JMORF/MORS — Morpho-Syntax

Binding Theory

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Lecture 6
Location: KB-1.11

Overview

- Review: what we are trying to do; last week's semantics
- The informal binding theory from Chapter 1
- Formalizing binding theory: ARG-ST, the ARP and the Binding Principles
- Binding and PPs
- Imperatives
- Problems: possessives, imperative 'subjects'

Review

What We're Trying To Do

- Objectives
  - Develop a theory of knowledge of language
  - Represent linguistic information explicitly enough to distinguish well-formed from ill-formed expressions
  - Assign plausible semantic representations
  - Be parsimonious, capturing linguistically significant generalizations

- Why formalize?
  - To formulate testable predictions
  - To check for consistency
  - To make it possible to get a computer to do it for us

How We Construct Sentences

- The components of our grammar
  - Grammar rules
  - Lexical entries
  - Principles
  - Type hierarchy (very preliminary, so far)
  - Initial symbol (S, for now)

$$\mathsf{S} = \begin{bmatrix} \textsc{head} & \textit{verb} \\ \textsc{val} & \begin{bmatrix} \textsc{spr} & \langle\rangle \\ \textsc{comps} & \langle\rangle \end{bmatrix} \end{bmatrix}$$

- We combine constraints from these components.

Review of Semantics

- Which aspects of semantics we'll tackle
- Semantics Principles
- Building semantics of phrases
- Modification, coordination
- Structural ambiguity

Our Slice of a World of Meanings

Aspects of meaning we won't account for (in this course)

- Pragmatics
- Fine-grained lexical semantics
  The meaning of *life* is
  - `life` or life′ or $\begin{bmatrix} \text{RELN} & \textit{life} \\ \text{INST} & i \end{bmatrix}$
  - Not like WordNet: $\texttt{life}_1 \subset \texttt{being}_1 \subset \texttt{state}_1$ ...
- Quantification (covered lightly in the book)
- Tense, mood, aspect (covered in the book)

Our Slice of a World of Meanings

$$\begin{bmatrix} \text{MODE} & \textit{prop} \\ \text{INDEX} & s \\ \text{RESTR} & \left\langle \begin{bmatrix} \text{RELN} & \textbf{save} \\ \text{SIT} & s \\ \text{SAVER} & i \\ \text{SAVED} & j \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{name} \\ \text{NAME} & \textit{Chris} \\ \text{NAMED} & i \end{bmatrix}, \begin{bmatrix} \text{RELN} & \textbf{name} \\ \text{NAME} & \textit{Pat} \\ \text{NAMED} & j \end{bmatrix} \right\rangle \end{bmatrix}$$

"...the linguistic meaning of *Chris saved Pat* is a proposition that will be true just in case there is an actual situation that involves the saving of someone named Pat by someone named Chris."

(Sag et al., 2003, p. 140)

Semantics in Constraint-Based Grammar

- Constraints as (generalized) truth conditions
  - **proposition**: what must be the case for a proposition to be true
  - **directive**: what must happen for a directive to be fulfilled
  - **question**: the kind of situation the asker is asking about
  - **reference**: the kind of entity the speaker is referring to

