

Ling 566  
Nov 4, 2010  
Grammar and Processing

# Overview

- Psycholinguistics and grammar design
  - What grammar has to say
  - What psychological evidence has to say
    - Acquisition
    - Production
    - Comprehension
- Universals

# What does grammar have to do with psychology?

Three ways it could be relevant:

- It provides insight into how children acquire language.
- It provides insight into how speakers produce utterances.
- It provides insight into how listeners understand utterances.

# Our model: Key characteristics

- Surface-oriented
- Constraint-based
- Lexicalist

# Chomsky's position:

- Grammar represents knowledge of language (“competence”).
- This is distinct from use of language (“performance”).
- We can draw a strong conclusion about language acquisition, namely, most grammatical knowledge is innate and task-specific.
- Serious study of language use (production and comprehension) depends on having a well-developed theory of competence.

# Brief remarks on language acquisition

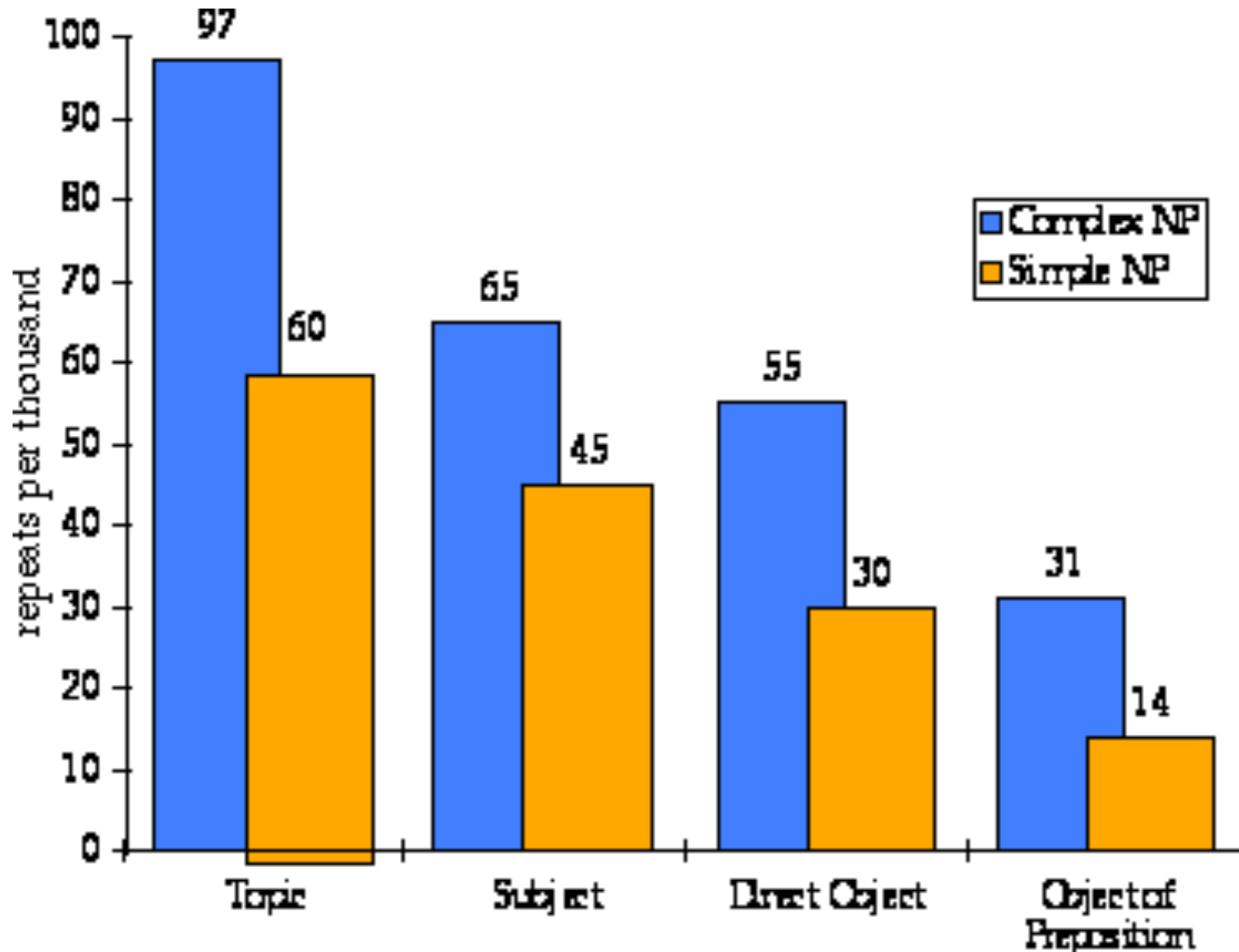
- Chomsky's nativism is very controversial
  - It is based on the “poverty of the stimulus” argument, and a model of learning as hypothesis testing.
  - The environment may be more informative than he assumes.
  - There may be more powerful learning methods than he assumes.
- There has not been much work on language acquisition using constraint-based lexicalist theories like ours; **but**
  - Explicit formulation is a prerequisite for testing learning models
  - Our feature structures could model richer context information.
- We're neutral with respect to this controversy.

