Cognitive Psychology

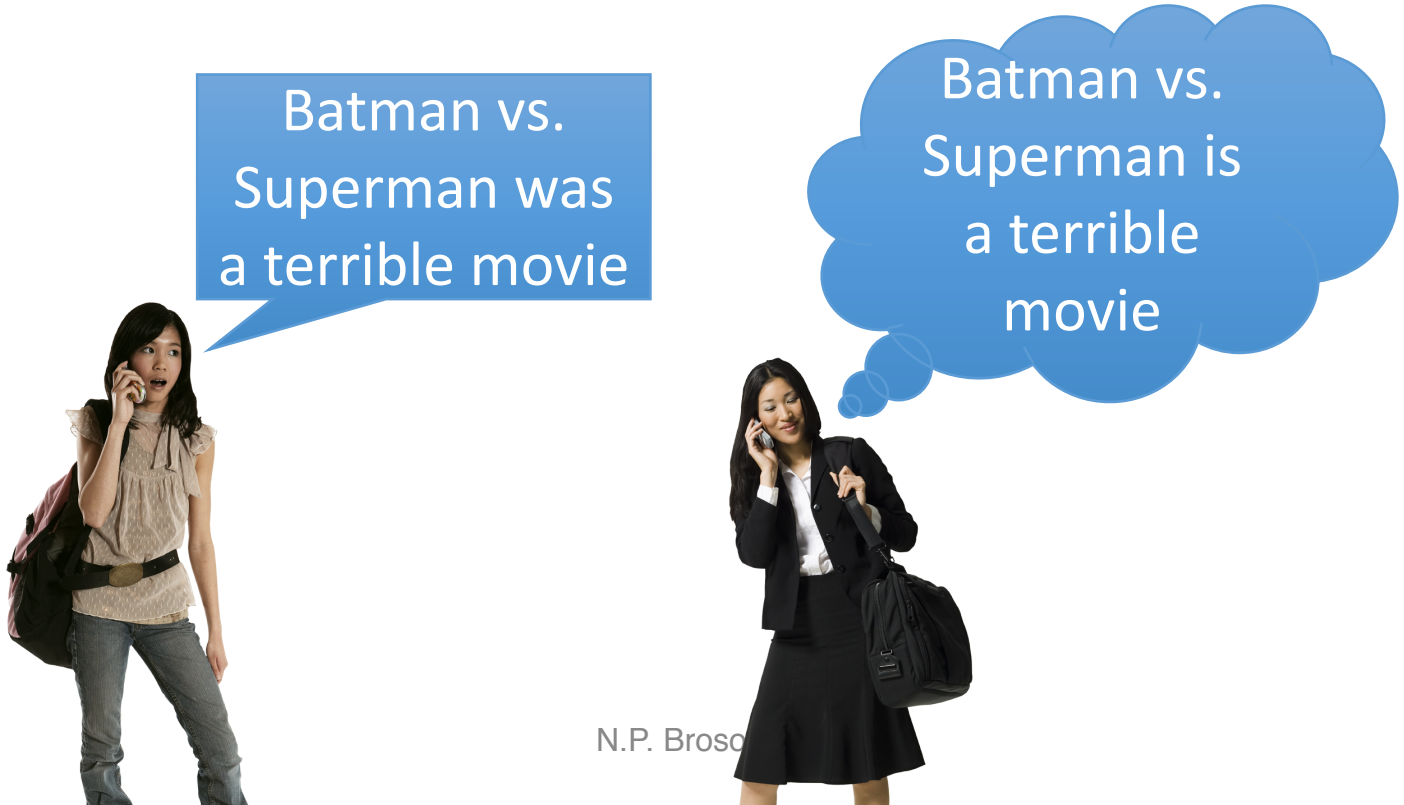
Lecture 11: Language

Outline for today

- Introduction to language
- Language comprehension
  - Words
  - Sentences
  - Text
- Language production

What is language?

- System of communication using sounds or symbols
- Express feelings, thoughts, ideas, and expressions



What is language?

How many languages?

- Average New Yorker guesses 100
- 1911 encyclopedia says ~1000
- Current estimates: ~7000

- What is the most popular language?
  - 1,213,000,000 people speak Mandarin Chinese

What is language?

The creativity of human language

- Language goes beyond fixed calls and signals of animal communication:
  1. Hierarchical system
     - Components that can be combined to form larger units
  2. Governed by rules
     - Specific ways components can be arranged

- Allows us to transmit (and understand) sentences that may have never been uttered in human history

What is language?

The universality of language

- Deaf children invent sign language that is all their own
- All humans with normal capacities develop a language and learn to follow its complex rules
- Language is universal across cultures
- Language development is similar across cultures
- Languages are “unique but the same”
  - Different words, sounds, and rules
  - All have nouns, verbs, negatives, questions, past/present tense

What is language?

Studying Language in Cognitive Psychology

- B.F. Skinner (1957) *Verbal Behavior*
  - Language learned through reinforcement

- Noam Chomsky (1957) *Syntactic Structures*
  - Human language coded in the genes
  - Underlying basis of all language is similar
  - Children produce sentences they have never heard and that have never been reinforced
  - Argued that we cannot understand language without referencing the mind

What is language?