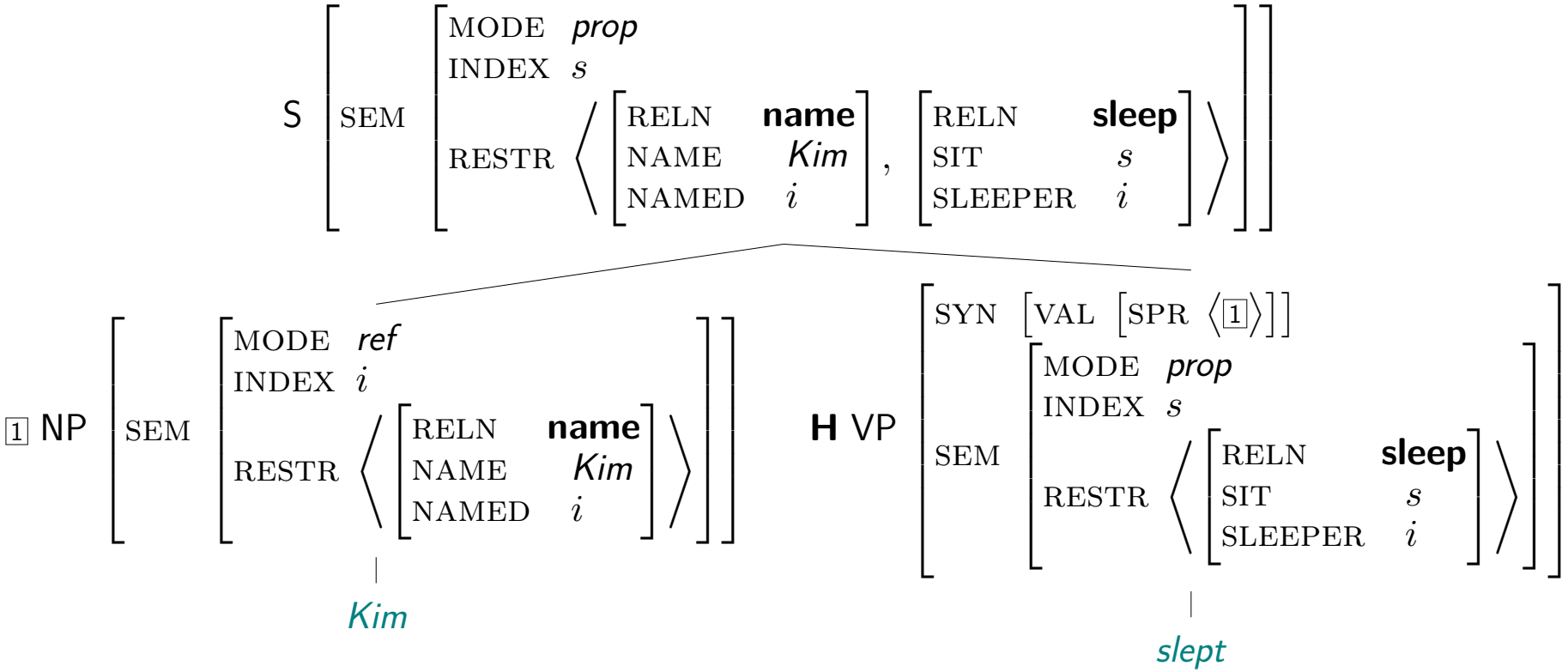
- **Syntax/semantics interface**:

  Constraints on how syntactic arguments are related to semantic ones, and on how semantic information is compiled from different parts of the sentence.

Feature Geometry

$$\begin{bmatrix} \textit{expression} & & \\ \text{SYN} & \begin{bmatrix} \textit{syn-cat} & \\ \text{HEAD} & \begin{bmatrix} \textit{pos} \\ \dots \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{SPR} & \langle \dots \rangle \\ \text{COMPS} & \langle \dots \rangle \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \textit{sem-cat} & \\ \text{MODE} & \{\text{PROP, QUES, DIR, REF, NONE}\} \\ \text{INDEX} & \{\text{I, J, K, ..., } \text{S}_1\text{, } \text{S}_2\text{, ...}\} \\ \text{RESTR} & \langle \dots \rangle \end{bmatrix} \end{bmatrix}$$

An Example


S
SEM
MODE prop
INDEX s
RESTR
RELN name
NAME Kim
NAMED i
RELN sleep
SIT s
SLEEPER i
1 NP
SEM
MODE ref
INDEX i
RESTR
RELN name
NAME Kim
NAMED i
Kim
H VP
SYN
VAL
SPR
1
SEM
MODE prop
INDEX s
RESTR
RELN sleep
SIT s
SLEEPER i
slept

How to Share Semantic Information

- **The Semantic Inheritance Principle**

  In any headed phrase, the mother's MODE and INDEX are identical to those of the head daughter.

- **The Semantic Compositionality Principle**

  In any well-formed phrase structure, the mother's RESTR value is the sum of the RESTR values of the daughters.

Where Is the Information?

- Words
  - Contribute predications
  - 'Expose' one index in those predications, for use by words or phrases
  - Relate syntactic arguments to semantic arguments

- Rules
  - Identify (link) feature structures across daughters
  - License trees that are subject to the semantic principles
    - SIP: 'passes up' MODE and INDEX from head daughter
    - SCP: 'gathers up' predications (RESTR list) from all daughters

- The semantics is strictly compositional — all of the meaning comes from the words, rules and principles.

The Informal Binding Theory

Some Examples from Chapter 1

(1) *She likes herself.*
(2) **She*$_i$ *likes her*$_i$*.*
(3) *We gave presents to ourselves.*
(4) **We gave presents to us.*
(5) *We gave ourselves presents.*
(6) **We gave us presents.*
(7) **Leslie told us about us.*
(8) *Leslie told us about ourselves.*
(9) **Leslie told ourselves about us.*
(10) **Leslie told ourselves about ourselves.*

Some Terminology

- **Binding**: The association between a pronoun and an antecedent.
- **Anaphoric**: A term to describe an element (e.g. a pronoun) that derives its interpretation from some other expression in the discourse.
- **Antecedent**: The expression an anaphoric expression derives its interpretation from.
- **Anaphora**: The relationship between an anaphoric expression and its antecedent.

