizing it is 0.3 seconds.



# Solving Problems

## *Creativity*

- Creativity
- Sternberg's five components
  - Expertise
  - Imaginative thinking skills
  - A venturesome personality
  - Intrinsic motivation
  - A creative environment

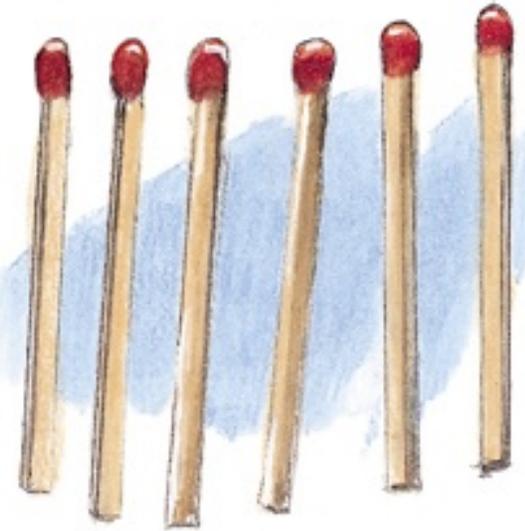


*Everyone held up their crackers as David threw the cheese log into the ceiling fan.*

# Solving Problems

## *Obstacles to Problem Solving*

- Confirmation bias
- Fixation
  - Mental set
  - Functional fixedness



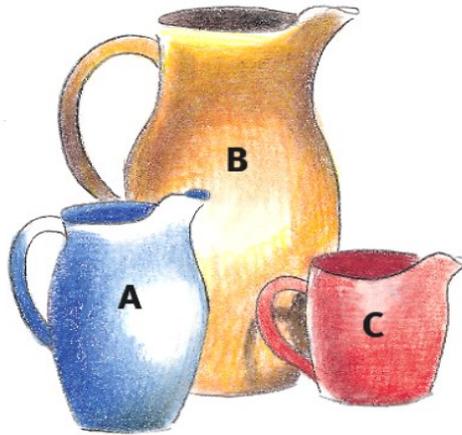
# Obstacles in Solving Problems

**Confirmation Bias:** A tendency to search for information that confirms a personal bias.

2 – 4 – 6

Rule: Any ascending series of numbers. 1 – 2 – 3 would comply. Ss had difficulty figuring out the rule due to a confirmation bias (Wason, 1960).

# The Three-Jugs Problem



- Using jugs A, B, and C, with the capacities shown, how would you measure out the volumes indicated?

Problem	Given jugs of these sizes			Measure out this much water
	A	B	C	
1	21	127	3	100
2	14	46	5	22
3	18	43	10	5
4	7	42	6	23
5	20	57	4	29
6	23	49	3	20
7	15	39	3	18

# The Three-Jugs Problem



(a)



(b)

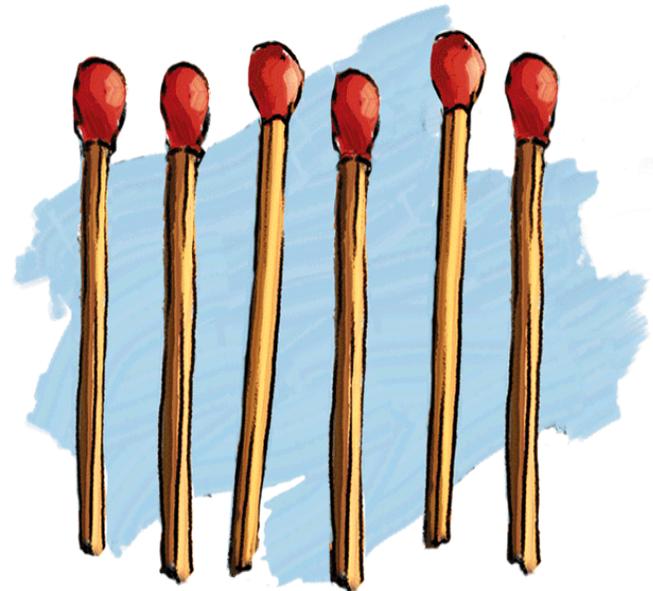
- Solution: a)  
All seven problems can be solved by the equation shown in (a):  
 $B - A - 2C = \text{desired volume}$ .
- b) But simpler solutions exist for problems 6 and 7, such as  $A - C$  for problem 6.

# Fixation

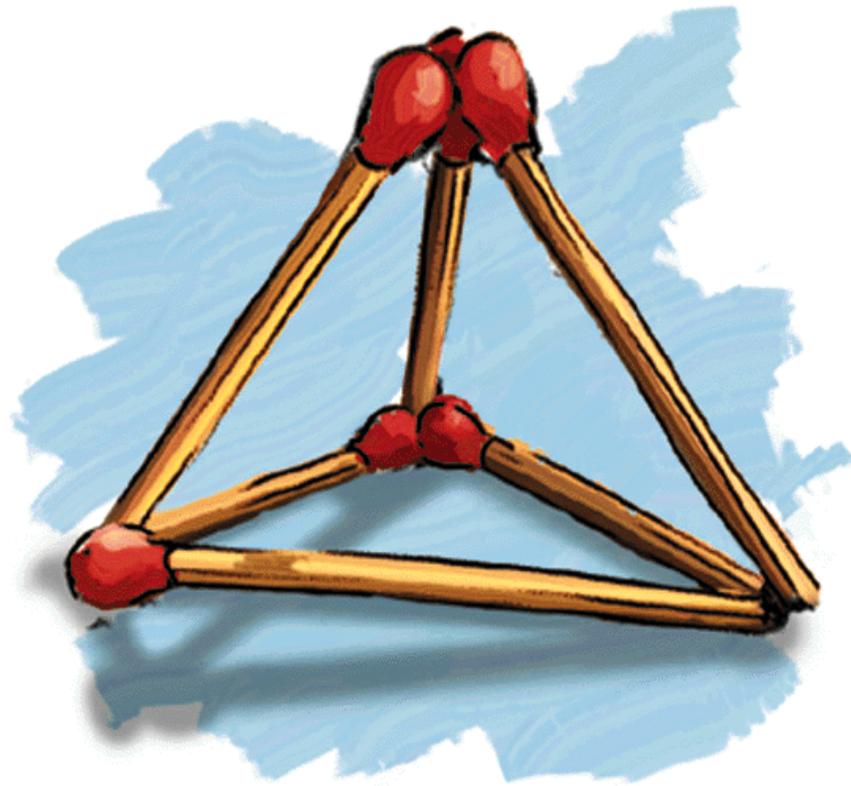
**Fixation:** An inability to see a problem from a fresh perspective. This impedes problem solving. Two examples of fixation are *mental set* and *functional fixedness*.