Studying Language in Cognitive Psychology

- Psycholinguistics: discover psychological process by which humans acquire and process language
  - Comprehension
  - Speech production
  - Representation
  - Acquisition

Understanding Words

Components of words

- Phonemes
  - Refers to the units of sounds
  - Shortest segments of speech that, if changed, changes the meaning of the word
  - Bit = /b/ + /i/ + /t/
    - Changing /i/ to /a/ would change the meaning from bit to bat

Understanding Words

Components of words

- Morphemes
  - Refers to units of meaning
  - Smallest units of language that has meaning or grammatical function
  - Table = 1 morpheme / Tables = 2 morphemes
  - Bedroom = 2 morphemes

Understanding Words

Perception of words

- Phonemic restoration effect
  - Insert a cough masking a single phoneme
  - We “fill in” missing phonemes based on context of sentence and portion of word presented
  - People can’t indicate where the cough was in the word
  - The phoneme they hear can also be influenced by words *after* the cough-word
    - E.g., “there was time to *ave…”

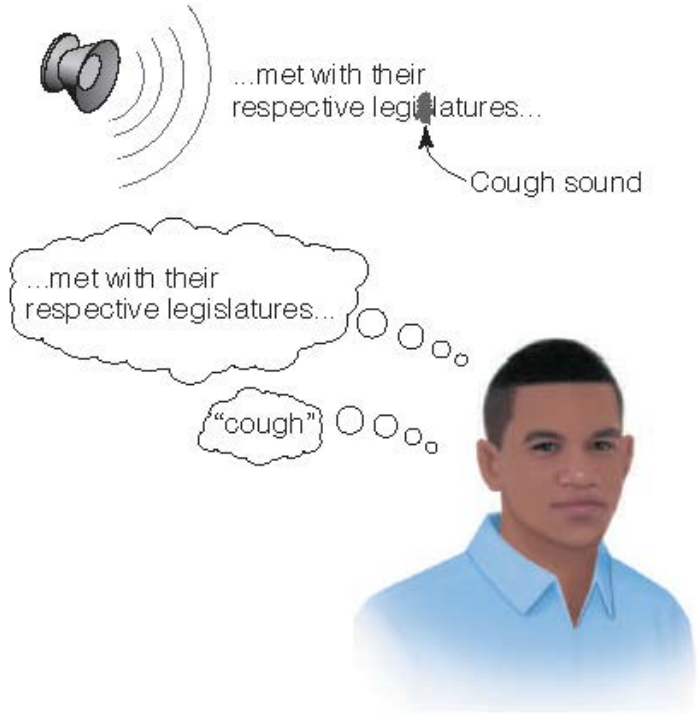


Figure 11.1 Phonemic restoration effect. In the sound stimulus presented to the listener, the first /s/ sound in “legislatures” is masked by a cough sound. What the person hears is indicated below. Although the person hears the cough, he also hears the first /s/. © Cengage Learning

Understanding Words

Perception of words

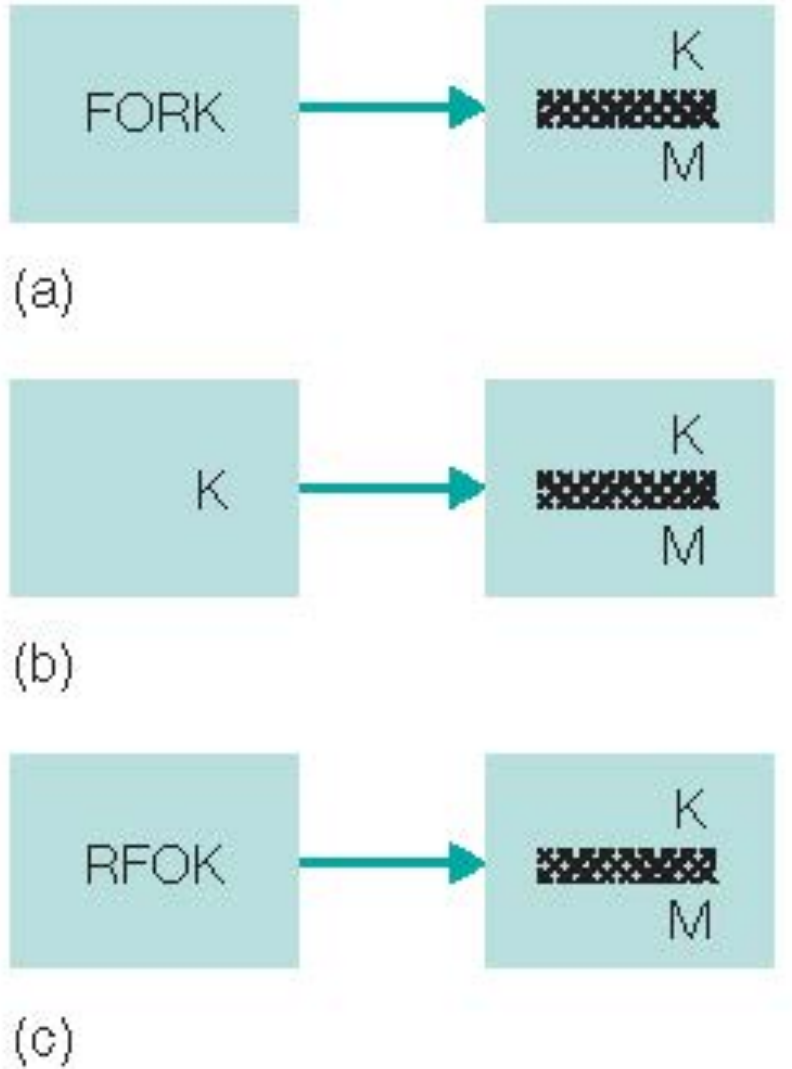
- Phonemic restoration effect
  - https://www.youtube.com/watch?v=UlJs24j3i8E

- The McGurk Effect
  - https://youtu.be/_UzWeZZ9XeQ?t=17s

Understanding Words

Perception of words

- The word superiority effect
  - The finding that letters are easier to recognize when they are contained in a word than when they appear alone or are contained in a non-word
- Shows that letters in words are not processed one-by-one, but influenced by the word context
  - Just as context influences how we ***hear*** phonemes in words, it also influences how we ***see*** letters in word