The Chapter 1 Binding Theory Reformulated

- Old formulation:
  - A reflexive pronoun must be an argument of a verb that has another preceding argument with the same reference.
  - A nonreflexive pronoun cannot appear as an argument of a verb that has a preceding coreferential argument.

- New formulation (version I):
  - **Principle A**: A reflexive pronoun must be bound by a preceding argument of the same verb.
  - **Principle B**: A nonreflexive pronoun may not be bound by a preceding argument of the same verb.

- The (opaque) names Principle A and B come from Chomsky (1981)

Some Challenges

- Replace notions of bound and preceding argument of the same verb by notions definable in our theory.

- Generalize the Binding Principles to get better coverage.

How can we do this?

Q What would be a natural way to formalize the notion of "bound" in our theory?

A Two expressions are bound if they have the same INDEX value ("are coindexed").

Q Where in our theory do we have information about a verb's arguments?

A In the verb's VAL features.

Q What determines the linear ordering of a verb's arguments in a sentence?

A The interaction of the grammar rules and the ordering of elements in the COMPS list.

Formalizing Binding Theory

The Argument Realization Principle

- For Binding Theory, we need a single list with both subject and complements.
- We introduce a feature ARG-ST, with the following property:

$$\left[\begin{array}{l} \textit{word} \\ \\ \textsc{syn} \quad \left[\textsc{val} \left[\begin{array}{ll}\textsc{spr} & \boxed{A} \\ \textsc{comps} & \boxed{B}\end{array}\right]\right] \\ \\ \textsc{arg-st} \ \boxed{A} \oplus \boxed{B} \end{array}\right]$$

- This is a constraint on the type *word*

Notes on ARG-ST

- It's neither in SYN nor SEM.
- It only appears on lexical heads (not appropriate for type *phrase*)
- No principle stipulates identity between ARG-STs.

The Binding Principles

- **Principle A**: A [MODE *ana*] element must be outranked by a coindexed element.
- **Principle B**: A [MODE *ref*] element must not be outranked by a coindexed element.

Formalization

- Definition: If A precedes B on some ARG-ST list, then A **outranks** B.
- Elements that must be **anaphoric** — that is, that require an antecedent — are lexically marked [MODE *ana*]. These include reflexive pronouns and reciprocals.
- Normal **referential** NPs, including pronouns, are marked [MODE *ref*].

Pronoun-Antecedent Agreement

- The Binding Principles by themselves don't block:

  (11) **I amused yourself.*
  (12) **He amused themselves.*
  (13) **She amused himself.*

- Coindexed NPs refer to the same entity, and AGR features generally correlate with properties of the referent.

- The **Anaphoric Agreement Principle** (AAP): Coindexed NPs agree.

Binding and PPs

Binding in PPs

- What do the Binding Principles predict about the following?

(14) *I brought a book with me.*

(15) **I brought a book with myself.*

(16) **I mailed a book to me.*

(17) *I mailed a book to myself.*

Two Types of Prepositions: the Intuition

- **Argument-marking**: Function like case markers in other languages, indicating the roles of NP referents in the situation denoted by the verb.

- **Predicative**: Introduce their own predication.

Formalization

- Argument-marking prepositions share their objects' MODE and INDEX values.
  - This is done with tagging in the lexical entries of such prepositions.
  - These features are also shared with the PP node, by the Semantic Inheritance Principle.
- Predicative prepositions introduce their own MODE and INDEX values.

Argument-Marking Preposition *to*

$$\left\langle \textit{to}, \begin{bmatrix} \textsc{syn} & \begin{bmatrix} \textsc{head} & \textit{prep} \\ \textsc{val} & \begin{bmatrix} \textsc{spr} & \langle\rangle \end{bmatrix} \end{bmatrix} \\ \textsc{arg-st} & \left\langle \textsc{np} \begin{bmatrix} \textsc{syn} & \begin{bmatrix} \textsc{head} & \begin{bmatrix} \textsc{case} & \textit{acc} \end{bmatrix} \end{bmatrix} \\ \textsc{sem} & \begin{bmatrix} \textsc{mode} & \boxed{1} \\ \textsc{index} & \boxed{2} \end{bmatrix} \end{bmatrix} \right\rangle \\ \textsc{sem} & \begin{bmatrix} \textsc{mode} & \boxed{1} \\ \textsc{index} & \boxed{2} \end{bmatrix} \end{bmatrix} \right\rangle$$

