

Chapter 14:
Long Distance Dependencies

Examples of LDDs

- *wh*-questions:

What did you find?

Tell me who you talked to.

- topicalization:

The manual, I can't find.

Chris, you should talk to.

- relative clauses:

the item that I found

the guy who(m) I talked to

- *easy*-adjectives:

My house is easy to find.

Pat is hard to talk to.

- Common properties:

- There is a 'gap': nothing following *find* and *to*, even though both normally require objects.
- Something that fills the role of the element missing from the gap occurs at the beginning of the clause.
- We use topicalization and *easy*-adjectives to illustrate

Very Rough Sketch of HPSG Approach to Long-Distance Dependencies

- A feature GAP (usually called SLASH) records information about a missing constituent.
- The GAP value is passed up the tree by a new principle.
- A new grammar rule expands S as a filler, followed by another S whose GAP value matches the filler.
- Caveat: Making the details of this general idea work is non-trivial.

The Feature GAP

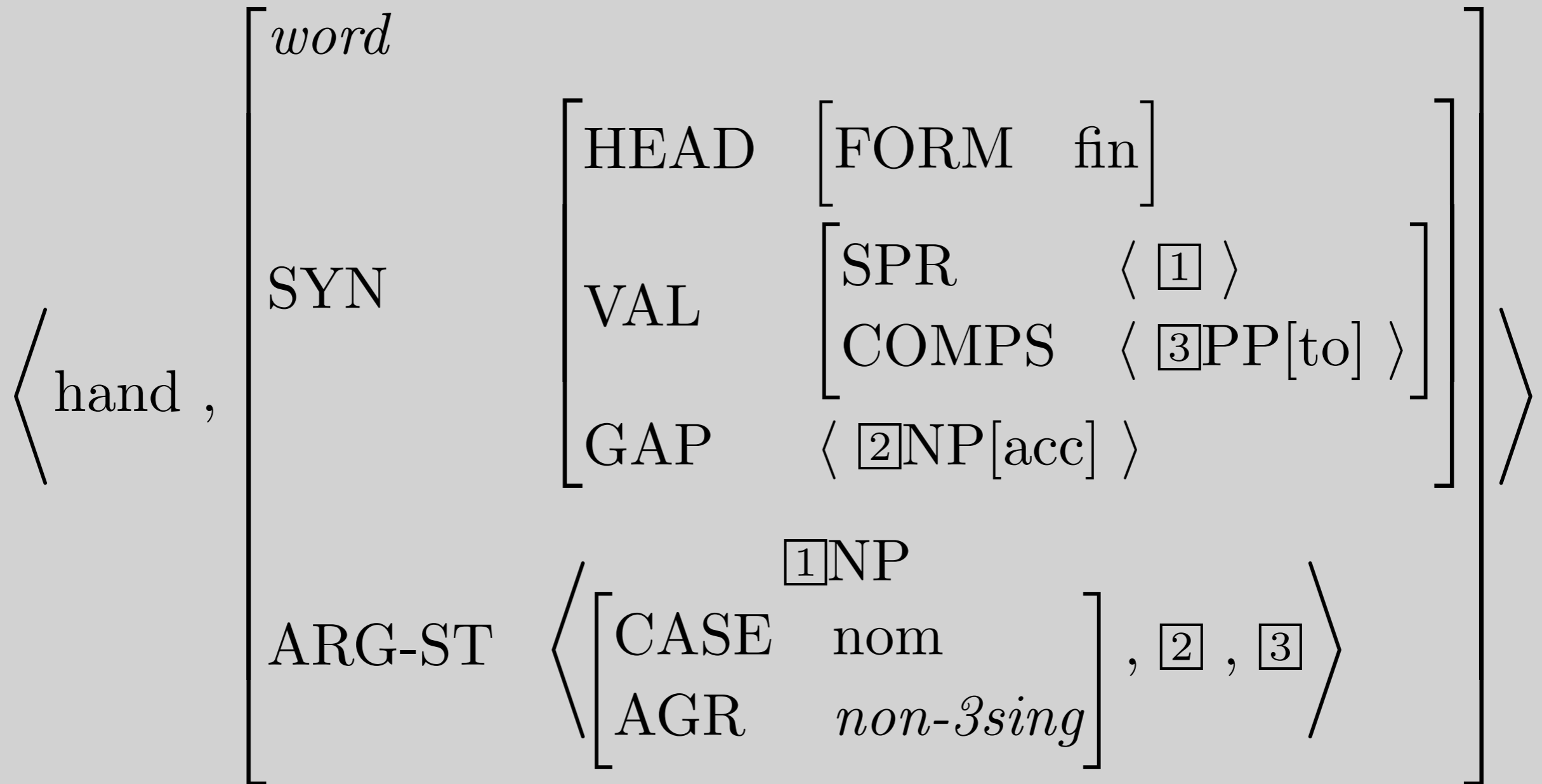
- Like valence features and ARG-ST, GAP's value is a list of feature structures (often empty).
- Subject gaps are introduced by a lexical rule we'll talk about later.
- Non-subject gaps are introduced by revising the Argument Realization Principle.

