Psychology of Language

9 Sentence (syntactic) processing

Fall 2023
Tues/Thur 5:00-6:15pm

Emma Wing
Drop-in hours:
Wednesdays 3-4pm
& by appointment
Webex link

Road map

- Review from **8 Meaning & semantic memory**
- Unit 2: The Mature System

  9 Sentence processing

Wrap-up from 8 Meaning & semantic memory

Key concepts

- ✓Semantic memory (structure and acquisition)
- ✓Psycholinguistics and experimental linguistics
- ✓Spreading activation
- ✓Evidence for categorical relationships
- ✓Types of meaning
- ✓Evidence of compositionality
- ✓Semantic ambiguity

Evidence for compositionality

- **Background:** verbs carry information about the number and type of participants/locations/objects involved in the events those verbs convey
  - Build
    - 2: a builder; a thing being built
  - Give
    - 3: a giver, a thing being given, receiver
  - Eat
    - 1 or 2: an eater, (optional: a thing being eaten)

Note: You will not be asked to figure out how many participants/ arguments a verb needs on an exam

Evidence for compositionality

- Participants are faster to read sentences with phrases when those phrases carry participant information (a and b), rather than when they carry extra information (c and d)

a) The saleswoman tried to interest the man in a wallet.
b) The man expressed his interest in a wallet.
c) The man expressed his interest in a hurry.
d) The saleswoman tried to interest the man in his fifties.

Clifton (1991)

Semantic ambiguity

- Sentences can be semantically ambiguous: they can have more than one interpretation

A child built every sandcastle.

- Imagine there are 5 sandcastles. How many children are there?
  - One child may have built all sandcastles
  - A different child may have built each sandcastle

Wrapping up

- There are many ways to study meaning
  - Compositional meaning and associations are two of the main ways
  - Ambiguity is another main area of research
    - Semantic ambiguity is related to syntactic ambiguity—more on this next time!

Unit 2: Development of Language

9 Sentence processing

Altmann, Ch. 7 – Time flies like an arrow

Learning objectives

- State the difference between grammaticality and acceptability
- Give 1 example to show syntactic processing is automatic
- Explain a study that provides evidence of incremental processing
- Give an example of syntactic ambiguity
- Describe the role of prediction in syntactic processing
- Describe how linguistic and visual context can affect processing
- Distinguish between two processing strategies: late and early closure

Grammaticality vs. acceptability

Note: you won't have to identify whether a sentence is grammatical or unacceptable on an exam

1. Colorless green ideas sleep furiously. — grammatical, unacceptable
2. A man that a woman that a child that a bird saw knows loves. — grammatical, unacceptable
3. More people have been to Russia than I have. — ungrammatical, acceptable
4. Efforts to make English the official language is gaining strength throughout the US. — ungrammatical, acceptable

Grammaticality: whether a sentence adheres to the syntactic rules of a language
Acceptability: whether a sentence "sounds good" or is easy or hard to process.

This distinction helps us see differences between our linguistic competence and our linguistic performance.

Syntactic processing (parsing) is automatic

Once we know the right prosody, we can parse the sentence

1. James while John had had had had had had had had had had had a better effect on the teacher
    - James, while John had had ‘had’, had had ‘had had’. ‘Had had’ had had a better effect on the teacher.
2. Buffalo buffalo buffalo buffalo buffalo buffalo buffalo buffalo
    - A bison from Buffalo who is bullied by another bison from Buffalo is bullying yet another bison from Buffalo.
3. Will will Will will Will Will’s will
    - Will1, will Will2 will Will3 Will4’s will?
    - Will1, is Will2 going to pass on to Will3 the legal document of Will4?

Ambiguity in sentence processing

1. Red tape holds up new bridge
2. Retired priest may marry Springsteen
3. British left waffles on Falkland
4. Squad helps dog bite victim
5. There will be no investigation into police contact with a man who killed his wife days before she died

The above sentences are all ambiguous: they have more than one interpretation because they can have more than one syntactic structure underlying them.

Ambiguity in sentence processing

1. The man photographed the giraffe in his pajamas.

Ambiguity in sentence processing

1. The man photographed the giraffe in his pajamas.

- Who is wearing pajamas?

Ambiguity in sentence processing

1. The man photographed the giraffe in his pajamas.

NP:
noun phrase

VP:
verb phrase

Note: You will not be asked to break sentences down like this (syntactically) on a quiz or exam.