Understanding Words

Perception of words

- How do we recognize words in sentences?
  - There are no physical breaks between words
  - Everyone pronounces words differently (“did you” versus “dijoo”)

- Speech segmentation is accomplished by using:
  - Context
  - Understanding of meaning
  - Understanding of sound and syntactic rules
  - Statistical learning

Understanding Words

Understanding the meaning of words

- Much of our comprehension of language comes down to **prediction**
  - Environmental (statistical) regularities guide comprehension and influence perception
  - Experience with our environment influences language comprehension

Understanding Words

Understanding the meaning of words

- **The word frequency effect**
  - Our ability to recognize words is influenced by their frequency of occurrence in language
- Lexical decision task
  - Read a list of words and non-words silently
  - Say “yes” when you read a word
  - Respond more rapidly to high-frequency words
- Eye movements while reading
  - Look at low-frequency words longer

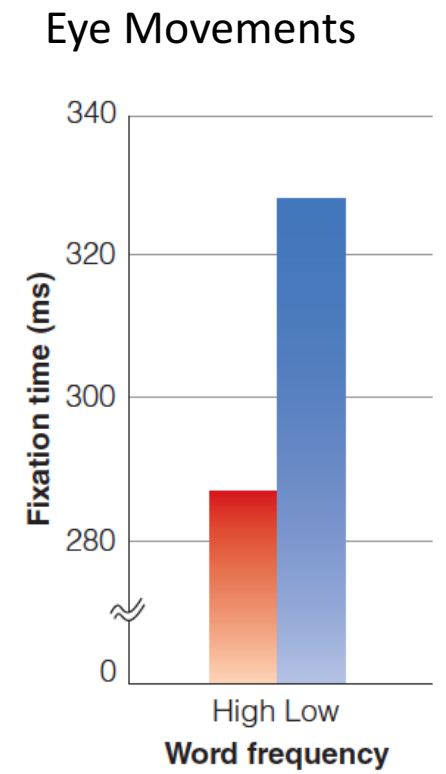


Figure 11.4 Results of

Understanding Words

Understanding the meaning of words

- Lexical ambiguity
  - Words have more than one meaning (e.g., bank)
  - Context clears up ambiguity after all meanings of a word have been briefly accessed
  - Particular meanings of words can also occur with different frequencies
    - E.g., More likely to use the word “bug” to refer to an insect as opposed to a listening device

Understanding Words

Understanding the meaning of words

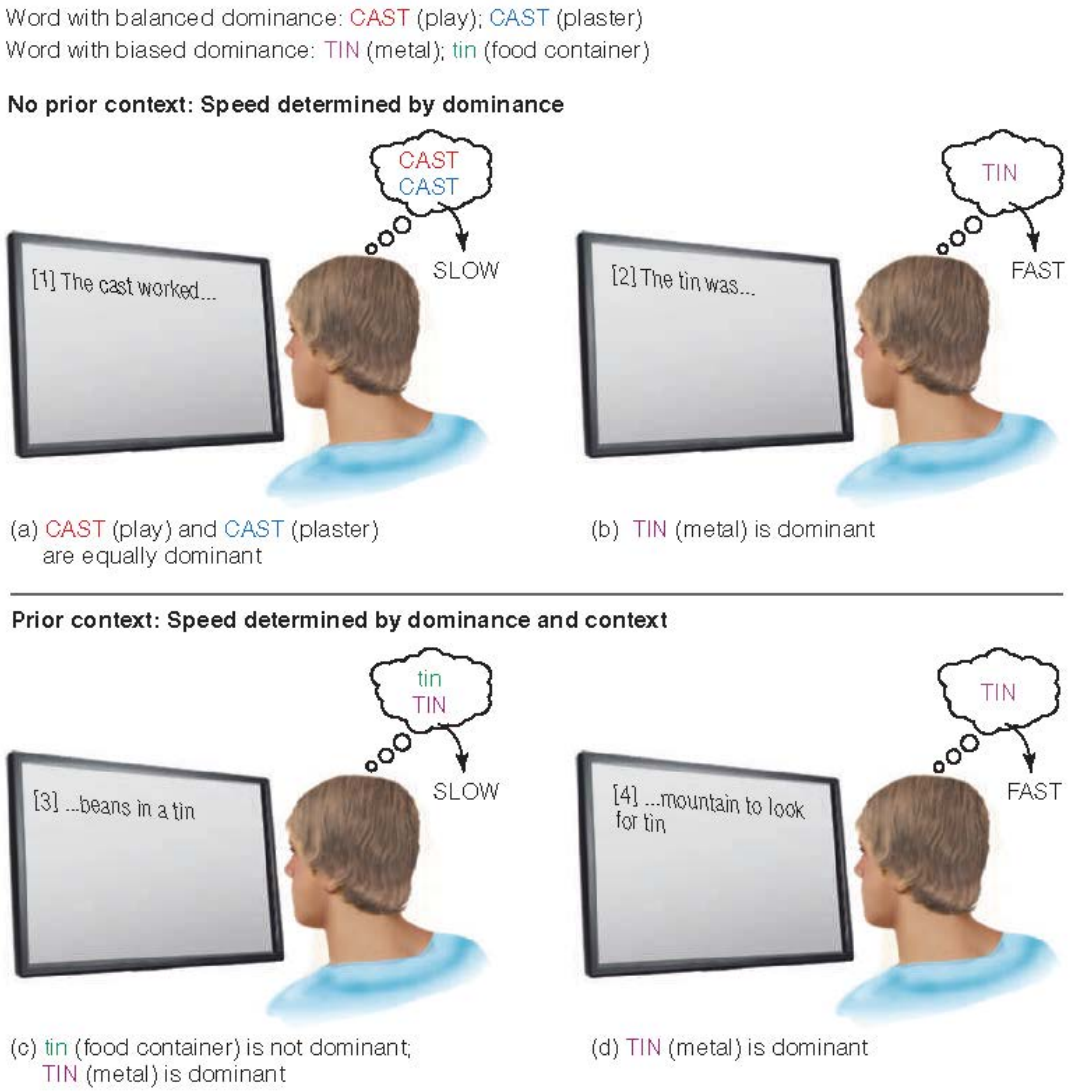
- Lexical ambiguity
- Meaning dominance – The fact that some words are used more frequently than others
  - Biased dominance
    - When words have two or more meanings with different dominance (e.g., tin)
  - Balanced dominance
    - When words have two or more meanings with about the same dominance (e.g., cast)