The Revised ARP

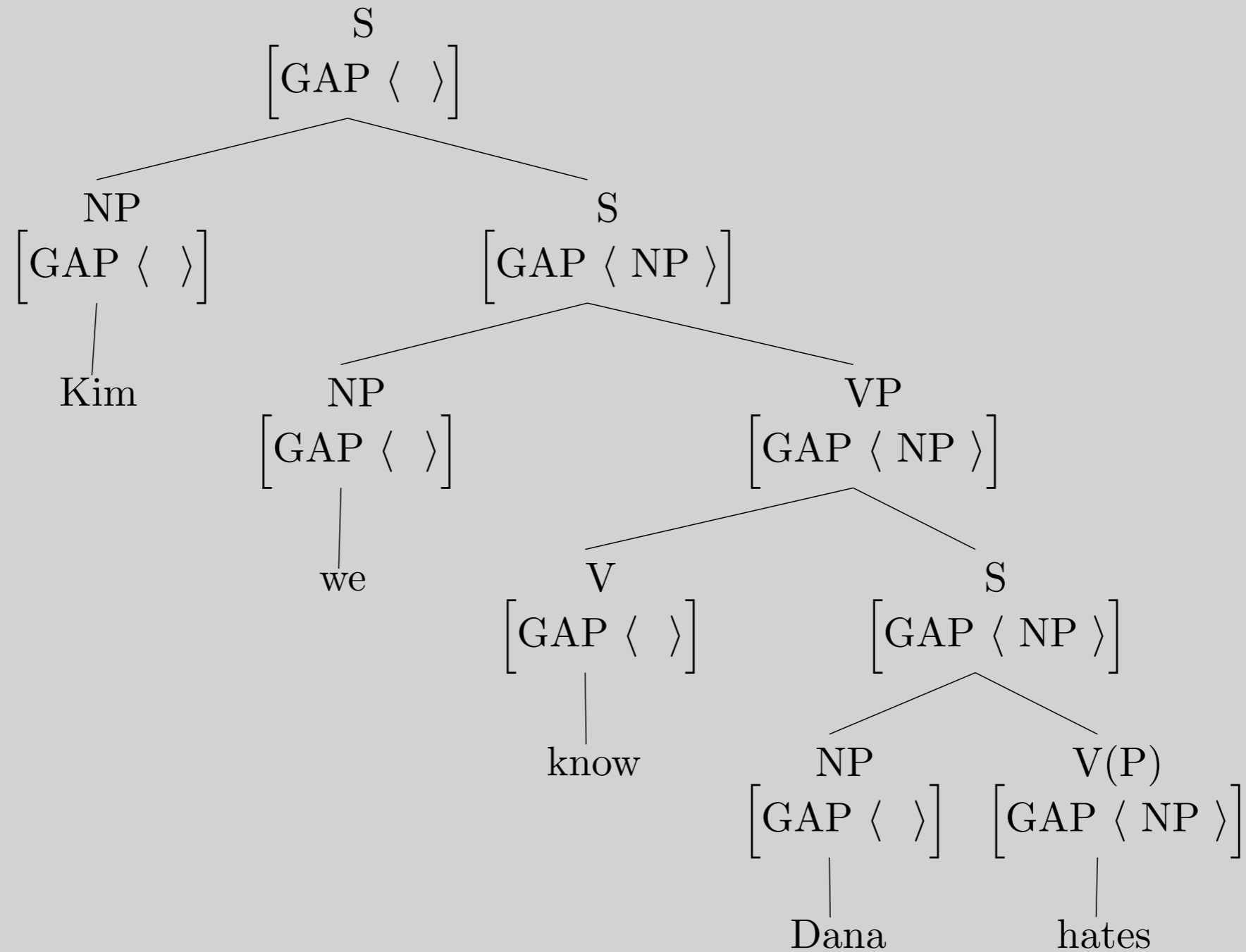
$$\text{word:} \left[\begin{array}{l} \text{SYN} \\ \text{ARG-ST} \end{array} \left[\begin{array}{l} \text{VAL} \\ \text{GAP} \end{array} \left[\begin{array}{l} \text{SPR} \\ \text{COMPS} \end{array} \left[\begin{array}{l} \boxed{A} \\ \boxed{B} \ominus \boxed{C} \end{array} \right] \right] \right] \right]$$