## The Matchstick Problem:

How would you arrange six matches to form four equilateral triangles?



# The Matchstick Problem: Solution

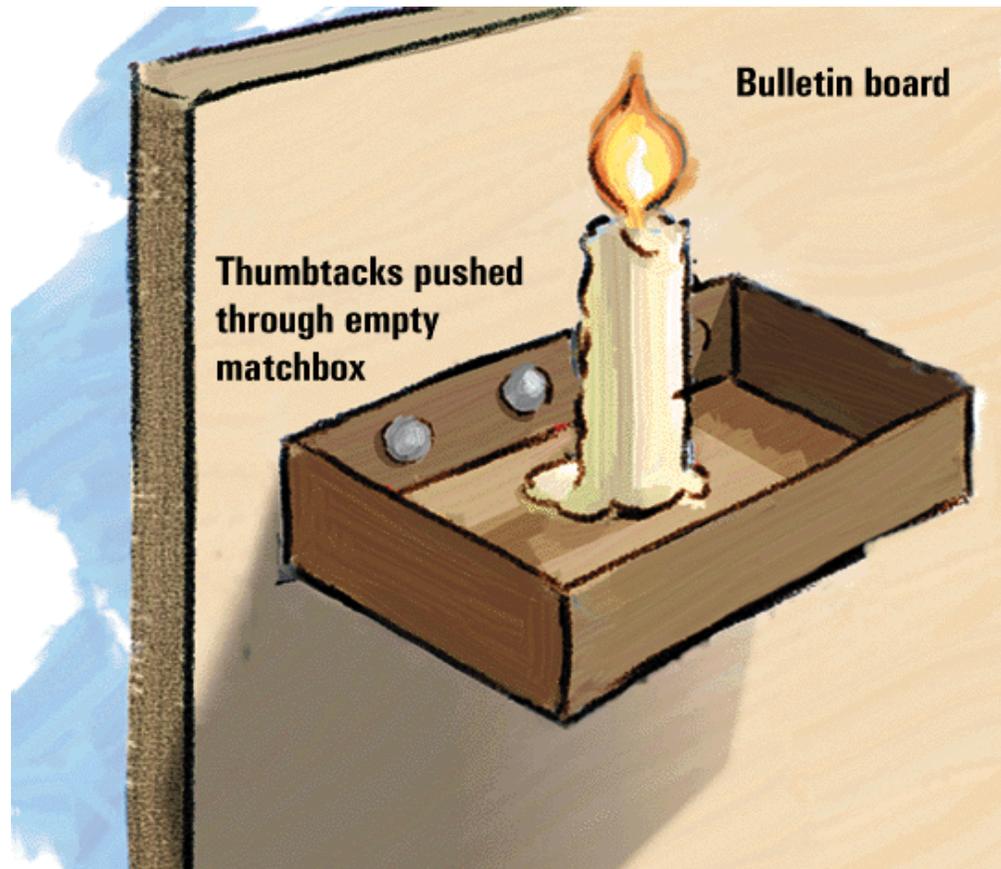


# Candle-Mounting Problem

Using these materials, how would you mount the candle on a bulletin board?



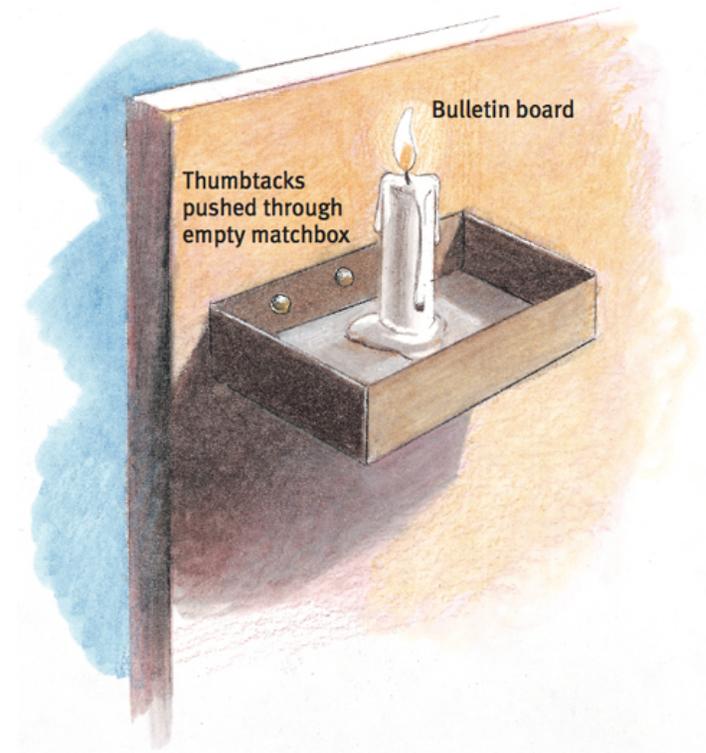
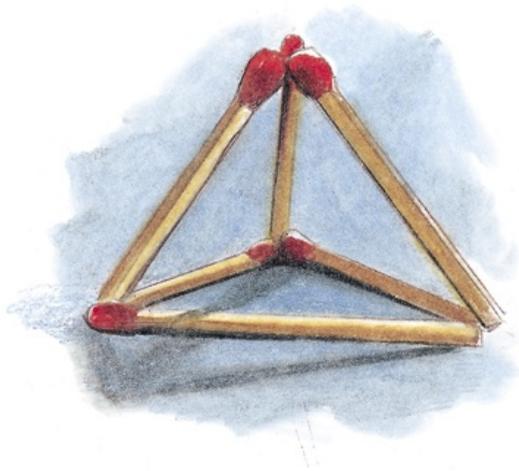
# Candle-Mounting Problem: Solution