Ambiguity in sentence processing

1. The man photographed the giraffe in his pajamas.

NP:
noun phrase

VP:
verb phrase

Ambiguity in sentence processing

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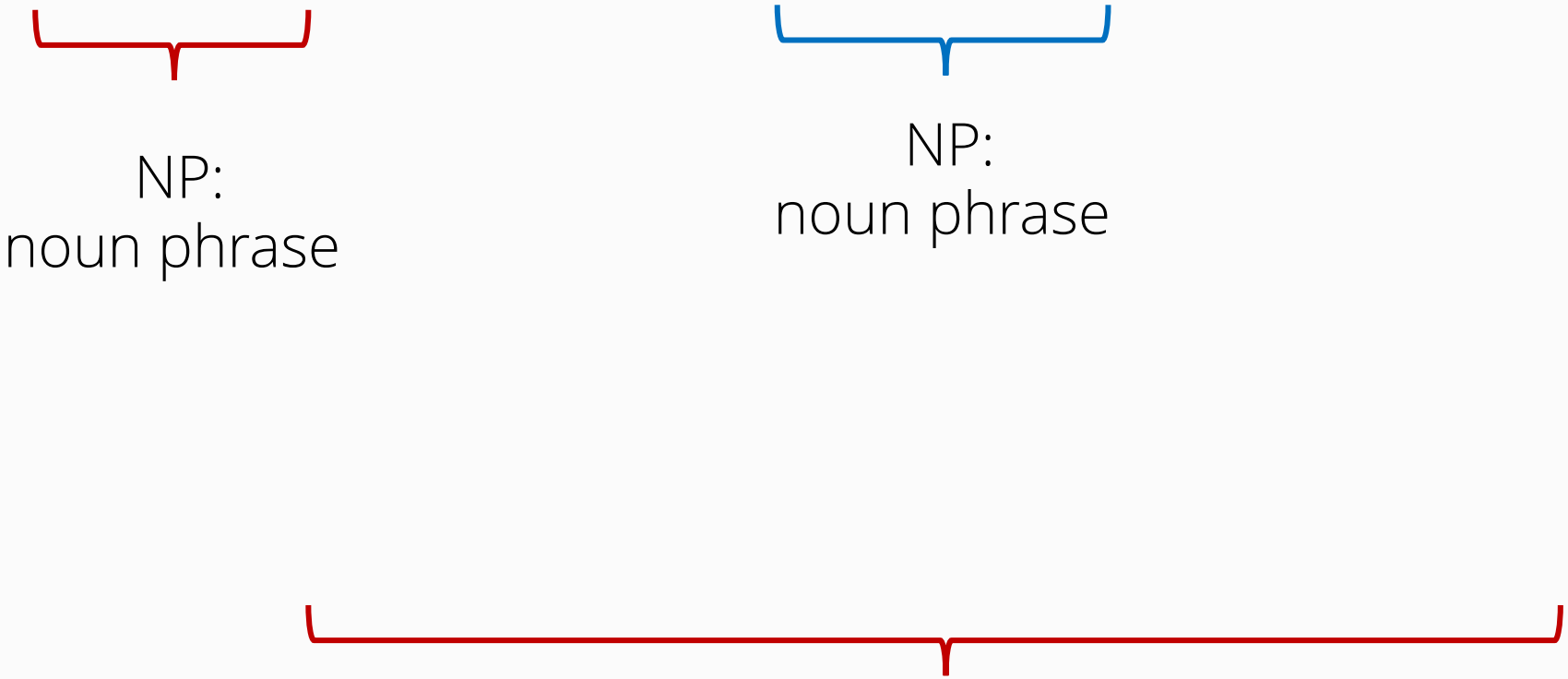

Ambiguity in sentence processing

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Structure 1

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prepositional
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Ambiguity in sentence processing

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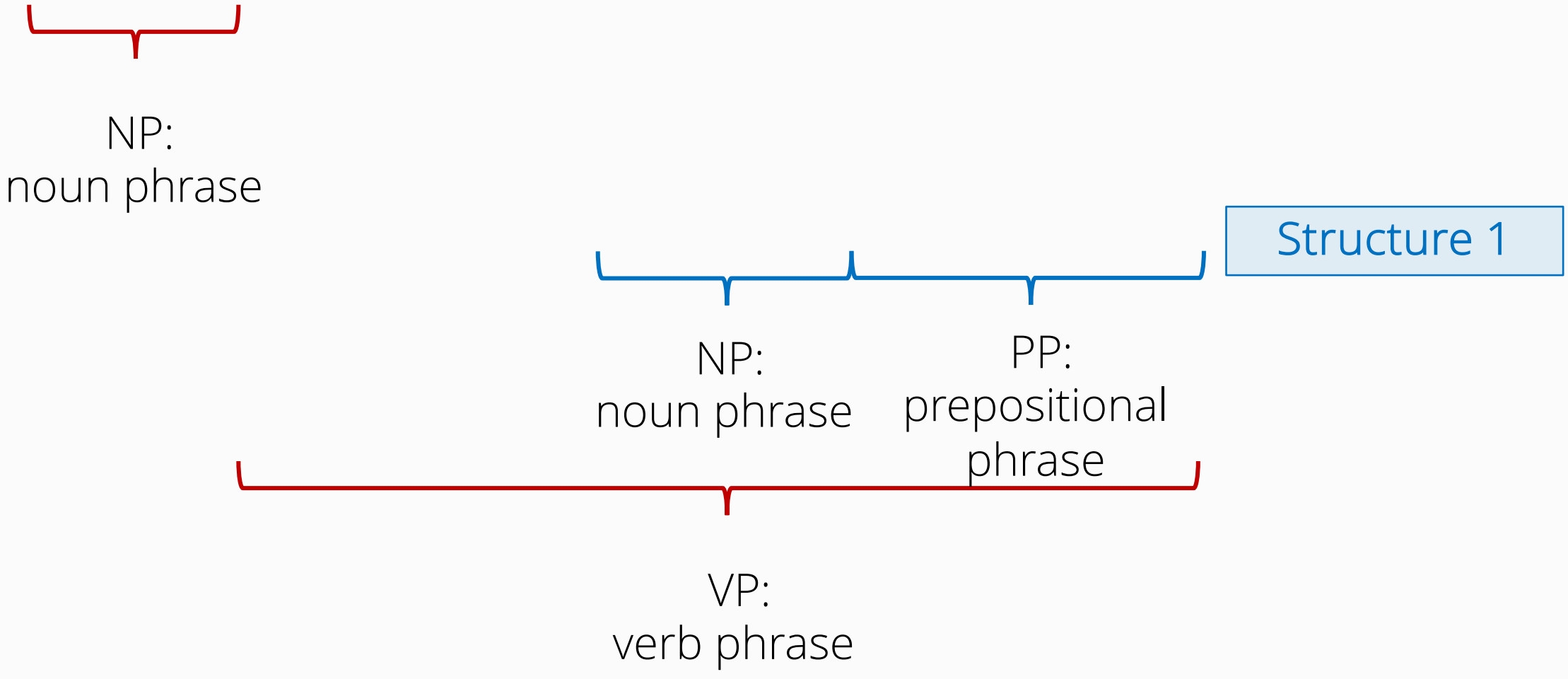

