JMORF/MORS — Morpho-Syntax

Grammar and Processing

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Lecture 8
Location: KB-1.11

Overview

- Grammar and psychology: competence, performance and acquisition
- Production
- Comprehension
- Lexical knowledge in processing
- Universals
- Problem: constant rules

Grammar and Psychology

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

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:

- More common in front of complex NPs
- More common with prominent NPs
  Topic > Subject > Direct Object > Preposition Object

(1) *The the book I told the student about on the train*
(2) > *The book I told the the student about on the train*
(3) > *The book I told the student about on the the train*

Production Errors Are Sensitive to Syntactic Structure

- Agreement errors are more common with PP complements than sentential complements: errors like (5) are significantly more common than errors like (4).

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

  (5) > **The claim about the newborn babies were rejected.*

- 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

(6) *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."

(7) *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.

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

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)

- "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.

Evidence for the Psychological Reality of Deep Structures

- The proposed Deep Structure for (9) had three occurrences of ***detective***, while the proposed DS for (8) had only two:

  (8) *The governor asked the detective to prevent drinking.*

  (9) *The governor asked the detective to cease drinking.*

- In a recall experiment, ***detective*** was significantly more effective in prompting people to remember (9) than (8).

Typical Problem Cases for the DTC

(10) *Pat swam faster than Chris swam.*

(11) *Pat swam faster than Chris did.*

(12) *Pat swam faster than Chris.*

- The DTC predicts that (10) should be less complex than (11) or (12), because (11) and (12) involve an extra deletion transformation.

- In fact, subjects responded more slowly to (10) than to either (11) or (12).

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.
- The 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 **p**encil and a **p**enny were present.

Non-Linguistic Visual Information Affects Syntactic Processing

- Eye movements showed that people hearing (13) often temporarily misinterpreted *on the towel* as the destination.

  (13) *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

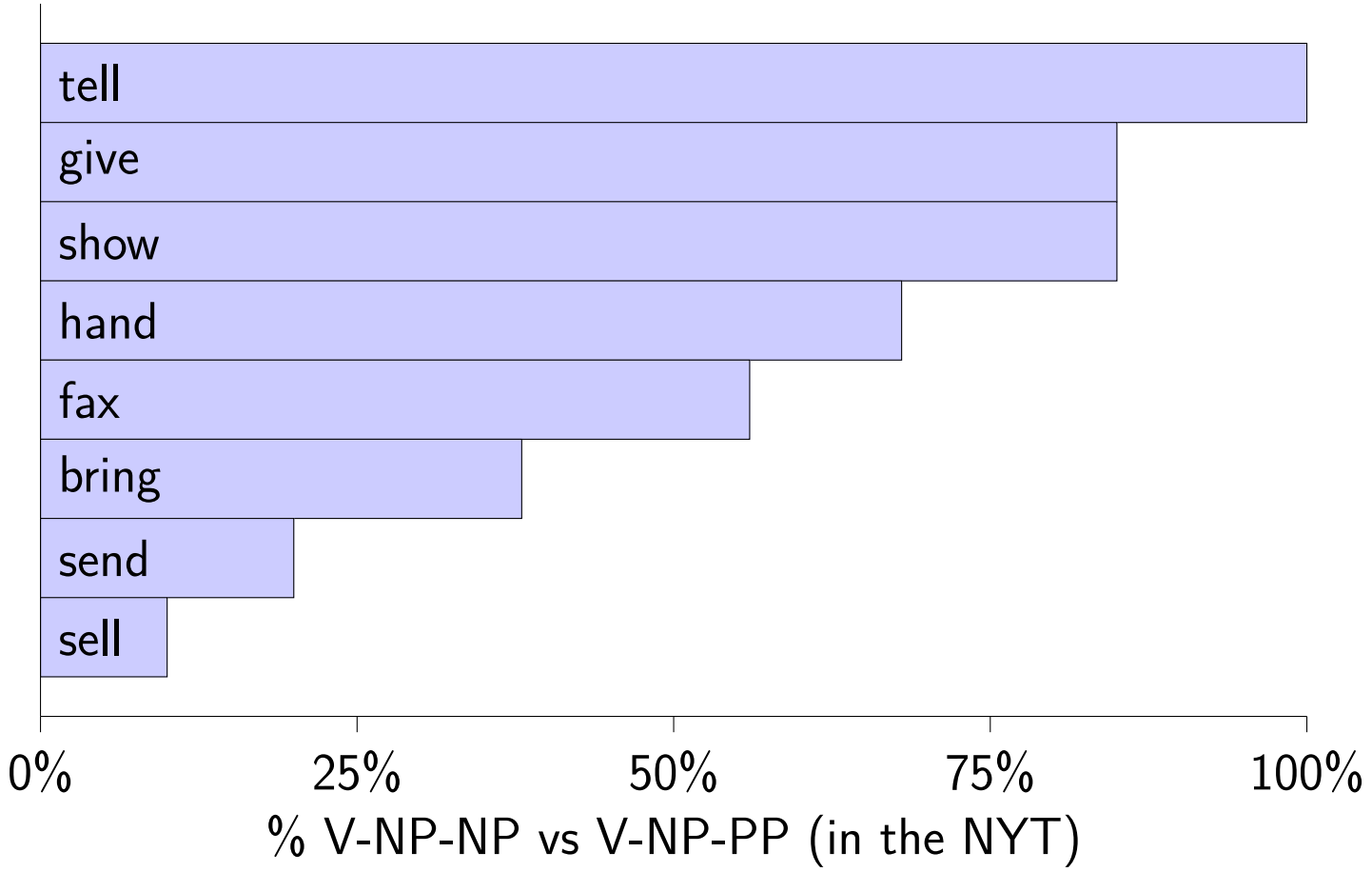
- People use whatever information is available as soon as it is useful in interpreting utterances.
- This argues against Fodorian modularity.
- It argues for a model of language in which information is represented in a uniform, order-independent fashion.