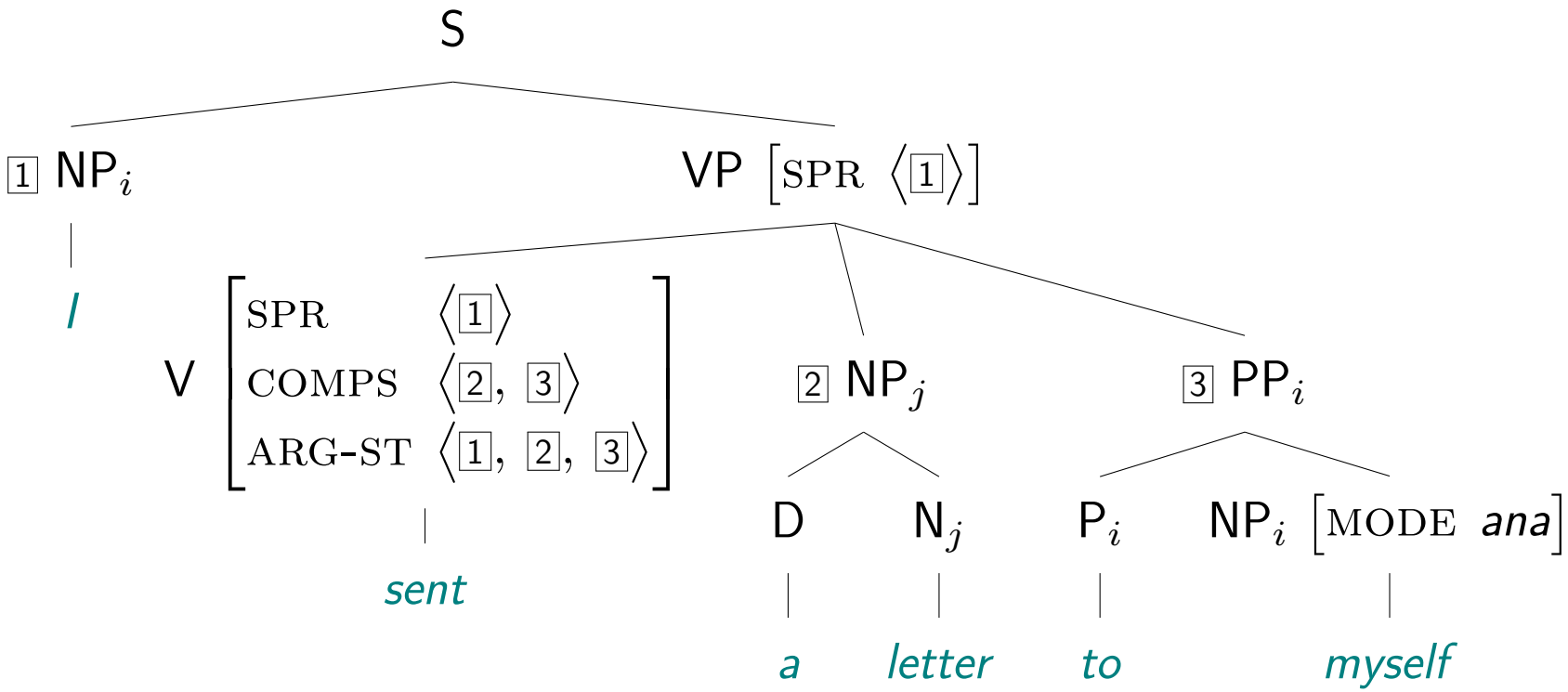
ARG-ST = spr $\oplus$ comps

Therefore COMPS here is a singleton list containing the NP, ...

Redefining Rank

- If there is an ARG-ST list on which A precedes B, then A outranks B.
- If a node is coindexed with its daughter, they are of equal rank — that is, they outrank the same nodes and are outranked by the same nodes.