Understanding Words

Understanding the meaning of words

- Lexical ambiguity
  - Which meaning of a word will be accessed and **how quickly** it is accessed can be influenced by a number of factors.
  - For example:

1. Meaning dominance
2. Context



Understanding Sentences

- Components of language are not processed in isolation
  - We couldn't avoid talking about sentences when discussing word comprehension

- Properties of sentences:
  - Semantics: meanings of words and sentences
  - Syntax: rules for combining words into sentences

- E.g., "the cat won't eat"
  - Semantic error: "the cat won't bake"
  - Syntactic error: "the cats won't eating"

Understanding Sentences

Evidence that syntax and semantics are processed in different areas of the brain

- **Broca's area** involved in language production (syntax)
  - Damage to Broca's area causes slow, labored, ungrammatical speech
  - Also have difficulty with sentences that rely on correctly identifying the syntax to understand
    - "The apple was eaten by the girl" – only one possible interpretation
    - "The boy was pushed by the girl" – two possible interpretations
  - Have concluded that damage to Broca's area causes problems in syntax – creating meaning based on word order

Understanding Sentences

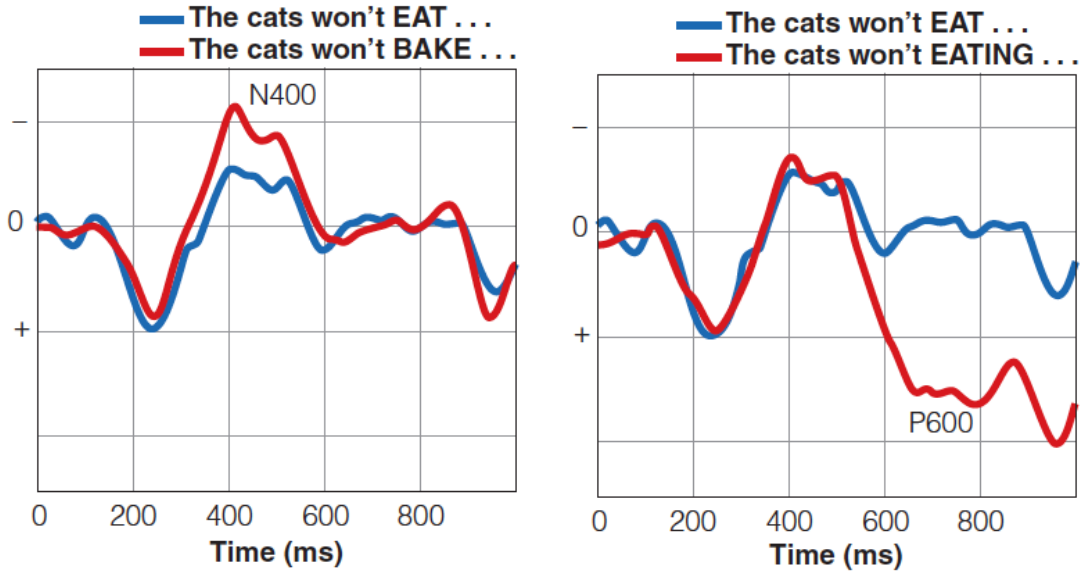
Evidence that syntax and semantics are processed in different areas of the brain

- **Wernicke's area** involved in language comprehension (semantics)
  - Damage to Wernicke's: can still produce fluent and grammatically correct speech, but was incoherent
    - "They make my favorite nine to severed and now I'm a been haved by the uh stam of fortment of my annulment.."
  - Also unable to understand speech and writing
    - Not dependent on word-order (syntax)

Understanding Sentences

Syntax and semantics can also be distinguished by measuring ERPs (EEG)

- Event-related potential and brain imaging studies have shown syntax and semantics are associated with different mechanisms
  - Illustrating different physiological responses to syntax and semantics



(a) How semantics affects N400 (b) How syntax affects P600

Figure 11.6 (a) The N400 wave of the ERP is affected by the meaning of

Understanding Sentences

- As we read a sentence, we encounter a series of words, one followed by another.