Lexical Knowledge in Processing

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.

Different Verbs Favor Different COMPS Lists



Lexical Biases Influence Processing

- Wasow et al. ran a production experiment to test whether ambiguity avoidance would influence speakers' choice between (14) and (15):

  (14) *They gave Grant's letters to Lincoln to a museum.* NP-PP

  (15) *They gave a museum Grant's letters to Lincoln.* NP-NP

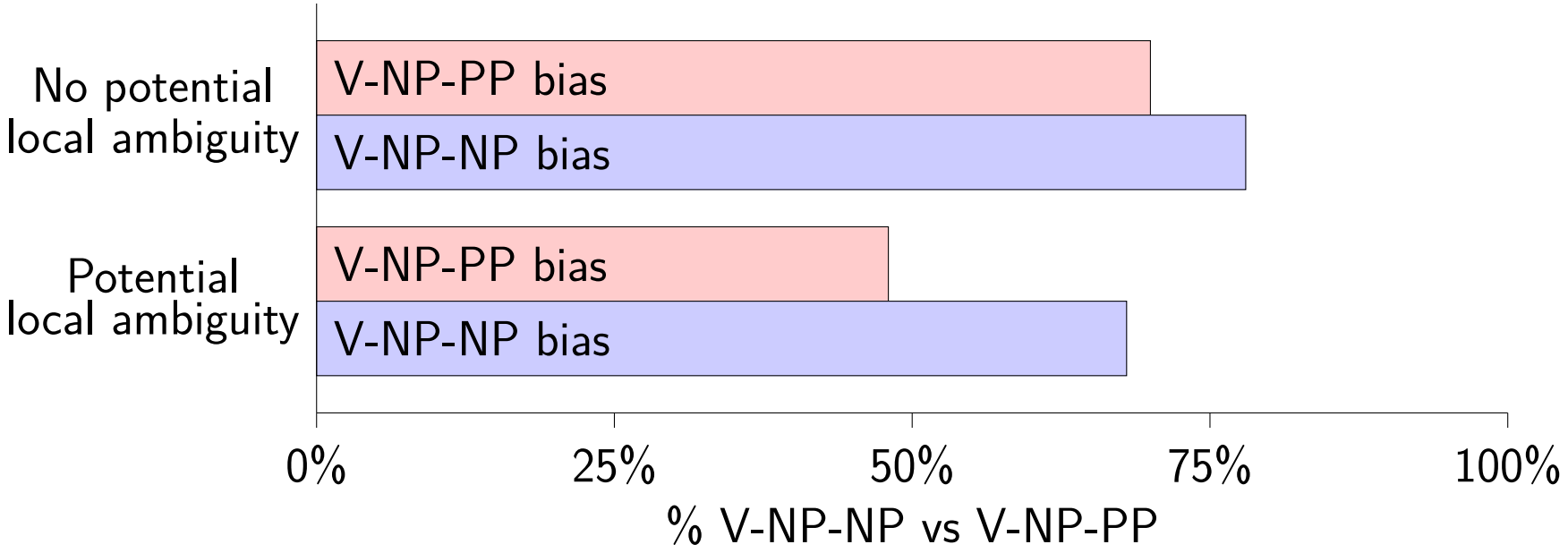
- Ambiguity avoidance predicts that you should prefer (15).