# Solving Problems

## *Obstacles to Problem Solving*

- Confirmation bias
- Fixation
  - Mental set
  - Functional fixedness



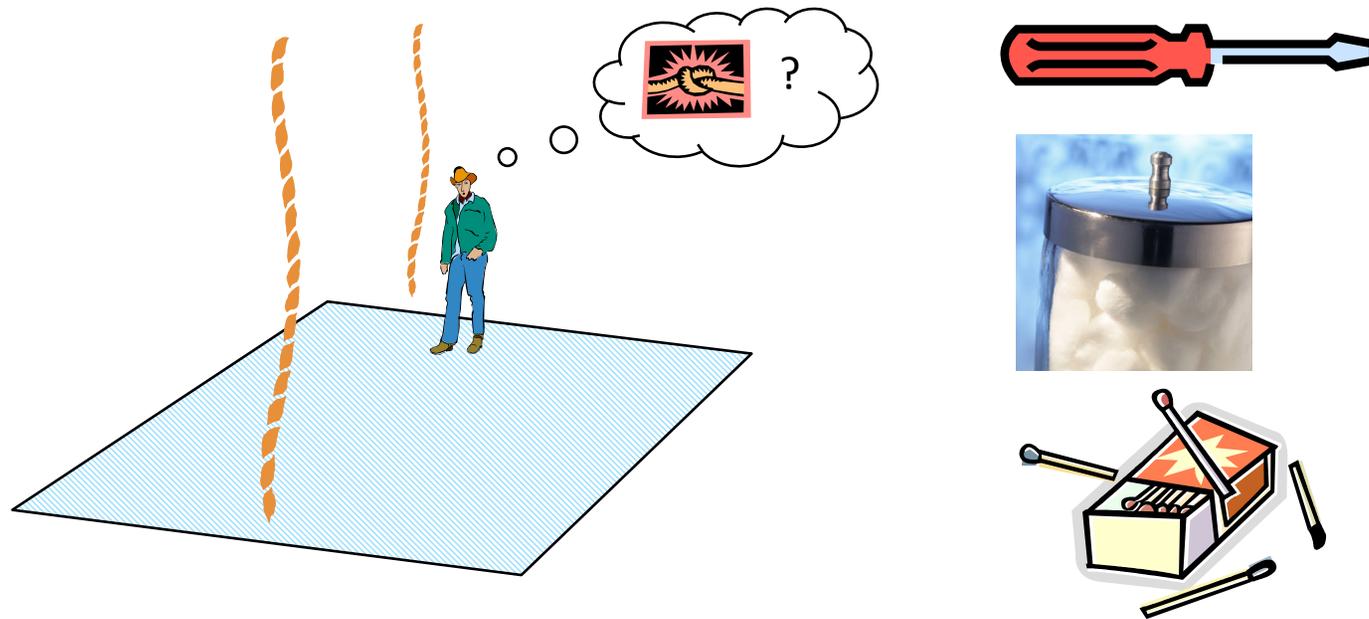
# Thinking

- **Mental Set**

- tendency to approach a problem in a particular way
- especially a way that has been successful in the past but may or may not be helpful in solving a new problem

# Functional Fixedness

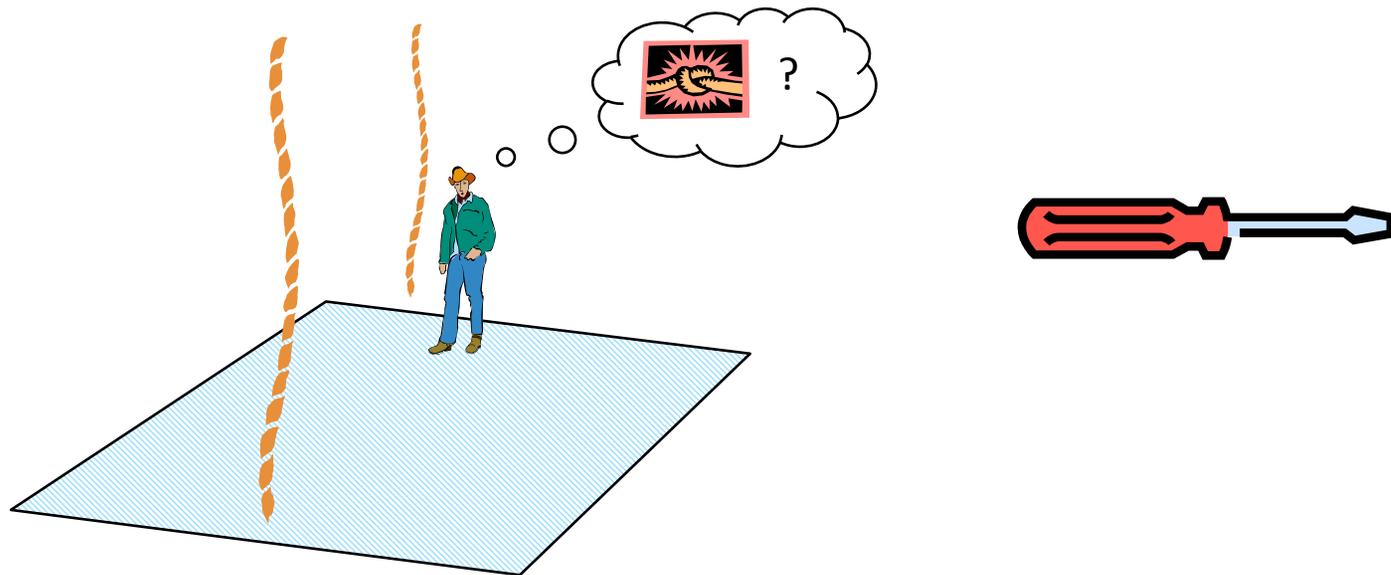
A tendency to think only of the familiar functions of an object.



Problem: Tie the two ropes together.  
Use a screw driver, cotton balls and a matchbox.

# Functional Fixedness

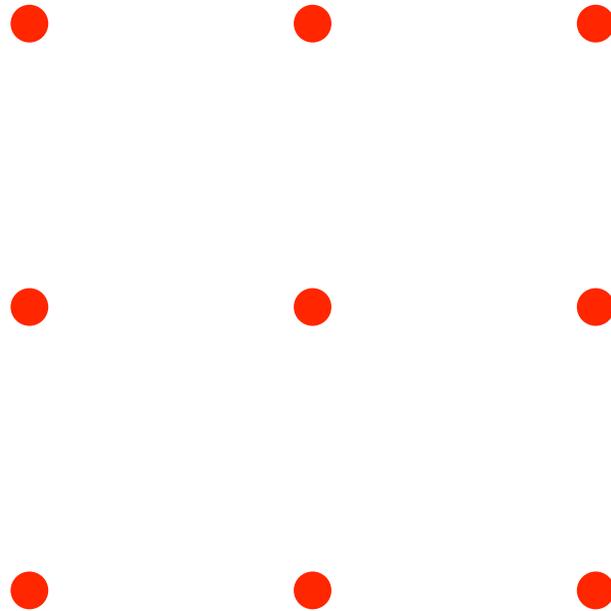
Use the screwdriver as a weight, and tie it to the end of one rope. Swing it toward the other rope to tie the knot.