- **Parsing** is the mental grouping of words into phrases
  - A central process for determining the meaning of a sentence

- **Garden path sentences** demonstrate **Temporary Ambiguity** when parsing sentences
  - Garden path sentences are sentences that begin by appearing to mean one thing, but then end up meaning something else
  - “after the musician played the piano was wheeled off of the stage”
  - “because he always jogs a mile seems a short distance to him“

Understanding Sentences

Dealing with ambiguity: Syntax-first approach to parsing

- Grammatical structure of sentence determines parsing
- **Late closure**: parser assumes each new word is part of the current phrase as long as possible
  - “After the musician played the piano… was wheeled..??”
  - “[After the musician played] [the piano was wheeled of the stage]
- Garden-path model

Understanding Sentences

Dealing with ambiguity: Interactionist approach to parsing

- Semantics and syntax both influence processing simultaneously as one reads a sentence

Understanding Sentences

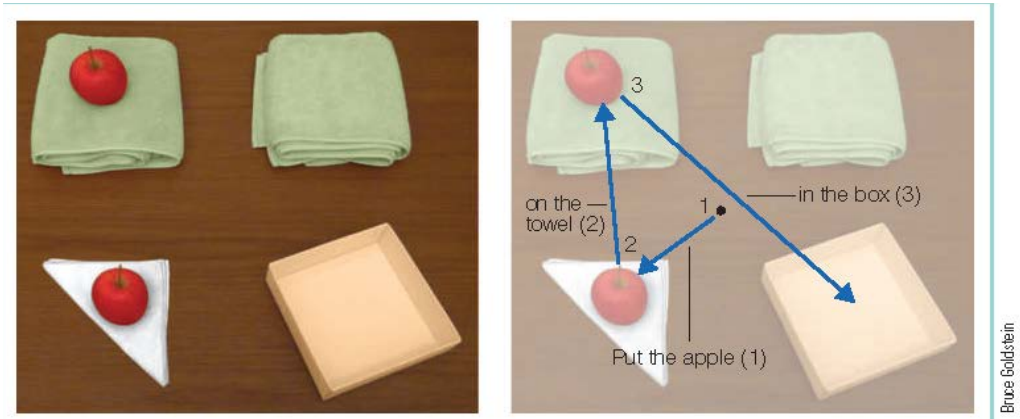
Dealing with ambiguity: Interactionist approach to parsing

- Example: Semantics can influence parsing from the beginning
  - Ambiguous meaning: “The spy saw the man with the binoculars”
  - Unambiguous meaning: “The bird saw the man with the binoculars”

Understanding Sentences

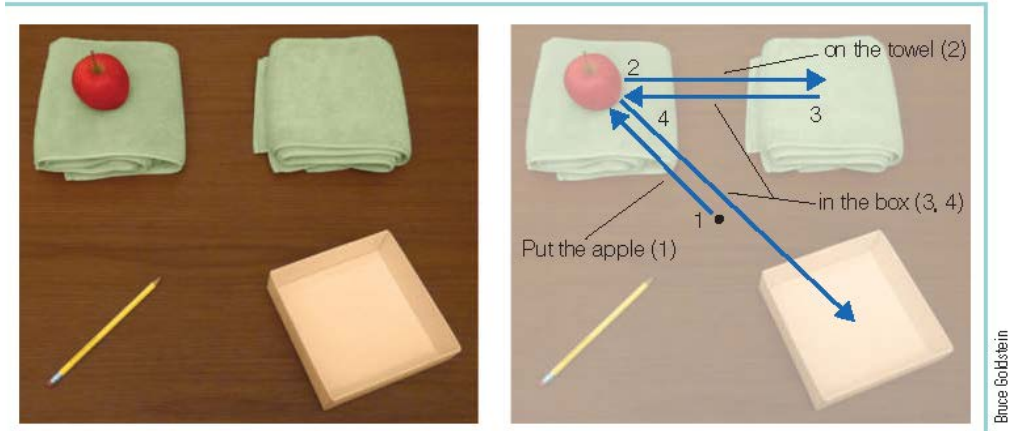
Dealing with ambiguity: Interactionist approach to parsing

- Example: Information in the visual scene can influence parsing
  - "Place the apple on the towel in the box"



(a) Two-apple condition (b) Eye movements

Figure 11.8 (a) Two-apple scene similar to the one viewed by Tanenhaus et al.'s (1995) subjects; (b) eye movements while comprehending the task. © Cengage Learning



(a) One-apple condition (b) Eye movements

Figure 11.9 (a) One-apple scene similar to the one viewed by Tanenhaus et al.'s (1995) subjects; (b) eye movements made while comprehending the task. © Cengage Learning

Understanding Sentences

Dealing with ambiguity: Interactionist approach to parsing

- Example: We make predictions based on knowledge of the environment
  - We use our knowledge of what is most likely to occur (environmental statistics) when determining meaning
  - E.g., “Getting himself and his car to work on the neighboring island was time consuming. Every morning he drove for a few minutes, and then boarded the…. “

Understanding Sentences

Dealing with ambiguity: Interactionist approach to parsing

- Example: We make predictions based on knowledge of language construction
  - We can measure how likely certain constructions occur in the English language, and our own parsing tends to reflect those statistics
  - “The experienced soldiers warned about the dangers conducted the midnight raid”
    - This type of construction is unlikely, so we make an error in our parsing

Understanding Text & Stories

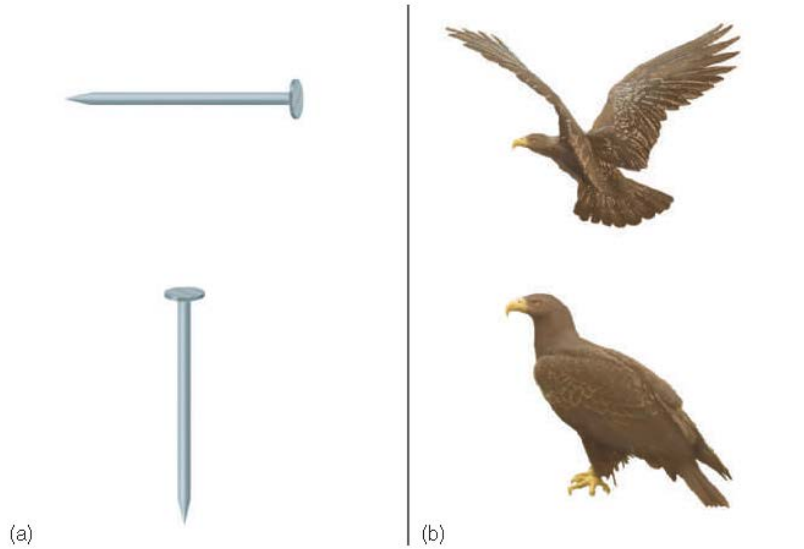
- An important part of creating a **coherent** story is making **inferences**
- **Coherence:** representation of the text in one's mind so that information from one part of the text can be related to information in another part of the text
- **Inference:** readers create information during reading not explicitly stated in the text
  - Anaphoric: connecting objects/people
  - Instrumental: tools or methods
  - Causal: events in one clause caused by events in previous sentence