# Production and Grammar

- Evidence for left-to-right effects
- Evidence for top-down planning

# Disfluencies are sensitive to structure:

Repeat rate of *the* varies with position and complexity of the NP it introduces:





# Production errors are sensitive to syntactic structure

Agreement errors are more common with PP complements than sentential complements: errors like (2) are significantly more common than errors like (1).

(1) *\*The claim that the wolves had raised the babies were rejected.*

vs.

(2) *\*The claim about the newborn babies were rejected.*

# So why?

- Speculation: Clauses are their own agreement domains, so people don't mistake an NP in a lower clause as a trigger for agreement
- Original work: Kay Bock (1980s).

# Some high-level sentence planning is necessary, too

- *Ich habe dem Mann, den ich gesehen habe geholfen.*  
I have the-dat man who-acc I seen have helped  
“I helped the man I saw”
- *Ich habe den Mann, dem ich geholfen habe gesehen.*  
I have the-acc man who-dat I helped have seen.  
“I saw the man I helped ”
- The choice between *dem* and *den* depends on the choice of verbs several words later.

# A production model should allow interaction of top-down and left-to-right information

- Grammar plays a role in production.
- Partial grammatical information should be accessible by the production mechanism as needed.
- This argues against grammatical theories that involve sequential derivations with fixed ordering.
- Our theory of grammar has the requisite flexibility.

# Comprehension

- Early work tried to use transformational grammar in modeling comprehension
- The Derivational Theory of Complexity: The psychological complexity of a sentence increases with the number of transformations involved in its derivation.
- Initial results seemed promising, but later work falsified the DTC.

# Some relevant quotes

- “The results show a remarkable correlation of amount of memory and number of transformations”  
– Chomsky, 1968
- “[I]nvestigations of DTC...have generally proved equivocal. This argues against the occurrence of grammatical derivations in the computations involved in sentence recognition”  
– Fodor, Bever, & Garrett, 1974

# Another quote

- “Experimental investigations of the psychological reality of linguistic structural descriptions have...proved quite successful.”  
– Fodor, Bever, & Garrett, 1974
- In particular, they concluded that “deep structures” and “surface structures” were psychologically real, but the transformations relating them weren’t.

# Early Evidence for the Psychological Reality of Deep Structures

- The proposed DS for (2) had three occurrences of *the detective*, while the proposed DS for (1) had only two:
  - (1) *The governor asked the detective to prevent drinking.*
  - (2) *The governor asked the detective to cease drinking.*
- In a recall experiment, *detective* was significantly more effective in prompting people to remember (2) than (1)



# Typical Problem Cases for the DTC

- (1) *Pat swam faster than Chris swam.*
- (2) *Pat swam faster than Chris did.*
- (3) *Pat swam faster than Chris.*

- The DTC predicts that (1) should be less complex than (2) or (3), because (2) and (3) involve an extra deletion transformation.
- In fact, subjects responded more slowly to (1) than to either (2) or (3).