The inability to think of the screwdriver as a weight is functional fixedness.

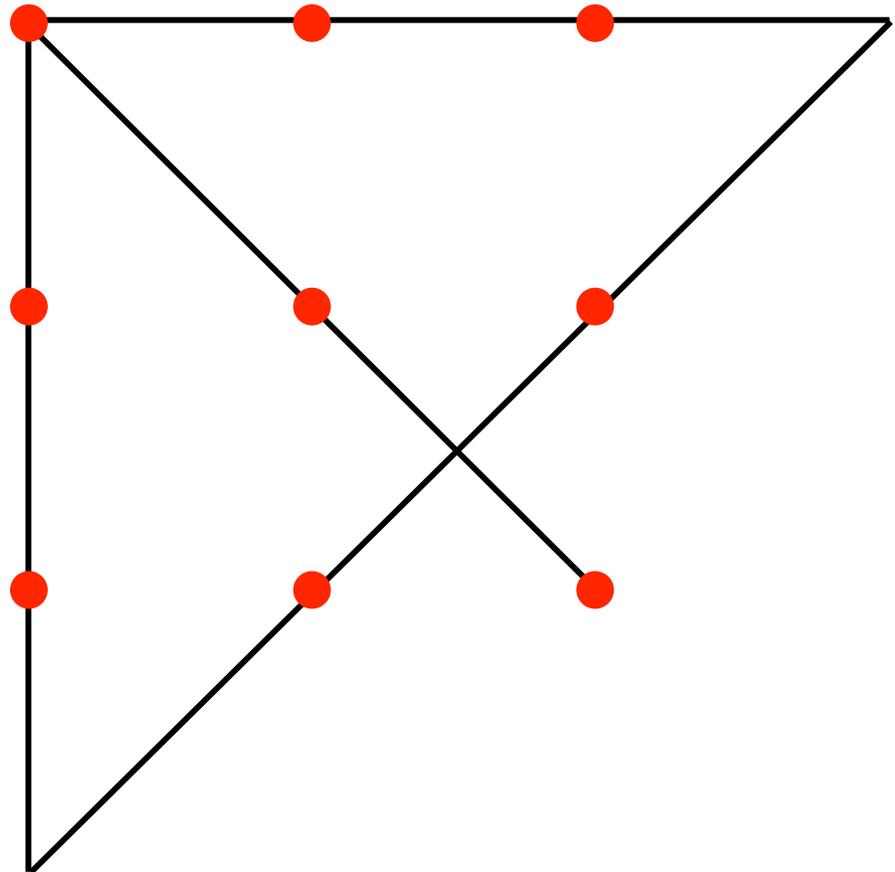
# Nine dots problem

- Without lifting your pencil or re-tracing any line, draw four straight lines that connect all nine dots



# Nine dots mental set

- Most people will not draw lines that extend from the square formed by the nine dots
- To solve the problem, you have to break your mental set

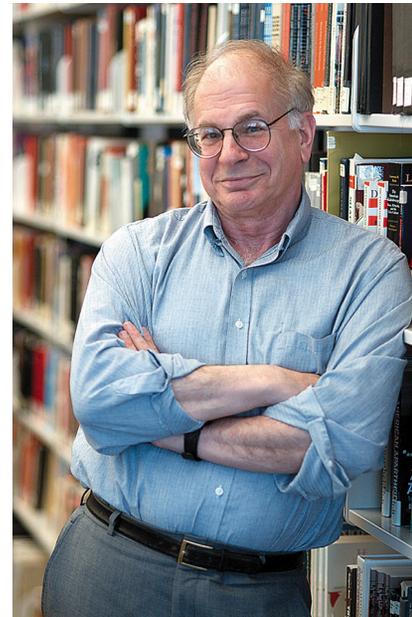


# Using and Misusing Heuristics

Two kinds of heuristics, **representative heuristics** and **availability heuristics**, have been identified by cognitive psychologists.



Amos Tversky



Daniel Kahneman

# Making Decisions and Forming Judgments *Using and Misusing Heuristics*

- The Representative Heuristic

# Representativeness Heuristic

Judging the likelihood of things or objects in terms of how well they seem to represent, or match, a particular prototype.

If you meet a slim, short, man who wears glasses and likes poetry, what do you think his profession would be?

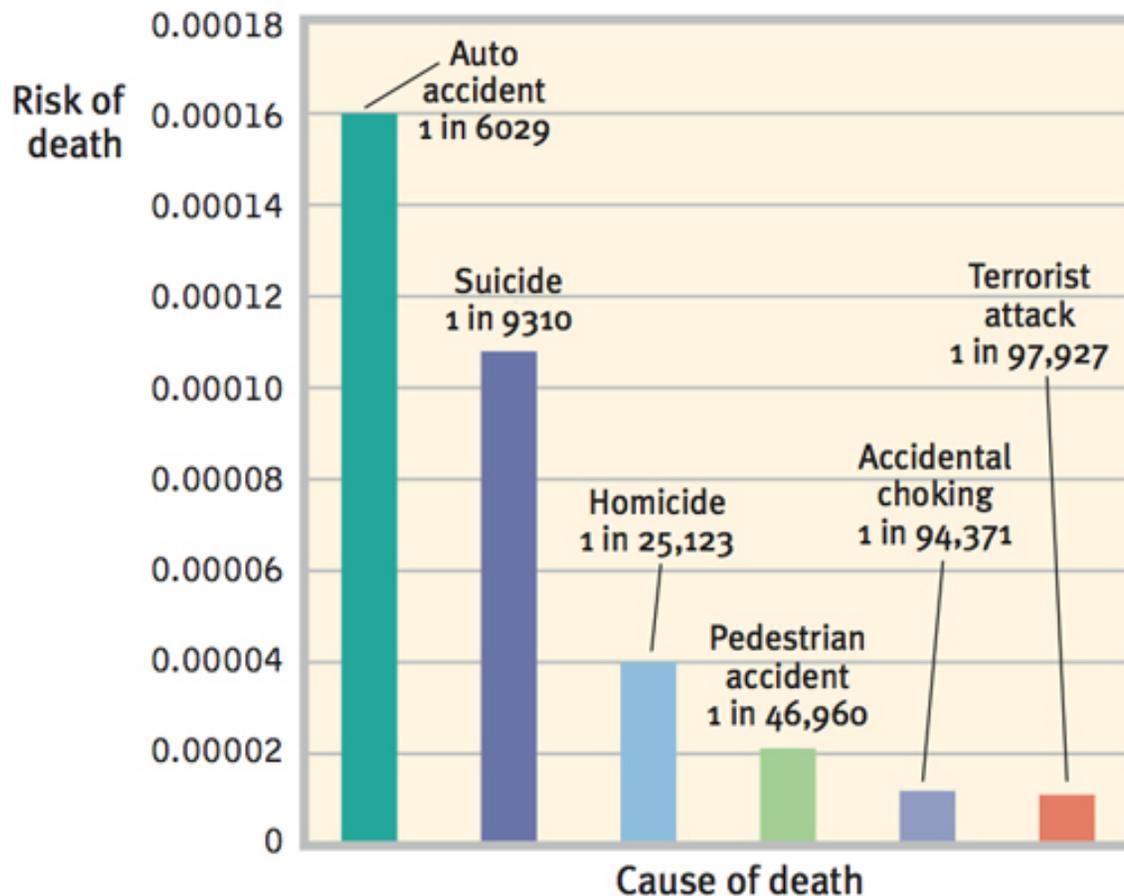
An Ivy league professor or a truck driver?