Understanding Text & Stories

- What is the mental representation that people form, when reading a story?
- **Situation models**
  - Represent events as if experiencing the situation
    - Point of view of protagonist
  - Does not consist of information about phrases, sentences, etc.
  - **Mental representations as simulations**
    - A person simulates the perceptual and motor characteristics of the objects and actions in the story

Understanding Text & Stories

- **Situation models**
  - **Mental representations as simulations**



(1) "He hammered the nail into the wall." (3) "The ranger saw the eagle in the sky."

(2) "He hammered the nail into the floor." (4) "The ranger saw the eagle in its nest."

Figure 11.12 Stimuli similar to those used in (a) Stanfield and Zwaan's (2001) "orientation" experiment and (b) Zwaan et al.'s (2002) "shape" experiment. Subjects heard sentences and were then asked to indicate whether the picture was the object mentioned in the sentence.

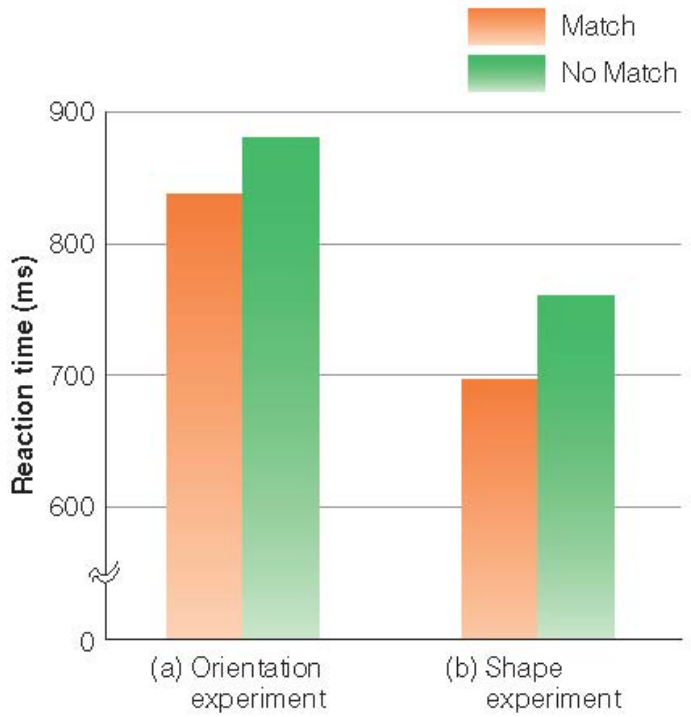


Figure 11.13 Results of Stanfield and Zwaan's (2001) and Zwaan et al.'s (2002) experiments. Subjects responded "yes" more rapidly for the orientation (in a) and the shape (in b) that was more consistent with the sentence. *(Source: Based on R. A. Stanfield & R. A. Zwaan, The effect of implied orientation derived from verbal content on picture recognition,* Psychological Science, 12, *153–156, 2001.)*

Understanding Text & Stories

- **Situation models**
  - **Mental representations as simulations**
  - Hauk et al. (2004)
    - Similar activity when actually performing motor movements and reading the "action" words