Ambiguity in sentence processing

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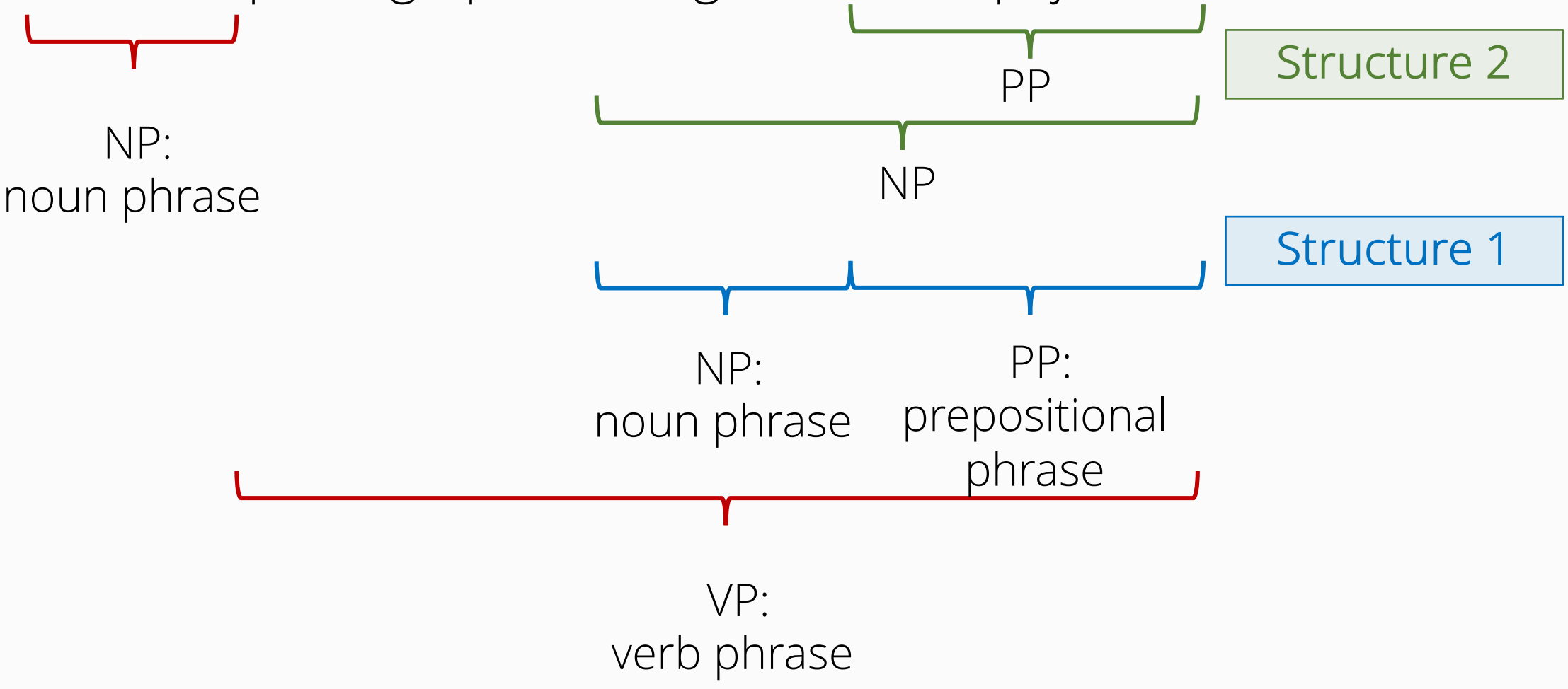


Ambiguity in sentence processing

1. The man photographed the giraffe in his pajamas.

- Sentences are **globally ambiguous** when there are multiple syntactic structures underlying them.
- Ambiguities have to be resolved during sentence processing
- We typically pick one interpretation and move forward with it…until it doesn't work anymore

Ambiguity in sentence processing

We don’t wait until the end of the sentence to resolve ambiguities!

- This is why we often don’t notice ambiguities

Incremental processing: As each word in a sentence is encountered, we process it as fully as we can, and build as full of a (partial) interpretation of the sentence as we can.

Incremental processing

- …can lead to issues
  - Example: **Garden path sentences:** sentences where we pick the wrong interpretation and have to backtrack and start again
  - These sentences are **locally ambiguous:** at some point in the sentence, they can be interpreted in more than one way, but later in the sentence they are disambiguated

1. The horse raced past the barn fell.
2. The florist sent the flowers was very pleased.
3. The spy saw the cop with the revolver.