I sent a letter to myself

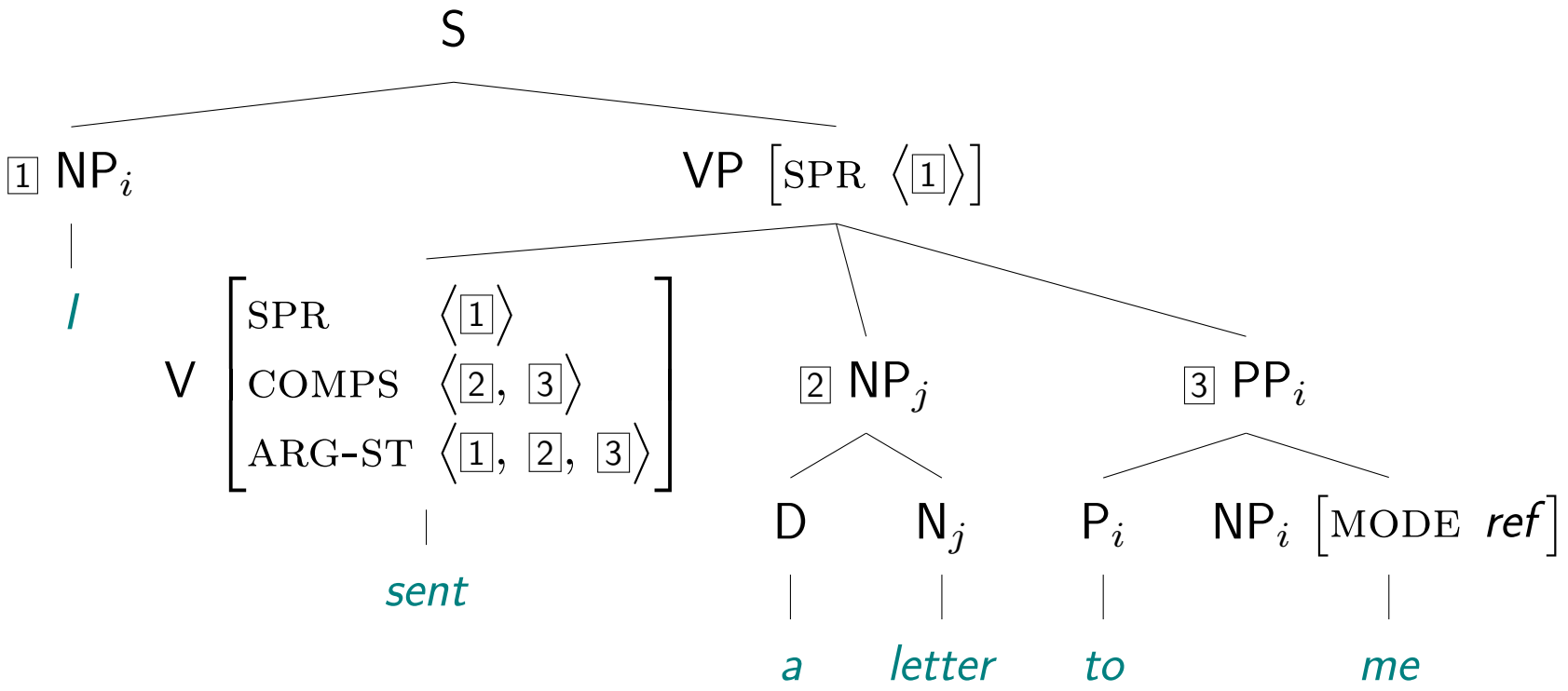


The ARG-ST

$$\left[\textsc{arg-st}\ \left\langle \mathrm{NP}_i\ \left[\textsc{mode}\ \textit{ref}\right],\ \mathrm{NP}_j\ \left[\textsc{mode}\ \textit{ref}\right],\ \mathrm{PP}_i\ \left[\textsc{mode}\ \textit{ana}\right]\right\rangle\right]$$

- The PP is outranked by the first NP. (Why?)
- *myself* has the same rank as the PP. (Why?)
- So, *myself* is outranked by the first NP. (Why?)
- Therefore, Principle A is satisfied: A [MODE *ana*] element must be outranked by a coindexed element.