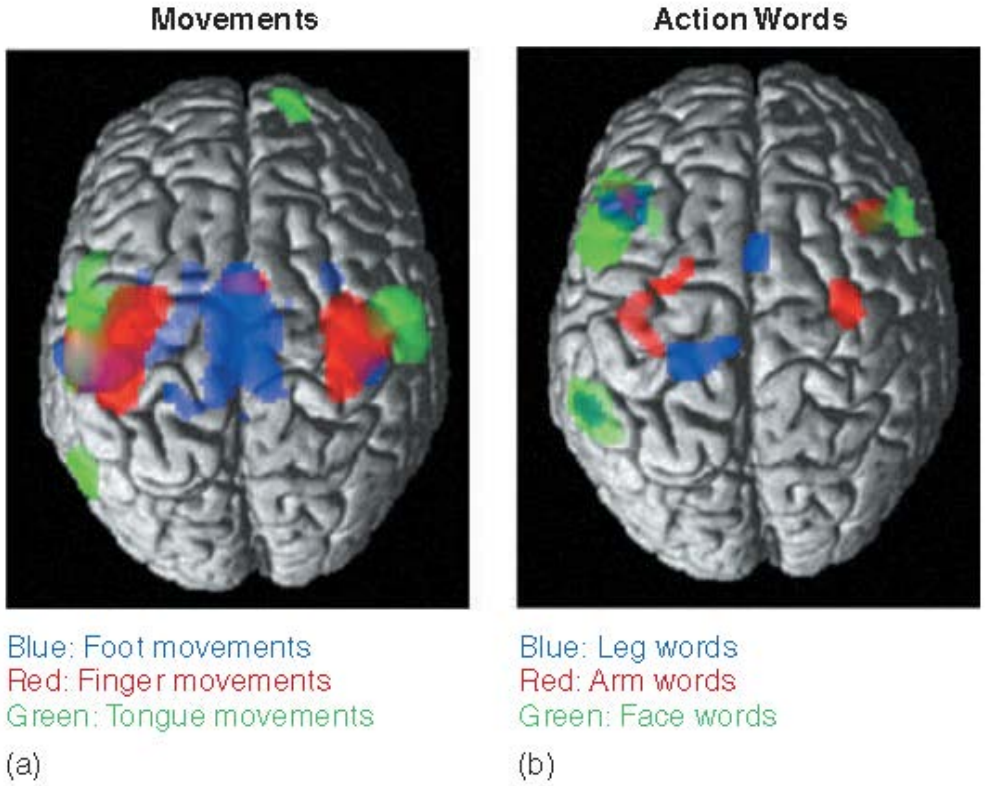


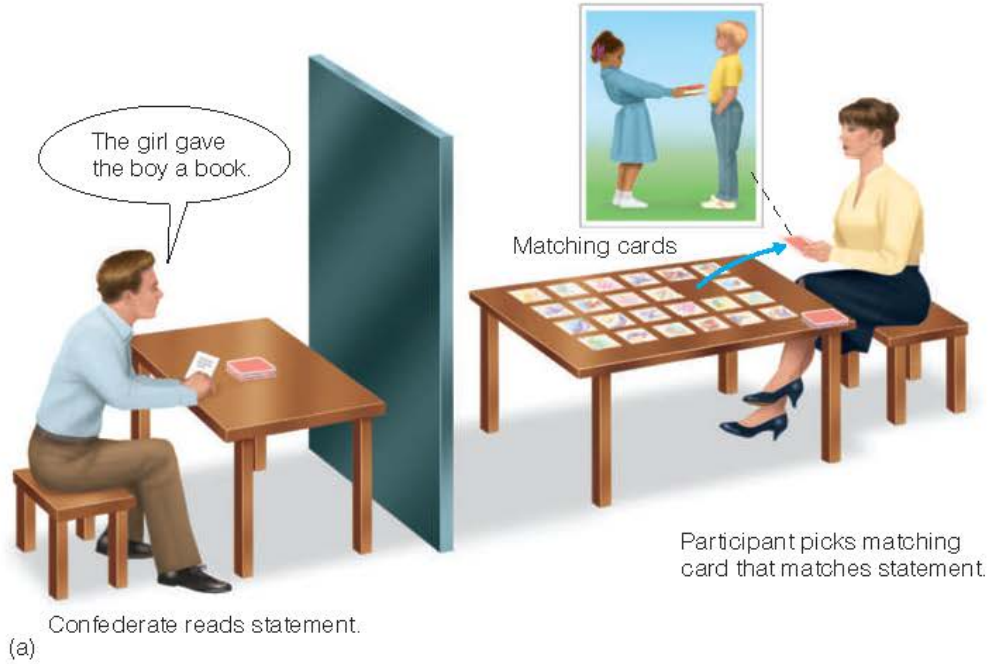
Figure 9.24 Hauk et al. (2004) results. Colored areas indicate the areas of the brain activated by (a) foot, finger, and tongue movements; (b) leg, arm, and face words. *(Source: O. Hauk, I. Johnsrude, & F. Pulvermuller, Somatotopic representation of action words in human motor and premotor cortex, Neuron, 41, 301–307, 2004, with permission from Elsevier.)*

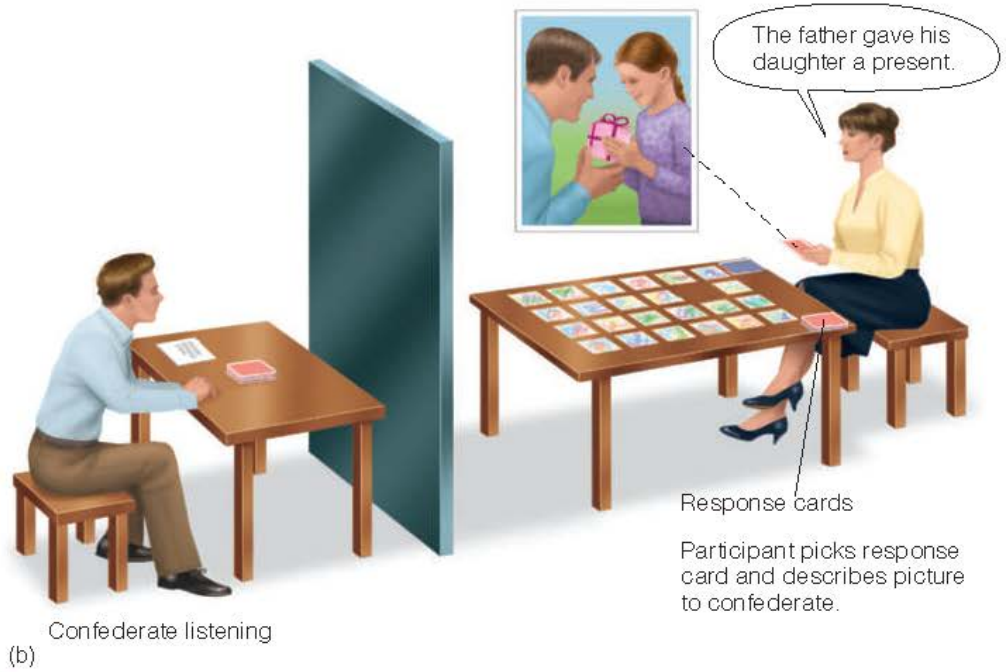
Producing Language

EFFECT	DESCRIPTION	CONCLUSION
Given–new contract	Speaker should provide both given and new information in a sentence.	Providing given information facilitates comprehension.
Common ground	Mutually recognized common knowledge.	Speakers tailor information to the listener's level of knowledge. People work together to achieve common ground in a conversation (see Figure 11.15).
Syntactic coordination	Similar grammatical constructions in sentences during conversation.	A person's speech patterns are influenced by the grammatical constructions used by the other person in a conversation (see Figure 11.16).