Incremental processing

- ...can lead to issues
  - Example: **Garden path sentences:** sentences where we pick the wrong interpretation and have to backtrack and start again
  - These sentences are **locally ambiguous**

1. The horse [that was] **raced** past the barn fell.
2. The florist [that was] **sent** the flowers was very pleased.
3. The spy saw [the cop with the revolver].

- In 1&2, the verb (bolded) looks like a main verb, but its part of the reduced relative clause (clauses that add information about a preceding noun).
- In 3, the phrase “with the revolver” should be integrated with the verb (”saw”), and not with “the cop”

Context effects (linguistic)

- Linguistic context can help us avoid the garden path (i.e., avoid choosing the wrong interpretation while processing a sentence incrementally)

- Without context:
  1. Annie hit the thief with the wart.

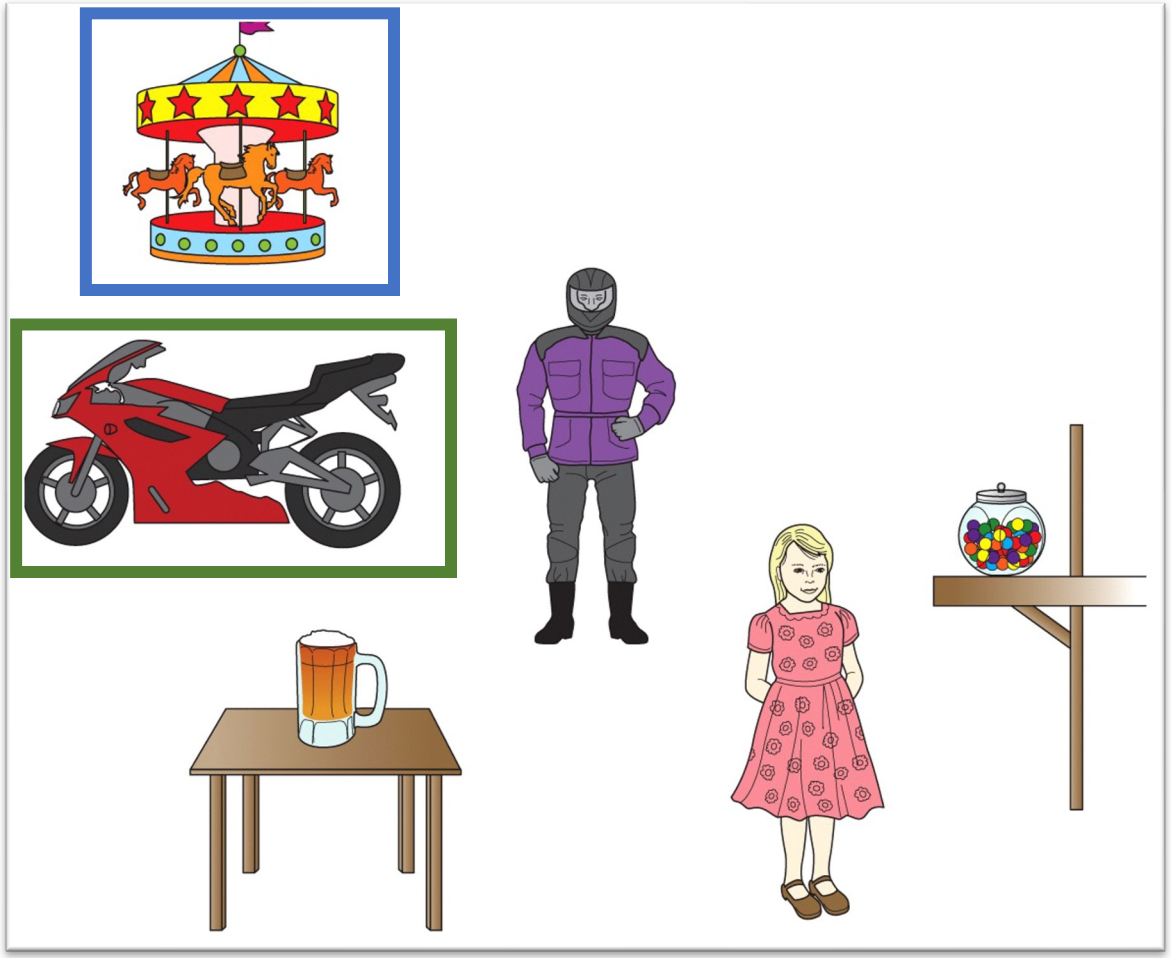
- With context:
  1. Two thieves came into the house. One of them had a wart. Annie hit the thief with the wart.

e.g., Altmann & Steedman (1988)

Context effects (visual)

1. The man/girl will ride the…

- The combination of subject and verb affects eye movements
    1. The man will ride…
    2. The girl will ride…