- \ominus is a kind of list subtraction, but:
 - it's not always defined, and
 - when defined, its value is not always unique
- The ARP now says the non-SPR arguments are distributed between COMPS and GAP.

A Word with a Non-Empty GAP Value



How We Want GAP to Propagate



What We Want the GAP Propagation Mechanism to Do

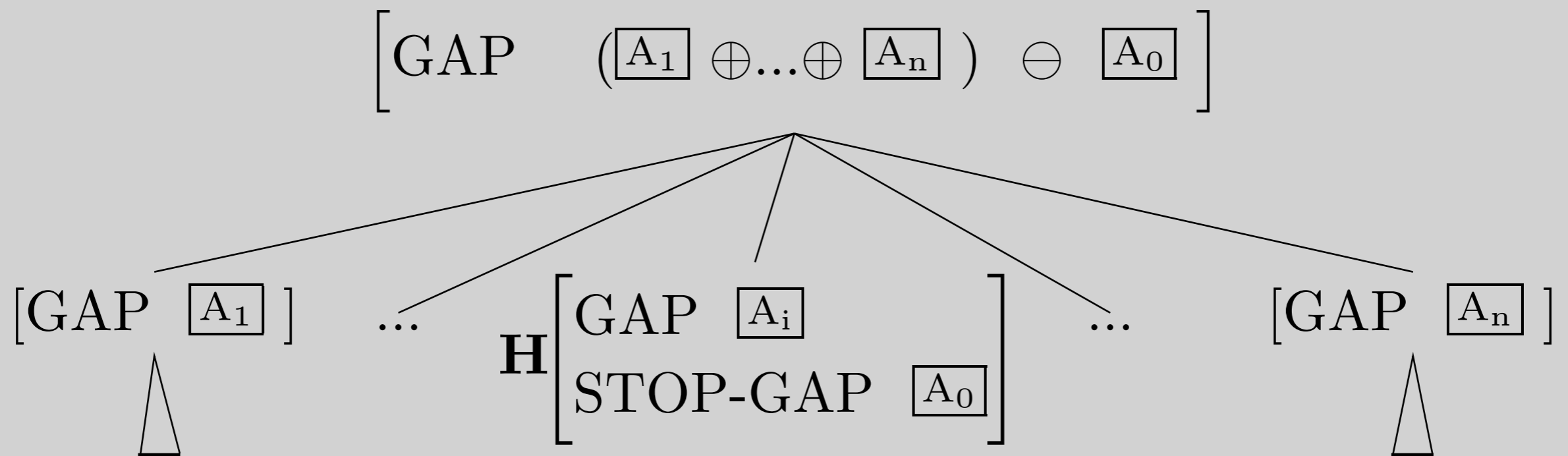
- Pass any GAP values from daughters up to their mothers,
- **except** when the filler is found.
- For topicalization, we could write the exception into the grammar rule, but
- For *easy*-adjectives, the NP that corresponds to the gap is the subject, which is introduced by the Head-Specifier Rule.
- Since specifiers are not generally gap fillers, we can't write the gap-filling into the HSR.