Producing Language

- Syntactic priming
  - Production of a specific grammatical construction by one person increases chances other person will use that construction
  - Reduces computational load in conversation





Culture, Language, and Cognition

- **Sapir-Whorf hypothesis**: language influences thought
- Russian-speakers have an extra category for shades of blue

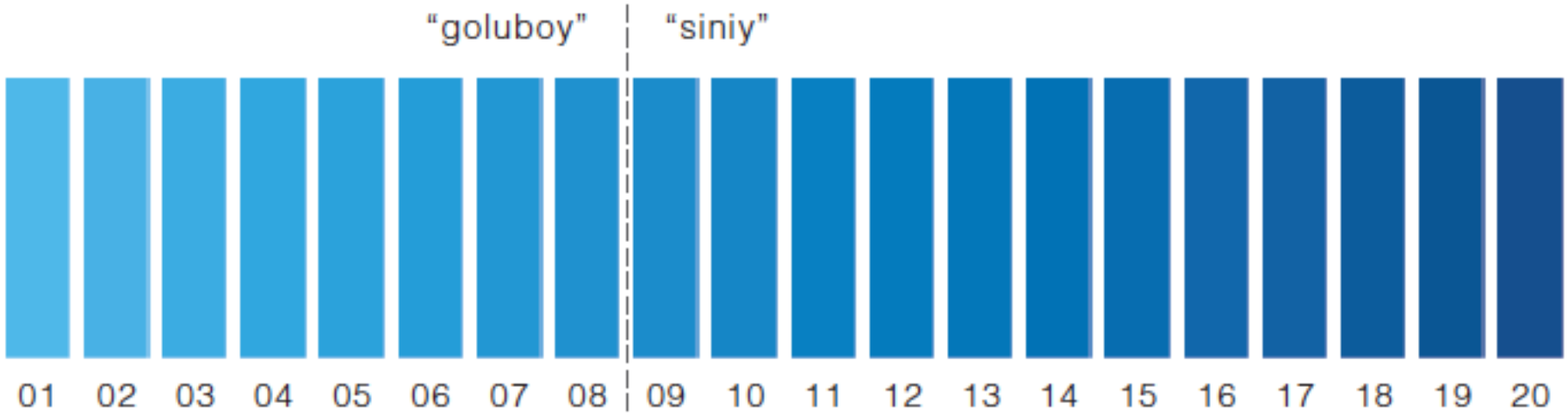


Figure 11.17 Colors ranging from light blue to dark blue. English-speakers call all of these colors *blue*. Russian-speakers call the lighter colors to the left of the line *goluboy* and the darker colors to the right of the line *siniy*. *(Source: Based on J. Winawer, N. Witthoft, M. C. Frank, L. Wu, A. R. Wade, & L. Bordoditsky, Russian blues reveal effects of language on color discrimination,* Proceedings of the National Academy of Sciences, 104, *7780–7785, Figure 1, 2007.)*

Culture, Language, and Cognition

- Differences in how quickly identify which bottom color is the same as the top
  - Russian-speakers faster when bottom two are different categories

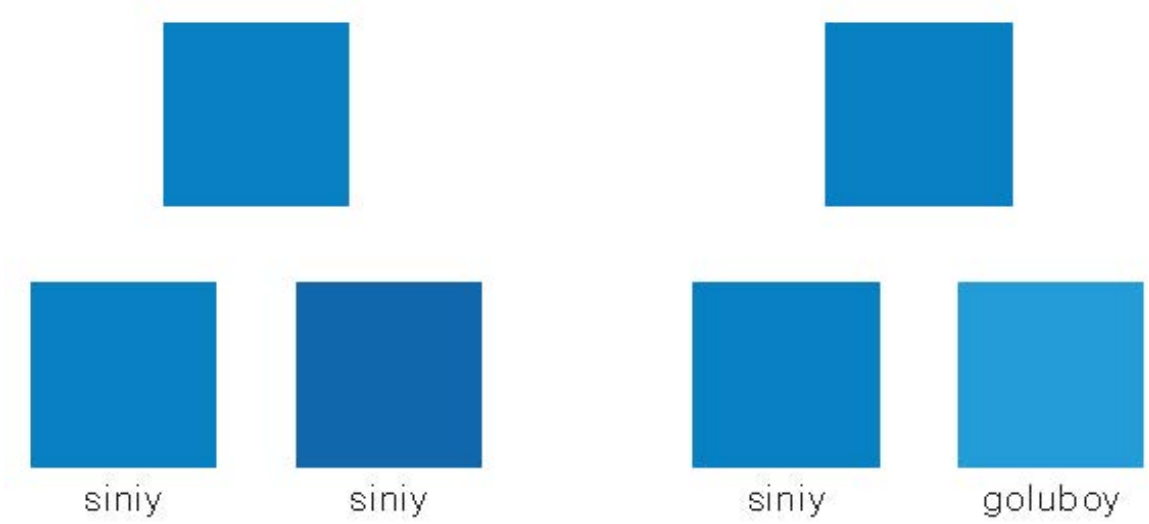


Figure 11.18 Sample stimuli from the Winawer et al. (2007) experiment. (a) The two bottom squares are from the same Russian category. (b) The two bottom squares are from different Russian categories. *(Source: Based on J. Winawer, N. Witthoft, M. C. Frank, L. Wu, A. R. Wade, & L. Bordoditsky, Russian blues reveal effects of language on color discrimination,* Proceedings of the National Academy of Sciences, 104, *7780–7785, Figure 1, 2007.)*