# What should a psychologically real theory of grammar be like?

- The “deep structure” distinctions that are not evident on the surface should be represented.
- The transformational operations relating deep and surface structures should not be part of the theory.
- Our information-rich trees include all of the essential information in the traditional deep structures, but without the transformations.

# Jerry Fodor claims the human mind is “modular”

“A module is...an informationally encapsulated computational system -- an inference-making mechanism whose access to background information is constrained by general features of cognitive architecture.”

-- Fodor, 1985

A central issue in psycholinguistics over the past 20 years has been whether language is processed in a modular fashion.

# Tanenhaus's Eye-Tracking Experiments

- Participants wear a device on their heads that makes a videotape showing exactly what they're looking at.
- They listen to spoken instructions and carry out various tasks.
- They eye-tracking provides evidence of the cognitive activity of participants that can be correlated with the linguistic input.

# Non-linguistic visual information affects lexical access

- Participants' gaze settled on a referent before the word was completed, unless the initial syllable of the word was consistent with more than one object.
- For example, participants' gaze rested on the pencil after hearing *Pick up the pencil* more slowly when both a pencil and a penny were present.

# Non-linguistic visual information affects syntactic processing

- Eye movements showed that people hearing (1) often temporarily misinterpreted *on the towel* as the destination.  
(1) *Put the apple on the towel in the box.*
- When *on the towel* helped them choose between two apples, such misparses were significantly less frequent than when there was only one apple.

# General Conclusion of Eye-Tracking Studies

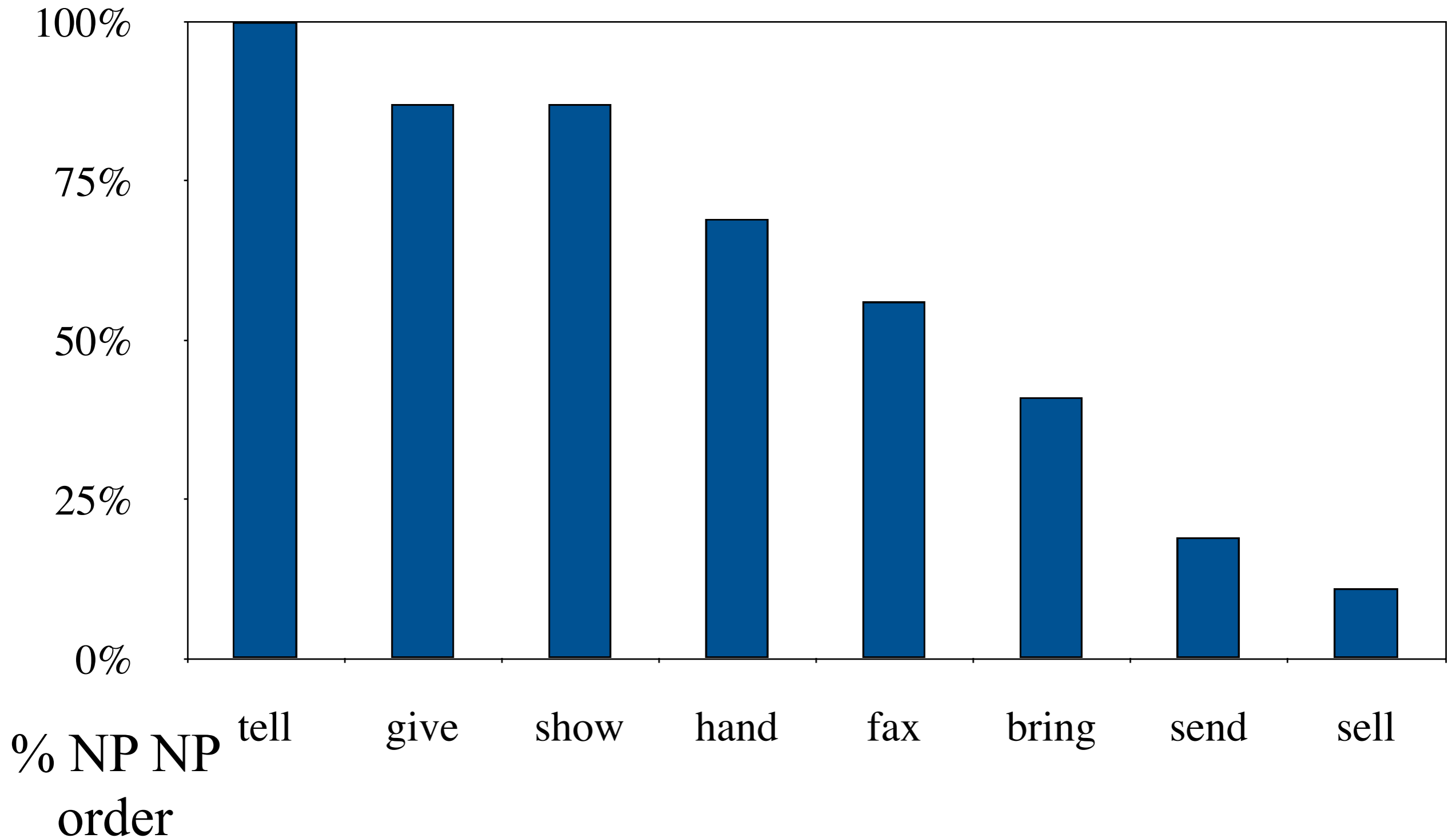
- People use whatever information is available as soon as it is useful in interpreting utterances.
- This argues against Fodorian modularity.
- It argues for a model of language in which information is represented in a uniform, order-independent fashion.