## How do you make sense of this?

- A young boy and his father are in a car accident. The father dies at the scene. The boy is transported to the hospital, taken immediately into surgery... but the surgeon steps out of the operating room and says, "I can't operate on this boy - he is my son!"

# Making Decisions and Forming Judgments *Using and Misusing Heuristics*

- The Availability Heuristic



# Availability Heuristic

Why does our availability heuristic lead us astray?

Whatever increases the ease of retrieving information increases its perceived availability.

How is retrieval facilitated?

1. How recently we have heard about the event.
2. How distinct it is.
3. How correct it is.

# Making Decisions and Forming Judgments

## *Overconfidence*

- Overconfidence

# Overconfidence

Intuitive heuristics, confirmation of beliefs, and the inclination to explain failures increase our **overconfidence**.  
Overconfidence is a tendency to overestimate the accuracy of our beliefs and judgments.

At a stock market, both the seller and the buyer may be confident about their decisions on a stock.



# Exaggerated Fear

The opposite of having overconfidence is having an **exaggerated fear** about what may happen. Such fears may be unfounded.

The 9/11 attacks led to a decline in air travel due to fear.



# Making Decisions and Forming Judgments

## *The Belief Perseverance Phenomenon*

- Belief perseverance
  - Consider the opposite



*"I'm happy to say that my final judgment of a case is almost always consistent with my prejudgment of the case."*

# Making Decisions and Forming Judgments

## *The Perils and Powers of Intuition*

- [Intuition](#)
  - Unconscious intuition



# Perils & Powers of Intuition

Intuition may be perilous if unchecked, but may also be extremely efficient and adaptive.

## INTUITION'S PERILS AND POWERS (TEXT CHAPTER NUMBERS FOLLOW)

### Intuition's Dozen Deadly Sins

- *Hindsight bias*—looking back on events, we falsely surmise that we knew it all along. (1)
- *Illusory correlation*—intuitively perceiving a relationship where none exists. (1)
- *Memory construction*—influenced by our present moods and by misinformation, we may form false memories. (9)
- *Representativeness and availability*—fast and frugal heuristics become quick and dirty when leading us into illogical and incorrect judgments. (10)
- *Overconfidence*—our intuitive assessments of our own knowledge are often more confident than correct. (1,10)
- *Belief perseverance and confirmation bias*—thanks partly to our preference for confirming information, beliefs are often resilient, even after their foundation is discredited. (1,10)

### Evidence of Intuition's Powers

- *Blindsight*—brain-damaged persons' "sight unseen" as their bodies react to things and faces not consciously recognized. (2)
- *Right-brain thinking*—split-brain persons displaying knowledge they cannot verbalize. (2)
- *Infants' intuitive learning*—of language and physics. (4)
- *Moral intuition*—quick gut feelings that precede moral reasoning. (4)
- *Divided attention and priming*—unattended information processed by the mind's downstairs radar watchers. (5)
- *Everyday perception*—the instant parallel processing and integration of complex information streams. (5)
- *Automatic processing*—the cognitive autopilot that guides us through most of life (various).

# Perils & Powers of Intuition

- *Framing*—judgments flip-flop, depending on how the same issue or information is posed. (10)
- *Interviewer illusion*—inflated confidence in one's discernment based on interview alone. (12)
- *Mispredicting our own feelings*—we often miscalculate the intensity and duration of our emotions. (13)
- *Self-serving bias*—in various ways, we exhibit inflated self-assessments. (15)
- *Fundamental attribution error*—overly attributing others' behavior to their dispositions by discounting unnoticed situational forces. (18)
- *Mispredicting our own behavior*—our intuitive self-predictions often go astray. (18)
- *Implicit memory*—learning *how* to do something without knowing *that* one knows. (9)
- *Heuristics*—those fast and frugal mental shortcuts that normally serve us well enough. (10)
- *Intuitive expertise*—phenomena of nonconscious learning, expert learning, and physical genius. (10, 11, 15)
- *Creativity*—the sometimes-spontaneous appearance of novel and valuable ideas. (11)
- *Social and emotional intelligence*—the intuitive know-how to comprehend and manage ourselves in social situations and to perceive and express emotions. (11)
- *The wisdom of the body*—when instant responses are needed, the brain's emotional pathways bypass the cortex; hunches sometimes precede rational understanding. (13)
- *Thin slices*—detecting traits from mere seconds of behavior. (15)
- *Dual attitude system*—as we have two ways of knowing (unconscious and conscious) and two ways of remembering (implicit and explicit), we also have gut-level and rational attitude responses. (18)

# Making Decisions and Forming Judgments

## *The Effects of Framing*

- Framing
  - Framing experiments

# Thinking

- Framing
  - the way an issue is posed
  - how an issue is framed can significantly affect decisions and judgments
  - Example: What is the best way to market ground beef--as 25% fat or 75% lean?