Our Solution to this Problem

- For *easy*-adjectives, we treat the adjective formally as the filler, marking its SPR value as coindexed with its GAP value.
- We use a feature STOP-GAP (usually called TO-BIND) to trigger the emptying of the GAP list.
 - STOP-GAP stops gap propagation
 - *easy*-adjectives mark STOP-GAP lexically
 - a new grammar rule, the Head-Filler Rule mentions STOP-GAP

The GAP Principle

A local subtree Φ satisfies the GAP Principle with respect to a headed rule ρ if and only if Φ satisfies:



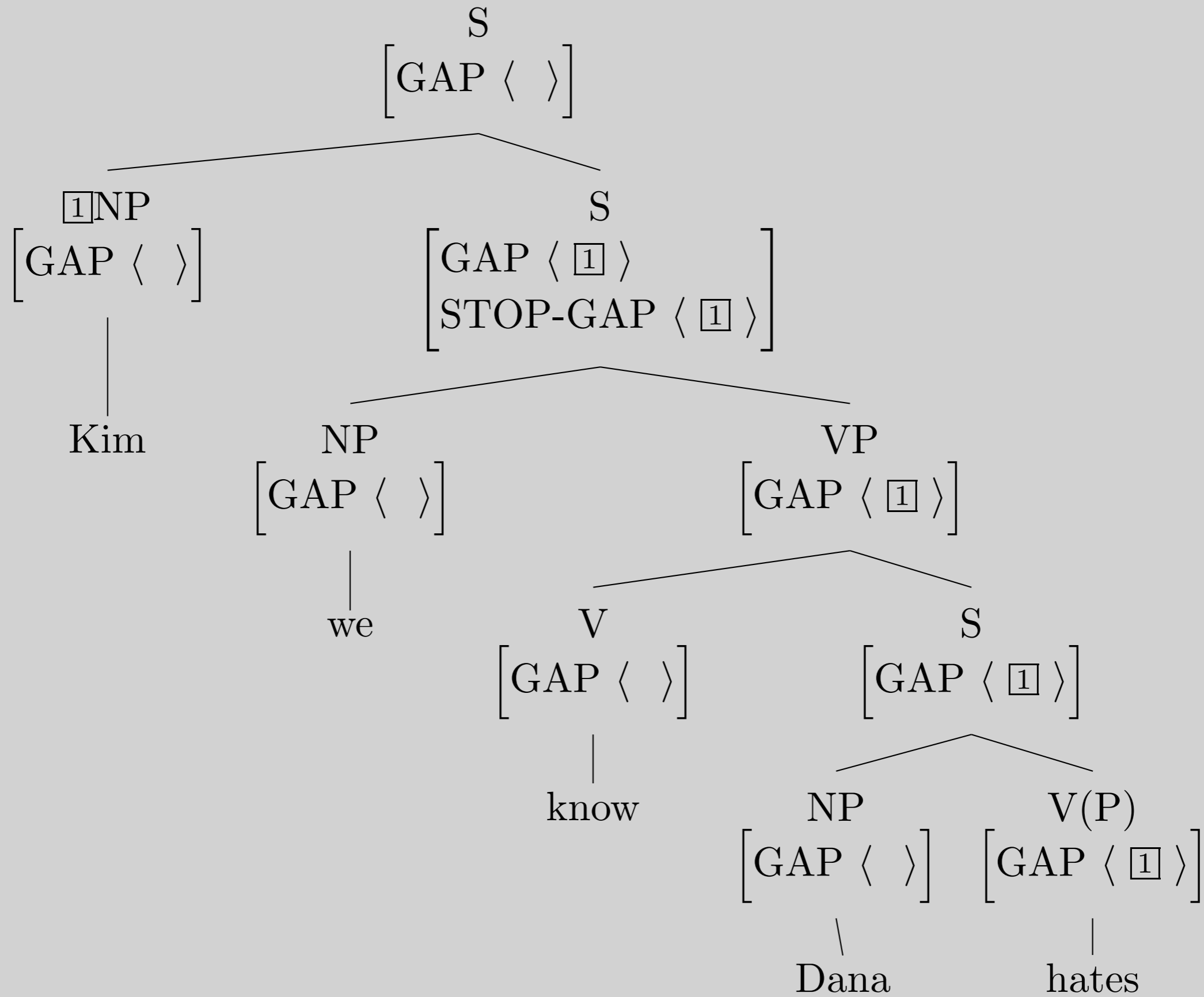
How does STOP-GAP work?