# Speakers know a great deal about individual words

- Individual lexical items have many idiosyncrasies in where they can occur, and in where they tend to occur.
- For example, the verb *behoove* occurs only with the subject *it* (and only in certain verb forms), and the verb *beware* has only the base form.
- We also know that the transitive use of *walk* is much rarer than the intransitive.



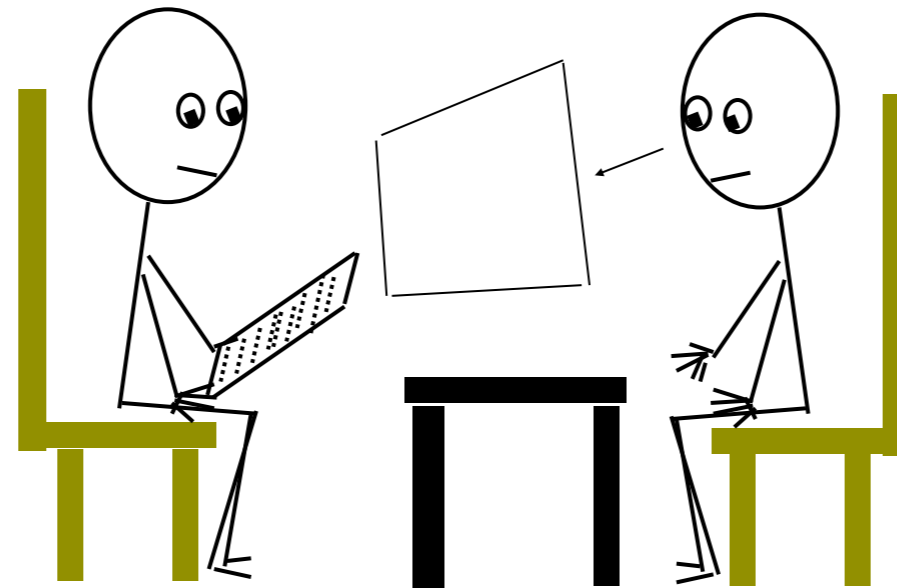
# V-NP-NP vs. V-NP-PP Frequency in the *NYT*



# Lexical biases influence processing

- Wasow et al ran a production experiment to test whether ambiguity avoidance would influence speakers' choice between (1) and (2):
  - (1) *They gave Grant's letters to Lincoln to a museum.*
  - (2) *They gave a museum Grant's letters to Lincoln.*
- Lexical bias of the verbs turned out to be a significant predictor of which form speakers used (and ambiguity avoidance turned out not to be).