# Thinking

- Framing
  - the way an issue is posed
  - how an issue is framed can significantly affect decisions and judgments
  - Example: What is the best way to market ground beef--as 25% fat or 75% lean?

# Framing Decisions

Decisions and judgments may be significantly affected depending upon how an issue is framed.

Example: What is the best way to market ground beef — as 25% fat or 75% lean?

## Belief Bias

The tendency of one's preexisting beliefs to distort logical reasoning by making invalid conclusions.

God is love.

Love is blind

Ray Charles is blind.

Ray Charles is God.

Anonymous graffiti

# Belief Perseverance

**Belief perseverance** is the tendency to cling to our beliefs in the face of contrary evidence.

If you see that a country is hostile, you are likely to interpret their ambiguous actions as a sign of hostility (Jervis, 1985).

# Language



# Language *Introduction*

- Language



# Language Structure

**Phonemes:** The smallest distinct sound unit in a spoken language. For example:

*bat*, has three phonemes *b · a · t*

*chat*, has three phonemes *ch · a · t*

# Language Structure

## *Phonemes*

- Phoneme
  - English about 40 phonemes
  - Learning another language's phonemes

# Language Structure

## *Morphemes*

- Morpheme
  - Includes prefixes and suffixes

# Language Structure

**Morpheme:** The smallest unit that carries a meaning. It may be a word or part of a word.  
For example:

Milk = *milk*

Pumpkin = *pump . kin*

Unforgettable = *un . for . get . table*

# Structuring Language

Phonemes	Basic sounds (about 40) ... <b>ea, sh.</b>
Morphemes	Smallest meaningful units (100,000) ... <b>un, for.</b>
Words	Meaningful units (290,500) ... <b>meat, pumpkin.</b>
Phrase	Composed of two or more words (326,000) ... <b>meat eater.</b>
Sentence	Composed of many words (infinite) ... <b>She opened the jewelry box.</b>

# Language Structure

## *Grammar*

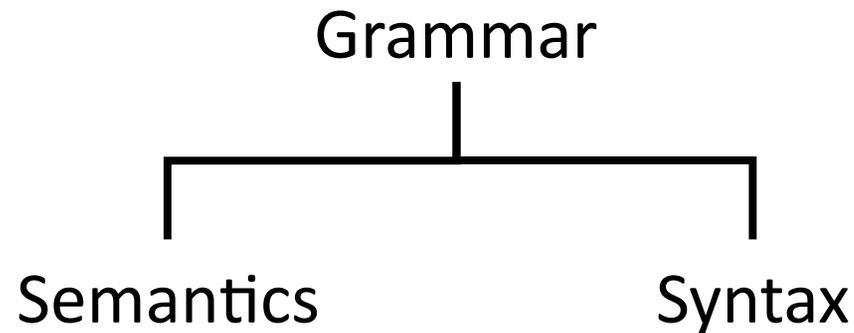
- Grammar
  - Semantics
  - Syntax



*“Let me get this straight now. Is what you want to build a jean factory or a gene factory?”*

# Grammar

**Grammar** is the system of rules in a language that enable us to communicate with and understand others.



# Semantics

Semantics is the set of rules by which we derive meaning from morphemes, words, and sentences. For example:

Semantic rule tells us that adding **-ed** to the word **laugh** means that it happened in the past.

# Syntax

Syntax consists of the rules for combining words into grammatically sensible sentences.

For example:

In English, syntactical rule says that adjectives come before nouns; **white house**. In Spanish, it is reversed; **casa blanca**.

# Language Development

## *When Do We Learn Language?*

- Receptive language
- Productive language
  - Babbling stage
  - One-word stage
  - Two-word stage
  - Telegraphic speech

# Language Development

## When Do We Learn Language?

### SUMMARY OF LANGUAGE DEVELOPMENT

Month (approximate)	Stage

# Language Development

## When Do We Learn Language?

### SUMMARY OF LANGUAGE DEVELOPMENT

Month (approximate)	Stage
------------------------	-------

4	Babbles many speech sounds.
---	-----------------------------

# Language Development

## When Do We Learn Language?

### SUMMARY OF LANGUAGE DEVELOPMENT

Month (approximate)	Stage
------------------------	-------

4	Babbles many speech sounds.
---	-----------------------------

10	Babbling resembles household language.
----	--

# Language Development

## When Do We Learn Language?

### SUMMARY OF LANGUAGE DEVELOPMENT

Month (approximate)	Stage
------------------------	-------

4

Babbles many speech sounds.

10

Babbling resembles household language.

12

One-word stage.

# Language Development

## When Do We Learn Language?

### SUMMARY OF LANGUAGE DEVELOPMENT

Month (approximate)	Stage
------------------------	-------

4	Babbles many speech sounds.
---	-----------------------------

10	Babbling resembles household language.
----	--

12	One-word stage.
----	-----------------

24	Two-word, telegraphic speech.
----	-------------------------------

# Language Development

## When Do We Learn Language?

### SUMMARY OF LANGUAGE DEVELOPMENT

**Month  
(approximate)**

**Stage**

4

Babbles many speech sounds.

10

Babbling resembles household language.

12

One-word stage.

24

Two-word, telegraphic speech.

24+

Language develops rapidly into complete sentences.

# Language Development

Children learn their native languages much before learning to add  $2+2$ .

We learn, on average (after age 1), 3,500 words a year, amassing 60,000 words by the time we graduate from high school.



# When do we learn language?

## Babbling Stage:

Beginning at 4 months, the infant spontaneously utters various sounds, like *ah-goo*. Babbling is not imitation of adult speech.



# When do we learn language?

**One-Word Stage:** Beginning at or around his first birthday, a child starts to speak one word at a time and is able to make family members understand him. The word **doggy** may mean **look at the dog out there.**

# When do we learn language?

**Two-Word Stage:** Before the 2nd year a child starts to speak in two-word sentences. This form of speech is called **telegraphic speech** because the child speaks like a telegram: “Go car,” means *I would like to go for a ride in the car.*

# When do we learn language?

**Longer phrases:** After telegraphic speech, children begin uttering longer phrases (**Mommy get ball**) with syntactical sense, and by early elementary school they are employing humor.

**You never starve in the desert because of all the sand-which-is there.**

# Language Development

## *Explaining Language Development*

- Skinner: Operant Learning
  - Learning principles
    - Association
    - Imitation
    - Reinforcement

# Explaining Language Development

1. **Operant Learning:** Skinner (1957, 1985) believed that language development may be explained on the basis of learning principles such as association, imitation, and reinforcement.