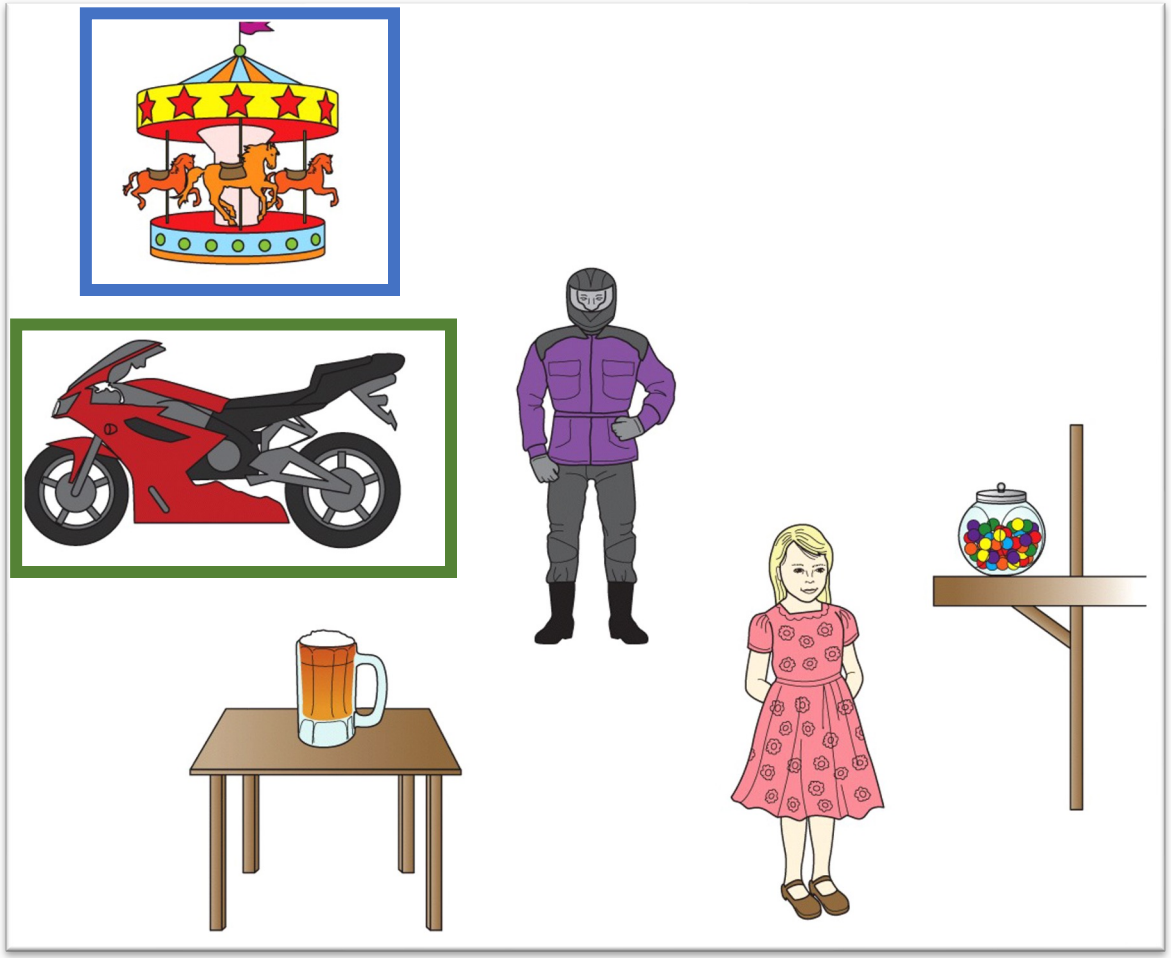


Altmann (2011)

Context effects (visual)

1. The man/girl will ride the…

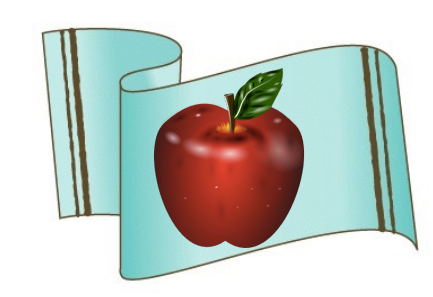
- The combination of subject and verb affects eye movements
  1. The man will ride…
     - People look at the motorcycle
  2. The girl will ride…
     - People look at the merry-go-round



Altmann (2011)

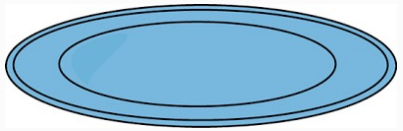
Context effects (visual)

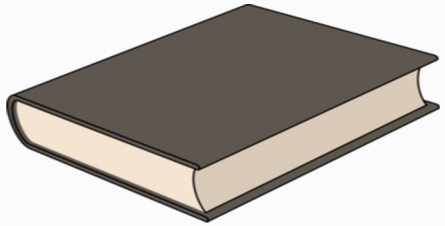
"Put the apple **on the towel** in the box."