# Experimental Method



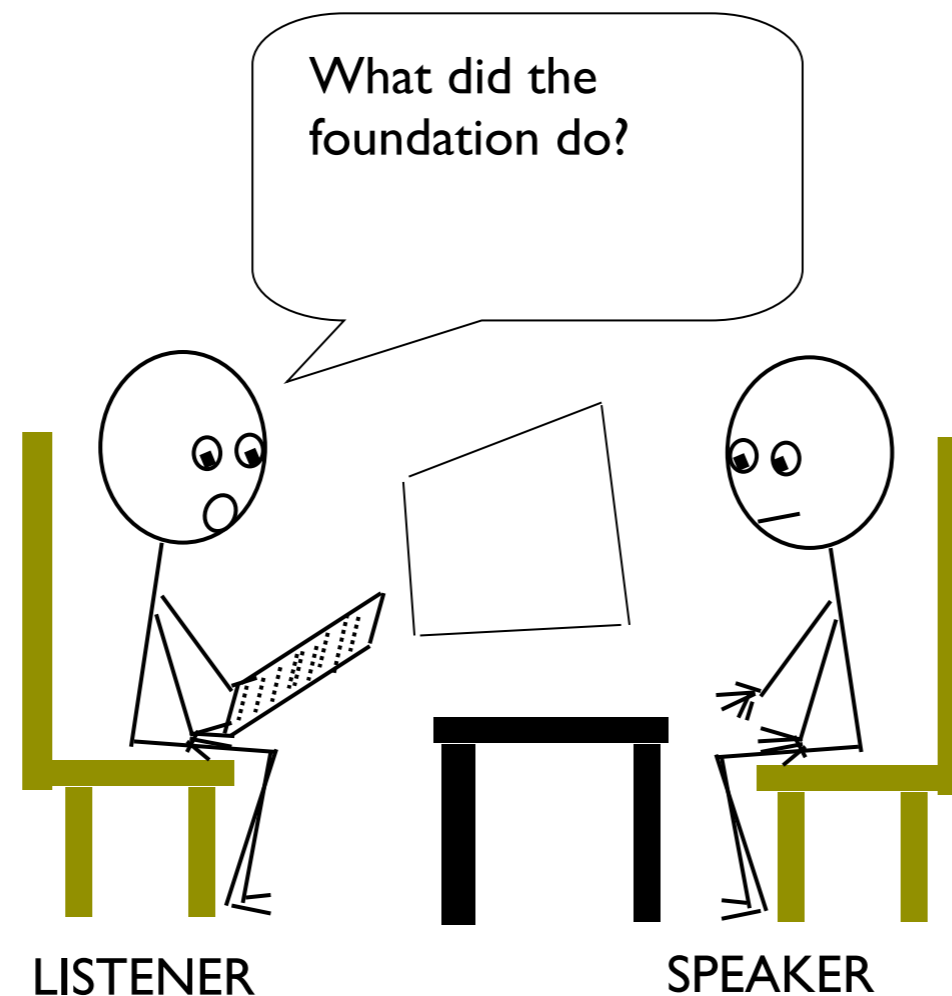
LISTENER

SPEAKER

1. Speaker silently reads a sentence:

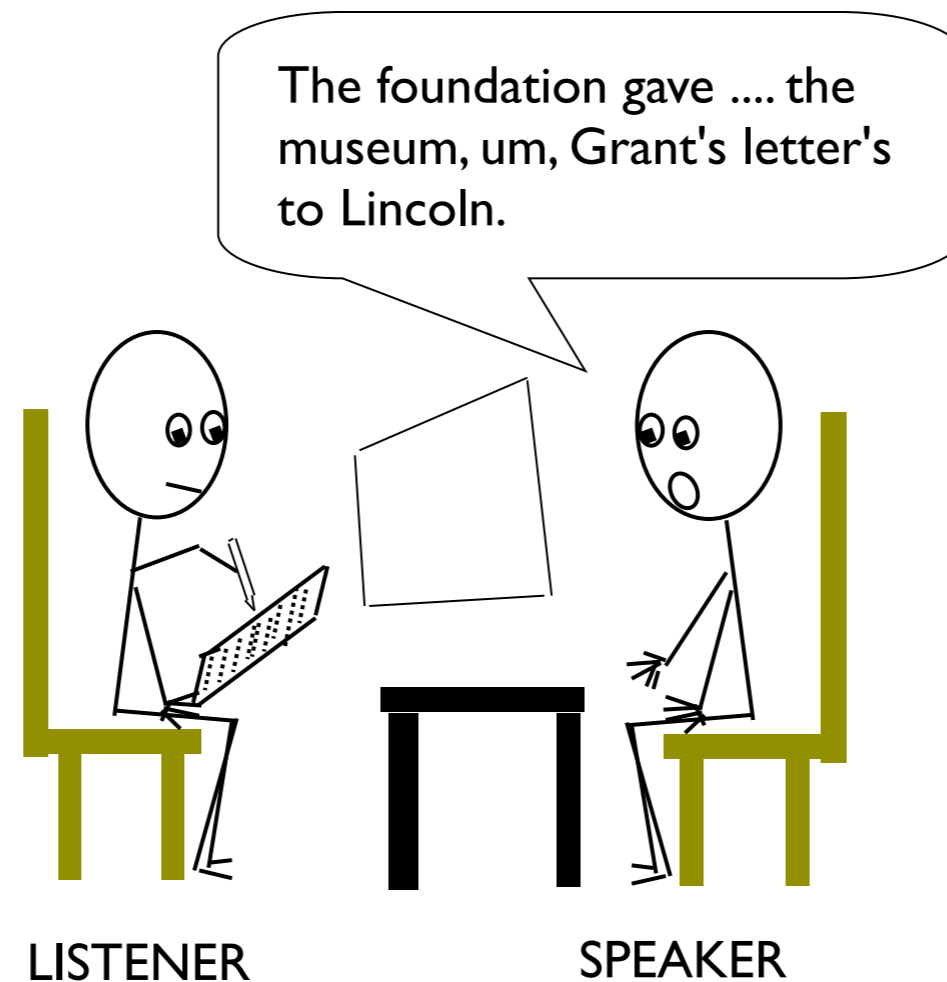
*A museum in Philadelphia received Grant's letters to Lincoln from the foundation.*