# Language Development

## *Explaining Language Development*

- Chomsky: Inborn Universal Grammar
  - Language acquisition device
  - Universal grammar



© 1994 by Sidney Harris.

*“Got idea. Talk better. Combine words.  
Make sentences.”*

# Explaining Language Development

2. **Inborn Universal Grammar:** Chomsky (1959, 1987) opposed Skinner's ideas and suggested that the rate of language acquisition is so fast that it cannot be explained through learning principles, and thus most of it is inborn.

Our language acquisition capacity is like a box—a “language acquisition device” (LAD) in which grammar switches are thrown as children experience their language.

# Language Development

## *Explaining Language Development*

- Statistical Learning and Critical Periods
  - Statistical learning
  - Critical (sensitive) period



# Explaining Language Development

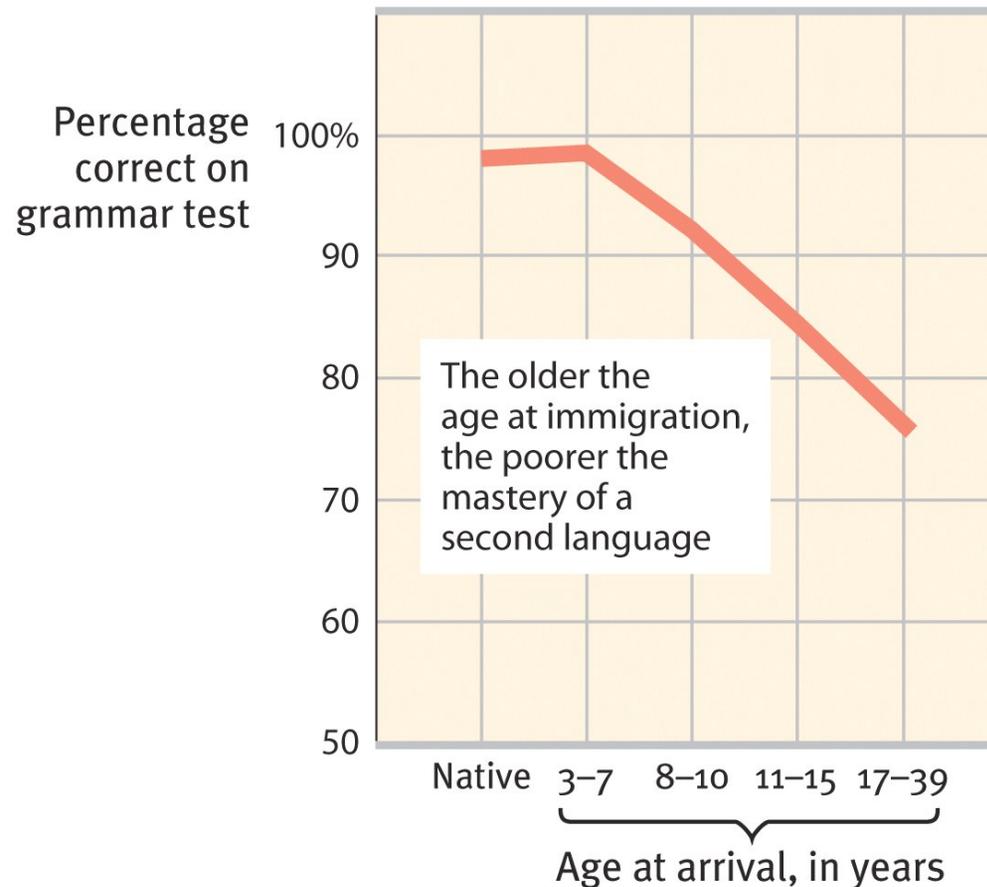
## 3. Statistical Learning and Critical Periods:

Well before our first birthday, our brains are discerning word breaks by statistically analyzing which syllables in *hap-py-ba-by* go together. These statistical analyses are learned during critical periods of child development.



# Language & Age

Learning new languages gets harder with age.



# Thinking and Language



# Language Influences Thinking

- Whorf's linguistic determinism
- Bilingual advantage

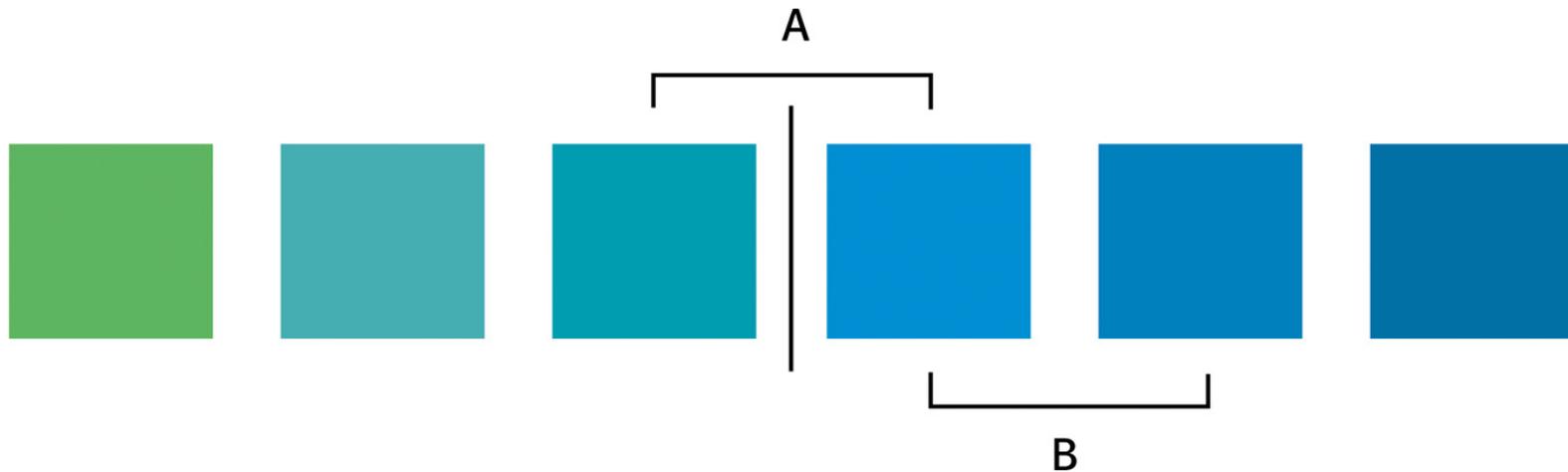


# Language

- Linguistic Determinism
  - Benjamin Whorf's hypothesis that language determines the way we think
  - The Hopi have no past tense for their verbs. Therefore, a Hopi could not so readily **think** about the past.