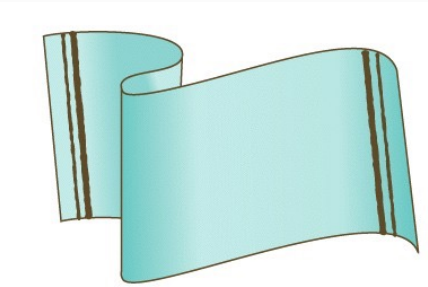


While incrementally processing, when you hear "on the towel", it's ambiguous because it can mean 2 things:

1. It can tell you which apple
2. It can tell you where to put the apple



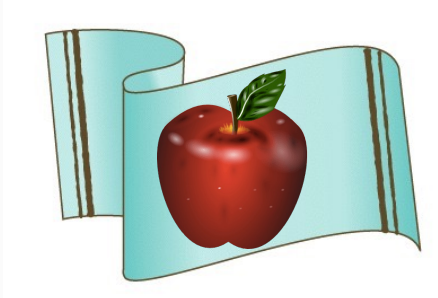


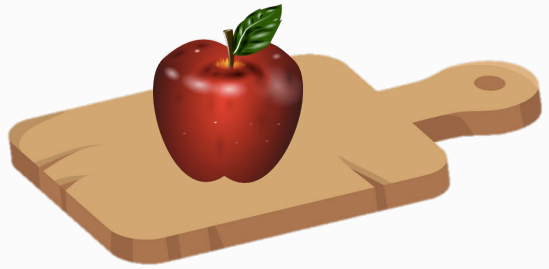


Spivey et al. (2002)

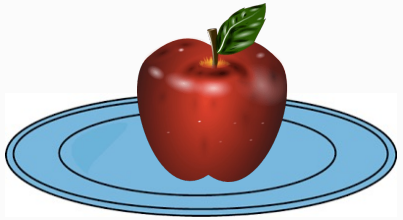
Context effects (visual)

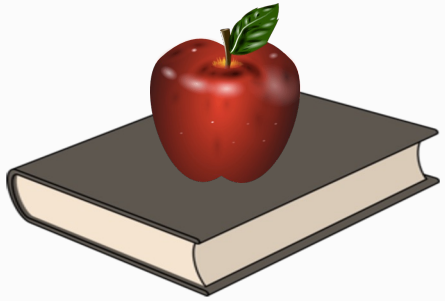
"Put the apple **on the towel** in the box."



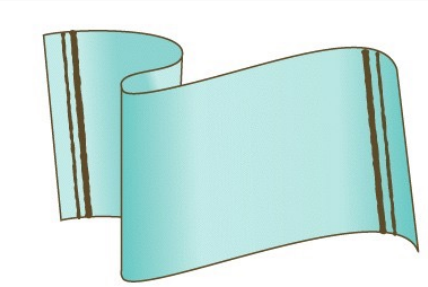


Now there is visual context which suggests that "on the towel" tells you *which apple.*





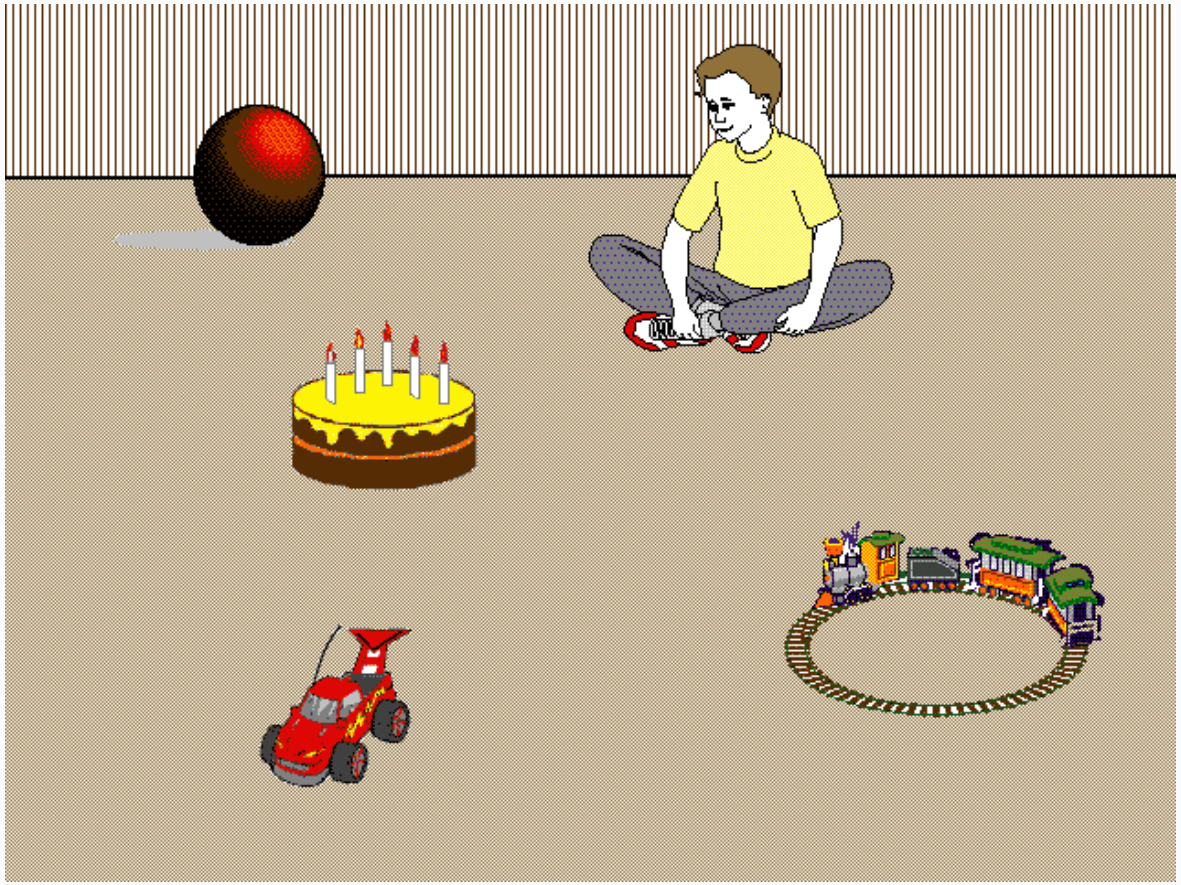
You are less likely to interpret "on the towel" as meaning the place where the apple should be put.