*I sent a letter to me

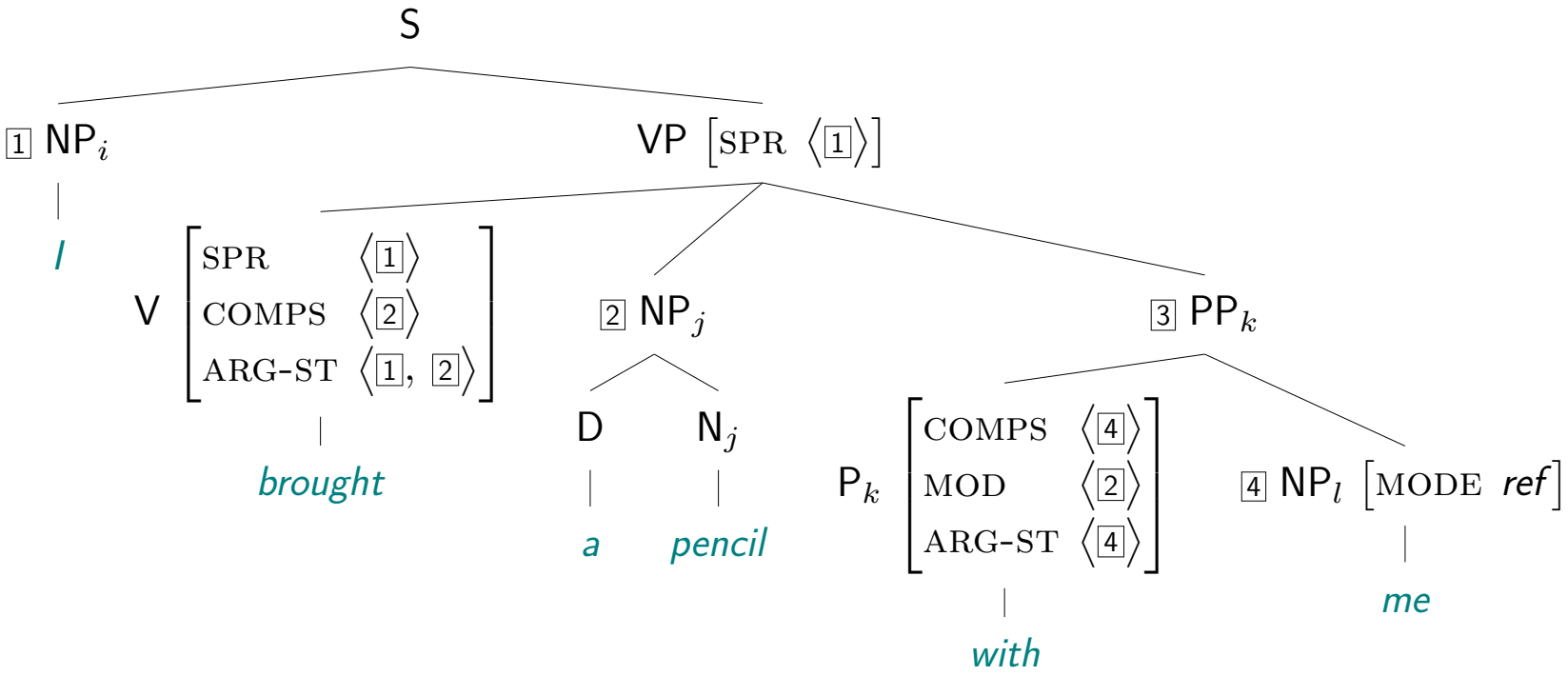


The ARG-ST

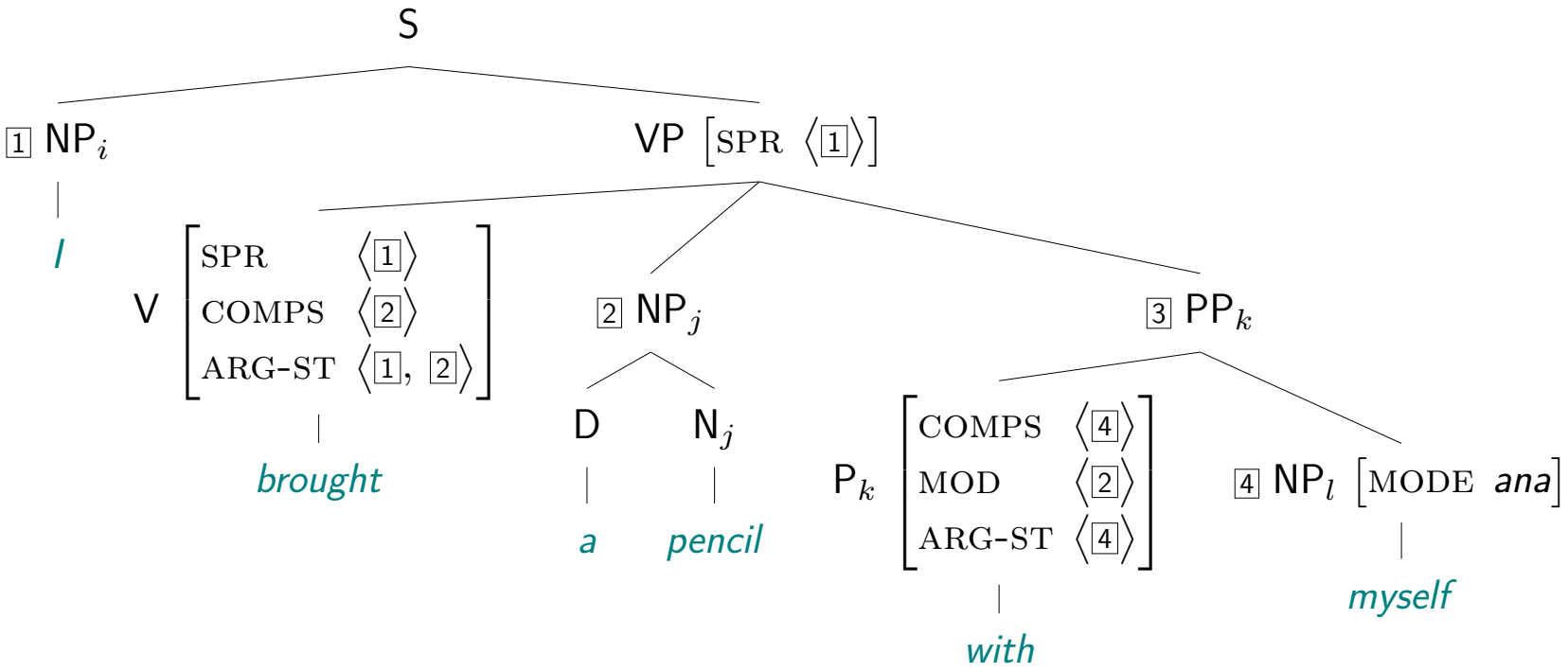
$$\left[\textsc{arg-st}\ \left\langle \mathrm{NP}_i\ \left[\textsc{mode}\ \textit{ref}\right],\ \mathrm{NP}_j\ \left[\textsc{mode}\ \textit{ref}\right],\ \mathrm{PP}_i\ \left[\textsc{mode}\ \textit{ref}\right]\right\rangle\right]$$