# Language Influences Thinking

When a language provides words for objects or events, we can think about these objects more clearly and remember them. It is easier to think about two colors with two different names (A) than colors with the same name (B) (Özgen, 2004).



## Word Power

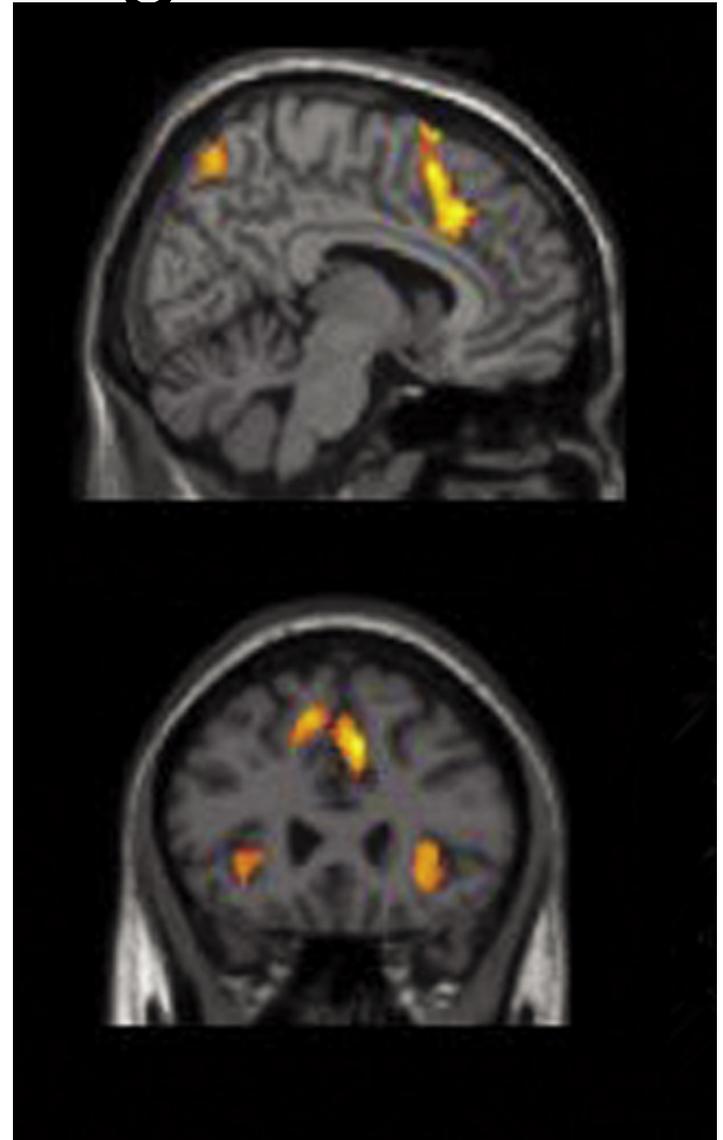
Increasing word power pays its dividends. It pays for speakers and deaf individuals who learn sign language.

## Linguistic Determinism Questioned

Although people from Papua New Guinea do not use our words for colors and shapes, they still perceive them as we do (Rosch, 1974).

# Thinking in Images

- Implicit memory



# Thinking in Images

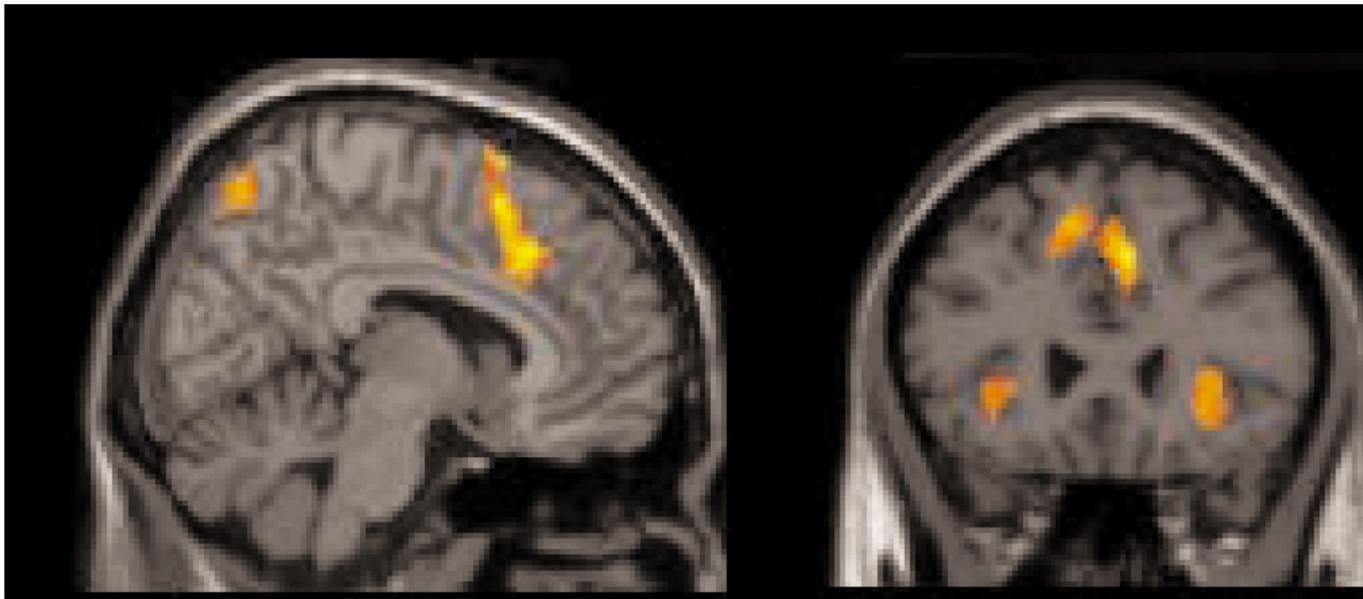
To a large extent thinking is language-based. When alone, we may talk to ourselves. However, we also think in images.

We don't think in words, when:

1. When we open the hot water tap.
2. When we are riding our bicycle.

# Images and Brain

Imagining a physical activity activates the same brain regions as when actually performing the activity.



Jean Dufly Decety, September 2003

**The End**