Spivey et al. (2002)

The role of prediction

1. The boy will eat the…
   - When participants hear “eat”, they look at the cake

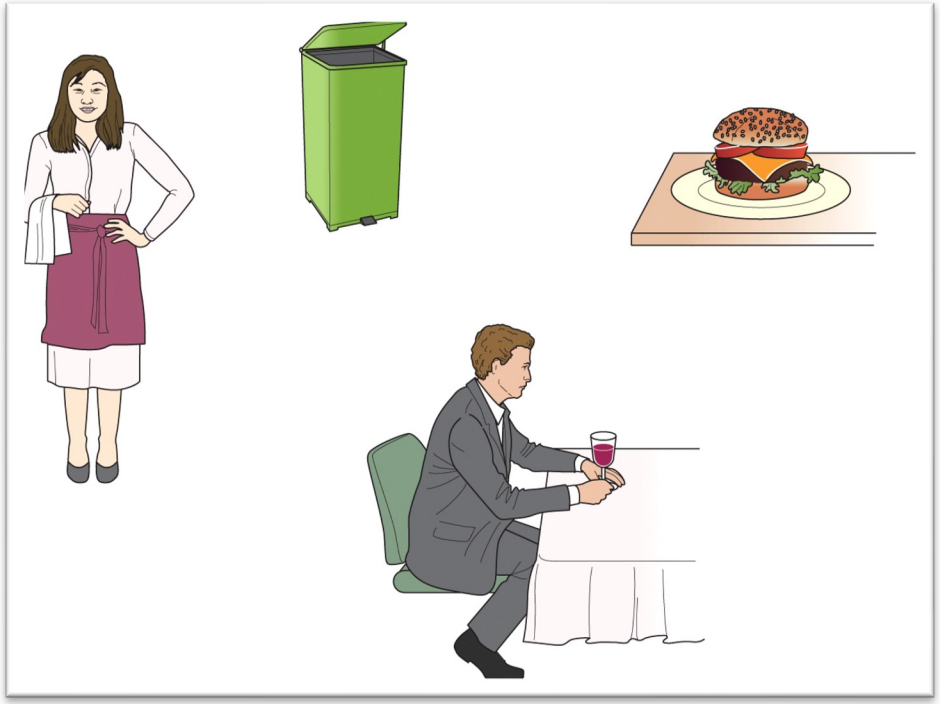


- Information in the verb and in the visual display are rapidly integrated
- We use this information to predict what is coming next in the sentence

Altmann & Kamide (1999)

The role of prediction

- Case marking: when noun phrases (subject, object, etc.) in the sentence carry morphemes that indicate whether they are the subject or object of the verb



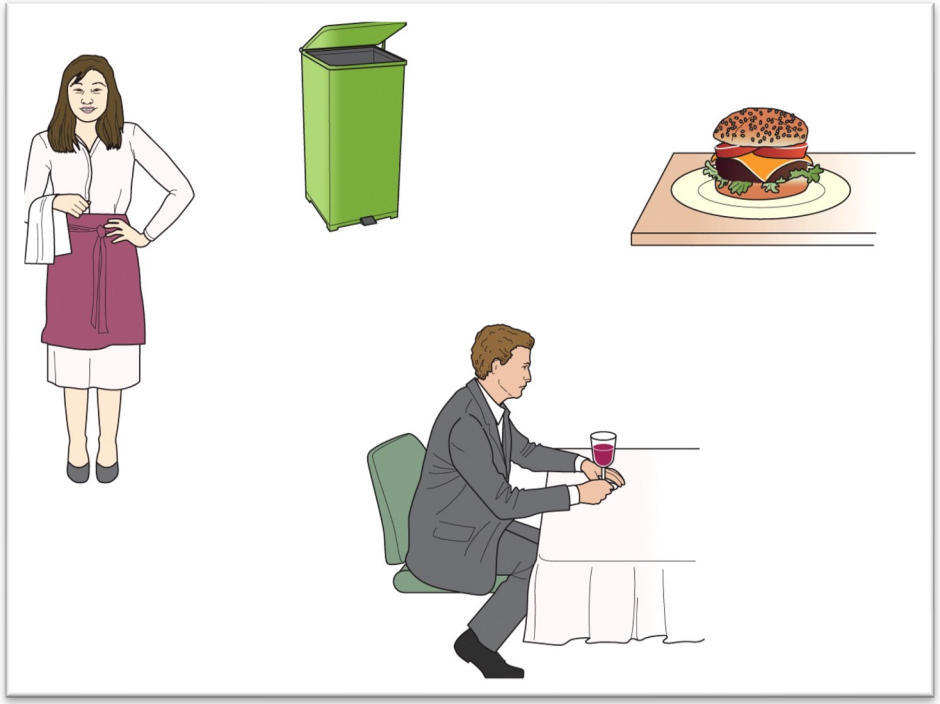
Japanese word order: *The waitress* *to the man* *happily* *the hamburger* *served.*

subject indirect object direct object verb

The role of prediction

- Case marking: when noun phrases (subject, object, etc.) in the sentence carry morphemes that indicate whether they are the subject or object of the verb