- The PP is outranked by the first NP.
- *me* has the same rank as the PP.
- So, *me* is outranked by the first NP.
- Therefore, Principle B is violated: A [MODE *ref*] element must not be outranked by a coindexed element.

I brought a pencil with me



*I brought a pencil with myself



Imperatives

Imperatives

- Have the internal structure of a VP

  (18) *Leave!*
  (19) *Read a book!*
  (20) *Give the dog a treat!*
  (21) *Put the ice cream in the freezer!*

- Function as **directives** (commands or requests)

- Have the verb in base form: *Be careful!* not **Are careful!*

- Allow 2nd person reflexives, and no others

  (22) *Defend yourself!*
  (23) **Defend myself/himself!*

The Imperative Rule

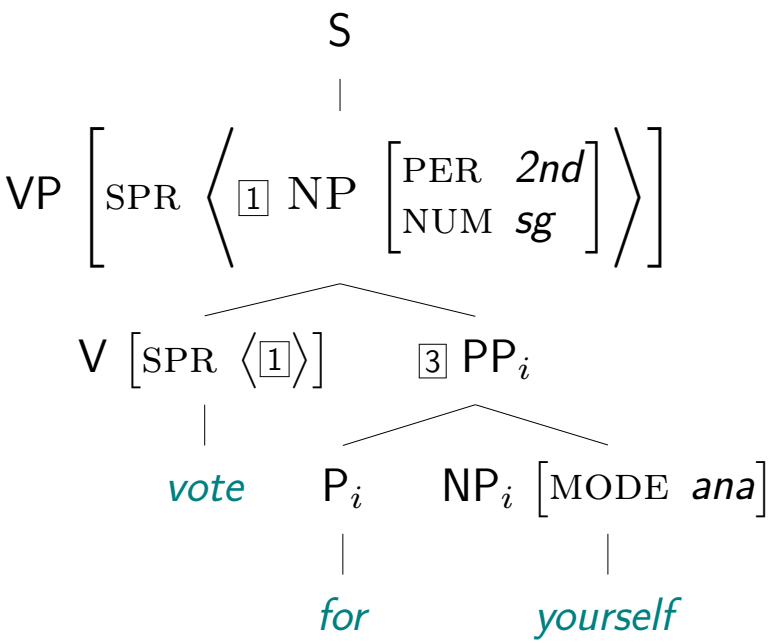
$$\begin{bmatrix} \textit{phrase} \\ \text{HEAD} \;\; \textit{verb} \\ \text{VAL} \;\; \begin{bmatrix} \text{SPR} \;\; \langle\rangle \end{bmatrix} \\ \text{SEM} \;\; \begin{bmatrix} \text{MODE} \;\; \textit{dir} \\ \text{INDEX} \;\; s \end{bmatrix} \end{bmatrix} \rightarrow \begin{bmatrix} \textit{phrase} \\ \text{HEAD} \;\; \begin{bmatrix} \textit{verb} \\ \text{FORM} \;\; \textit{base} \end{bmatrix} \\ \text{VAL} \;\; \begin{bmatrix} \text{SPR} \;\; \left\langle \text{NP} \;\; \begin{bmatrix} \text{PER} \;\; \textit{2nd} \end{bmatrix} \right\rangle \\ \text{COMPS} \;\; \langle\rangle \end{bmatrix} \\ \text{SEM} \;\; \begin{bmatrix} \text{INDEX} \;\; s \end{bmatrix} \end{bmatrix}$$

- Internal structure of a VP
- Directive function
- Base form
- Only 2nd person reflexives

Q Note that this is not a headed rule. Why?

A It would violate the HFP and the SIP.