- 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

- Speaker and Listener sit next to each other. Speaker can see a screen.
- Speaker silently reads a sentence shown on the screen
  A museum in Philadelphia received Grant's letters to Lincoln from the foundation.
- The sentence disappears from the screen.
- Listener asks a question:
  What did the foundation do?
- The speaker answers the listener's question.
  The foundation gave ... the museum, um, Grant's letters to Lincoln.
- The listener records which kind of response on a list (from two choices).

Experimental Results on Local Ambiguity



- Arnold, Wasow, Asudeh & Alrenga (2004: *Journal of Memory & Language*) re-ran the experiment with slightly better methodology and found an even 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 HPSG than in any other theory.
- It would be easy to add frequency information to the lexicon, though there is debate over the wisdom of doing so.
- Frequency is currently recorded as part of the **parse ranking model**s that select the most plausible out of all possible interpretations.

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 HPSG, LFG, construction grammar).

Universals

Universals?

- **Principles and Parameters (P&P)**: attempts to relate multiple typological properties to single parameters (top-down).

- **Grammar Matrix**: attempts to describe many languages in a consistent framework and then takes stock of common constraints (bottom-up).

  – Until we know more detail about more languages, we cannot test theories properly
  – So describing languages in precise detail is very important
  – HPSG is fully in the tradition of language documentation
  – The AGGREGATION Project[1] attempts to automate the construction of grammar fragments from language descriptions, building on interlinear glossed text (IGT) and using the Grammar Matrix

[1] Automatic Generation of Grammars for Endangered Languages from Glosses and Typological Information

Universals?

- Case Constraint
- SHAC
- Binding theory
- Head-Complement, Head-Specifier and Head-Modifier Rules
- Head Feature Principle
- Valence Principle
- Semantic Compositionality Principle
- ...

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Problem

P1: Constant Rules

The Singular Noun Lexical Rule, the Non-3rd-Singular Verb Lexical Rule, and the Base Form Lexical Rule are all inflectional lexical rules (*i-rule*s) that have no effect on the shape (i.e. the phonology) of the word.

A. Explain why we need these rules anyway.

B. Each of these rules has lexical exceptions, in the sense that there are lexemes that idiosyncratically don't undergo them. Thus, there are some nouns without singular forms, verbs without non-third-person singular present tense forms, and verbs without base forms. List any you can think of. The verb part is HARD.

Acknowledgments and References

- Course design and slides borrow heavily from Emily Bender's course: *Linguistics 566: Introduction to Syntax for Computational Linguistics* http://courses.washington.edu/ling566

- This lecture complements Sag et al. (2003, Chapter 9)

References

Ivan A. Sag, Tom Wasow, and Emily Bender. 2003. *Syntactic Theory: A Formal Introduction*. CSLI Publications, Stanford, second edition.