Note: you do not need to know what case marking is for the exam

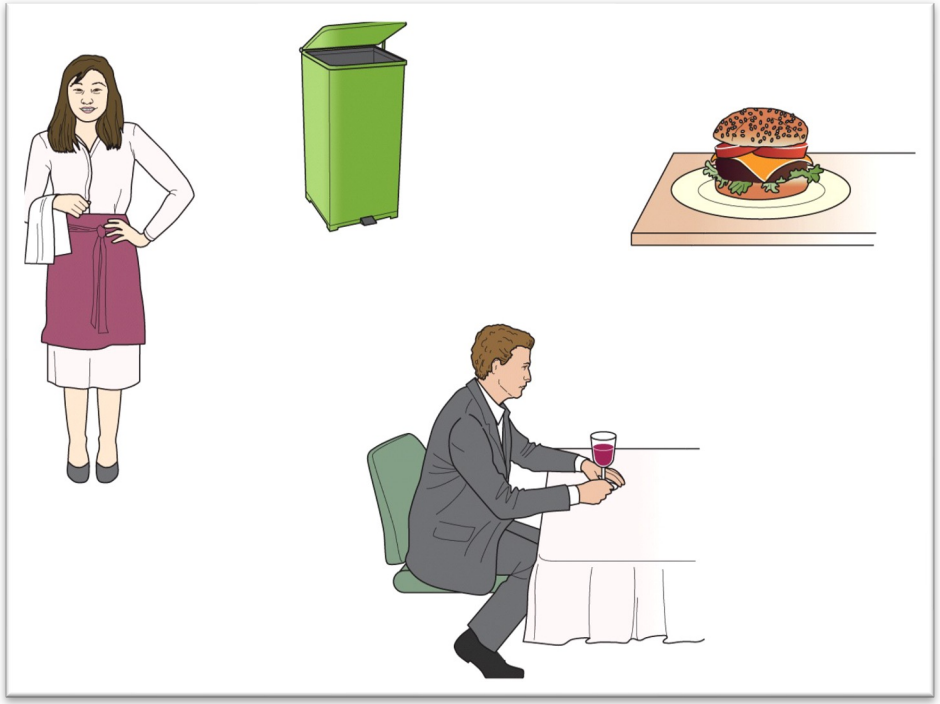


Japanese word order: *The waitress* *to the man* *happily* *the hamburger* *served.*

subject indirect object direct object verb

The role of prediction

- Case marking: when noun phrases (subject, object, etc.) in the sentence carry morphemes that indicate whether they are the subject or object of the verb
- We don't need to wait for the verb to make predictions; we can use other sentence info



Japanese word order: *The waitress* *to the man* *happily* *the hamburger* *served.*

subject indirect object direct object verb

Processing strategies

1. When Mary was knitting the socks fell to the floor.
2. (a) When that moves the square will…
   (b) When that moves the square it'll…
3. John said that Sue left yesterday.

What is the first interpretation that you get for each sentence or fragment?

Processing strategies

1. When Mary was knitting, the socks fell to the floor.
2. (a) When that moves, the square will…
   (b) When that moves the square, it'll…
3. John said that [Sue left] yesterday.
   John said that [Sue left yesterday].

What interpretations do you get now?

Processing strategies

1. When Mary was knitting the socks fell to the floor.

- **Early closure**: *knitting* ends the clause, and *the socks* is the subject of the verb *fell*
  - If speakers use this processing strategy, they think that "When Mary was knitting" is a good and complete clause, and they close off the clause at that point. *The socks*, when it is heard or read, is interpreted as the subject of the next clause ("the socks fell on the floor")
  - This results in the correct interpretation of the sentence

Frazier (1978)

Processing strategies

1. **When Mary was knitting** the socks fell to the floor.

- **Late closure**: *the socks* ends the clause as the object of *knitting*, resulting in a garden path effect at *fell*
  - If speakers use this processing strategy, they wait to close off the clause until after *the socks;* they interpret the first clause as "When Mary was knitting the socks…"
  - This results in the incorrect interpretation of the sentence
  - So when they hear or read "fell", they have to **reinterpret the sentence**

Frazier (1978)

Processing strategies

1. **When Mary was knitting** the socks fell to the floor.

- **Late closure**: *the socks* ends the clause as the object of *knitting*, resulting in a garden path effect at *fell*

- English speakers typically use the late closure strategy, resulting in a garden path effect
- But not all languages use late closure as the default processing strategy!
  - For example, Russian speakers use **early closure**

Frazier (1978)

Processing strategies

- Another example of late vs. early closure
  1. When Roger leaves the house is dark.
  2. When Roger leaves the house it's dark.
- We see increased reading times at *is* in (1) when we test English speakers
- But prosody helps the interpretation in speech (we can show this with a comma)
  1. When Roger leaves, the house is dark.
  2. When Roger leaves the house, it's dark.

Key concepts

- ✓Grammaticality vs. acceptability
- ✓Syntactic processing is automatic
- ✓Incremental processing
- ✓Syntactic ambiguity
  - ✓Local ambiguity
  - ✓Global ambiguity
- ✓The role of prediction in syntactic processing
- ✓The role of linguistic and visual context in syntactic processing
- ✓Processing strategies
  - ✓Late and early closure