Imperative Example



- What's the SPR value on S?
- What's the SPR value on VP?
- What's the SPR value on V?
- Which nodes have ARG-ST?
- Which ARG-ST matters for the licensing of *yourself*?

arg-st of *vote*

$$\left[\text{ARG-ST}\left\langle \text{NP}_i\ \left[\begin{array}{ll}\text{MODE} & \textit{ref}\\ \text{PER} & \textit{2nd}\\ \text{NUM} & \textit{sg}\end{array}\right],\ \text{PP}_i\ \left[\text{MODE}\ \textit{ana}\right]\right\rangle\right]$$

- Is Principle A satisfied?
- How?
- Is Principle B satisfied?
- How?

Day 1 Revisited

- Recall

  (24) *Screw yourself!*
  (25) *Go screw yourself!*
  (26) *Screw you!*
  (27) **Go screw you!*

- *Screw NP!* has two analyses
  - As an imperative
  - As a truly subjectless fixed expression

- *Go screw NP!* can only be analyzed as an imperative.

Summary

- Review of Chapter 1's informal binding theory
- Formalized Binding Theory
  - **Argument Realization Principle** (ARP)
    $\text{ARG-ST} = \text{SPR} \oplus \text{COMPS}$
  - **Anaphoric Agreement Principle** (AAP)
    Coindexed NPs agree.
  - **Principle A** A [MODE *ana*] element must be outranked by a coindexed element.
  - **Principle B** A [MODE *ref*] element must not be outranked by a coindexed element.
- Binding and PPs
- Imperatives

Problems

P1: English Possessives I

English uses *'s* to express possession, as in the following examples:

(28) *Leslie's coffee spilled.*
(29) *Jesse met the president of the university's cousin.*
(30) **Jesse met the president's of the university cousin.*
(31) *Don't touch that plant growing by the trail's leaves.*
(32) **Don't touch that plant's growing by the trail leaves.*
(33) *The person you were talking to's pants are torn.*
(34) **The person's you were talking to pants are torn.*

(While examples (31) and (33) are a bit awkward, people do use such sentences, and there is certainly nowhere else that the *'s* could be placed to improve them).

A. What is the generalization about where the *'s* of possession appears in English?

Based on Sag et al. (2003, Chapter 6, Problem 3)

One traditional treatment of the possessive marker (*'s*) is to claim it is a case marker. In our terms this means that it indicates a particular value for the feature CASE (say, 'poss' for 'possessive') on the word it attaches to. If we tried to formalize this traditional treatment of *'s*, we might posit a rule along the following lines, based on the fact that possessive NPs appear in the same position as determiners:

$$\text{D} \rightarrow \text{NP} \left[\text{CASE } \textit{poss}\right]$$

Taken together with our assumption that CASE is a HEAD feature, such an analysis of *'s* makes predictions about the grammaticality of (29)–(34).

B. Which of these sentences does it predict should be grammatical, and why?

P2: English Possessives II

An alternative analysis of the possessive is to say that *'s* is a determiner that builds a determiner phrase (abbreviated DP), via the Head-Specifier Rule. On this analysis, *'s* selects for no complements, but it obligatorily takes an NP specifier. The word *'s* thus has a lexical category that is like an intransitive verb in valence.

This analysis is somewhat unintuitive, for two reasons: first, it requires that we have an independent lexical entry for *'s*, which seems more like a piece of a word, phonologically; and second, it makes the nonword *'s* the head of its phrase! However, this analysis does a surprisingly good job of predicting the facts of English possessives, so we shall adopt it, at least for purposes of this text.

A. Ignoring semantics for the moment, give the lexical entry for *'s* assuming its analysis as a determiner, and draw a tree for the NP *Kim's brother*. (The tree should show the value of HEAD, SPR and COMPS on every node. Use tags to show identities required by the grammar. You may omit other features.)

B. Explain how your lexical entry gets the facts right in the following examples:

(35) *The Queen of England's crown disappeared.*

(36) **The Queen's of England crown disappeared.*

C. How does this analysis handle recursion in possessives, for example, *Robin's brother's wife*, or *Robin's brother's wife's parents*? Provide at least one tree fragment to illustrate your explanation. (You may use abbreviations for node labels in the tree.)

P3: Imperative 'Subjects'

- Some imperatives look like they have a subject:

  (i) *You get out of here!*
  (ii) *Everybody take out a sheet of paper!*

- But agreement is weird:

  (iii) *Everybody found ?himself/*yourself/themselves/*myself a seat.*
  (iv) *Everybody find ?himself/yourself/*themselves/*myself a seat.*

- What minimal modification of the Imperative Rule would let these parse?
  - Don't worry about the semantics for now (no one has solved that)
  - We just want an imperative rule that will license the good examples and not the bad examples shown above.

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 7)

References

Noam Chomsky. 1981. *Lectures on Government and Binding*. Foris, Dordrecht.

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