# Experimental Method, continued



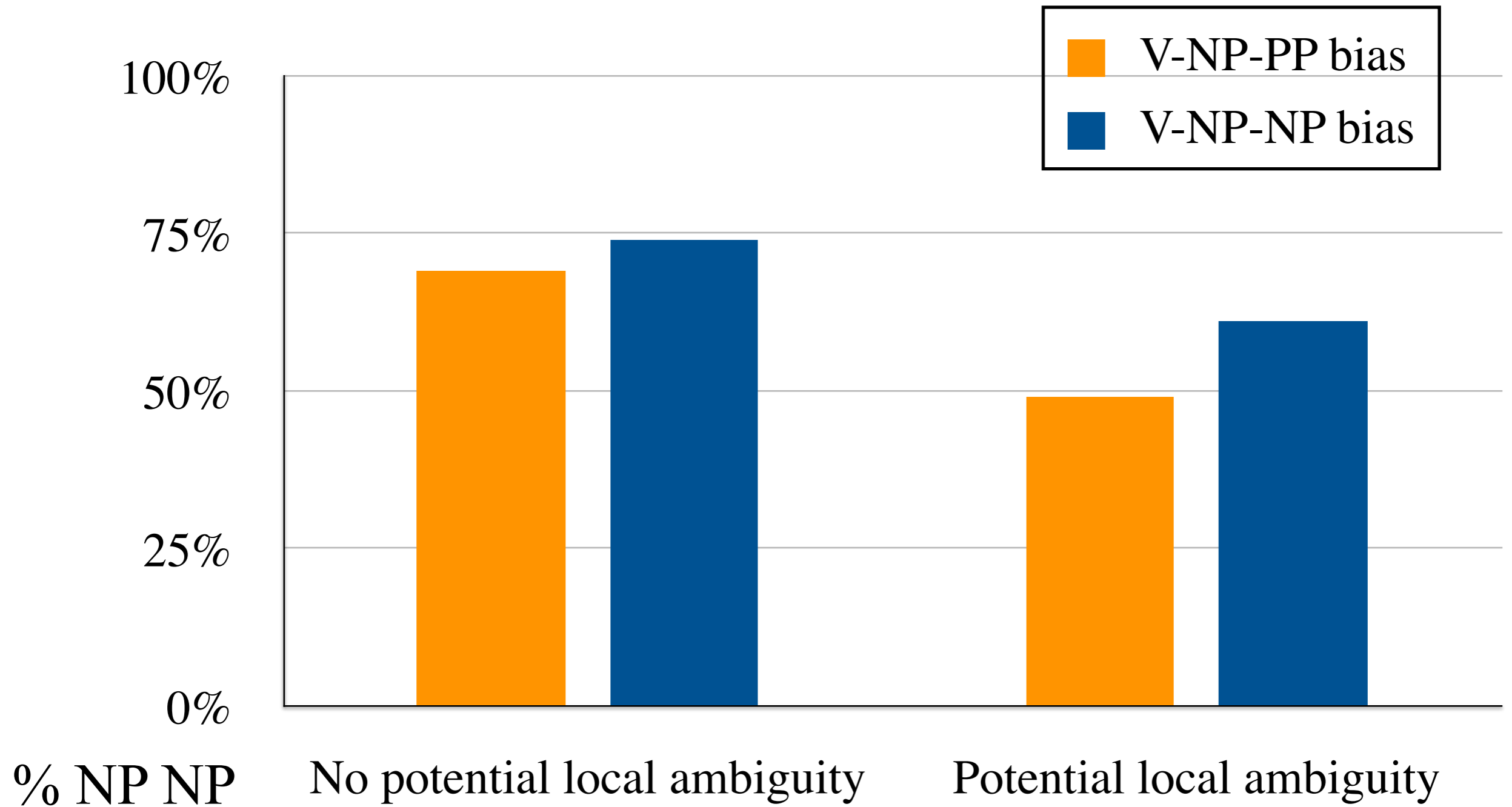
2. The sentence disappears from the screen.  
The listener reads the next question from a list.

# Experimental Method, continued



3. The speaker answers the listener's question.  
The listener chooses the correct response on a list (from two choices).

# Experimental Results on Local Ambiguity



# *Reverse ambiguity effect*

- Arnold, Wasow, Asudeh & Alrenga 2004  
*Journal of Memory & Language*
- Re-ran the experiment with slightly better methodology and found a *stronger* reverse ambiguity effect.

# A psychologically real grammar should be lexicalist

- Early generative grammars downplayed the lexicon.
- Now, however, the importance of the lexicon is widely recognized.
- This aspect of grammar has been developed in greater detail in our theory than in any other.
- It would be easy to add frequency information to our lexicon, though there is debate over the wisdom of doing so.



# Conclusion

- Grammatical theory should inform and be informed by psycholinguistic experimentation.
- This has happened less than it should have.
- Existing psycholinguistic evidence favors a constraint-based, lexicalist approach (like ours).

# Universals?

- P&P (top-down): attempts to relate multiple typological properties to single parameters.
- Grammar Matrix (bottom-up): attempts to describe many languages in a consistent framework and then takes stock of common constraints.

# Universals?

- Case constraint
- SHAC
- Binding theory
- Head-complement/-specifier/-modifier
- Head Feature Principle
- Valence Principle
- Semantic Compositionality Principle
- ...

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