- STOP-GAP is empty almost everywhere
- When a gap is filled, STOP-GAP is nonempty, and its value is the same as the gap being filled.
- This blocks propagation of that GAP value, so gaps are only filled once.
- The nonempty STOP-GAP values come from two sources:
 - a stipulation in the Head-Filler Rule
 - lexical entries for *easy*-adjectives
- No principle propagates STOP-GAP

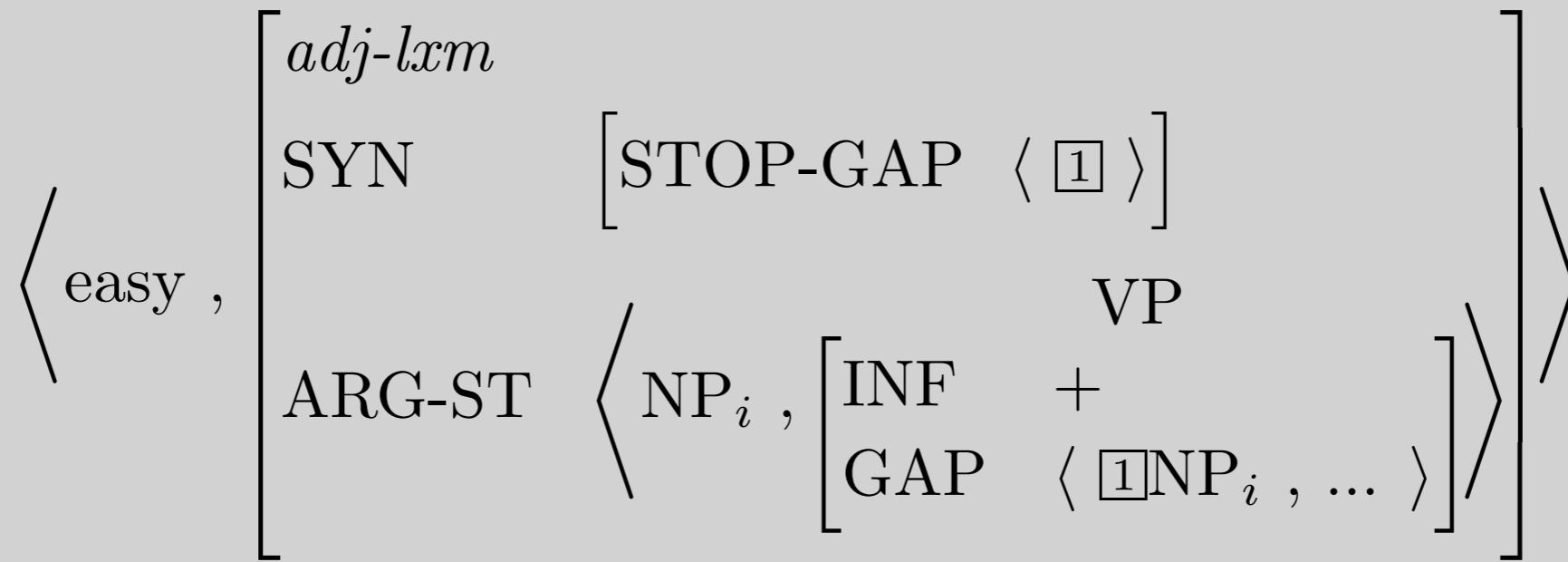
The Head-Filler Rule

$$[phrase] \rightarrow \boxed{1} \left[\text{GAP} \quad \langle \rangle \right] \mathbf{H} \left[\begin{array}{l} \text{HEAD} \quad \left[\begin{array}{l} \textit{verb} \\ \text{FORM} \quad \textit{fin} \end{array} \right] \\ \text{VAL} \quad \left[\begin{array}{l} \text{SPR} \quad \langle \rangle \\ \text{COMPS} \quad \langle \rangle \end{array} \right] \\ \text{STOP-GAP} \quad \langle \boxed{1} \rangle \\ \text{GAP} \quad \langle \boxed{1} \rangle \end{array} \right]$$

- This only covers gap filling in finite Ss
- The filler has to be identical to the GAP value
- The STOP-GAP value is also identical
- The GAP Principle ensures that the mother's GAP value is the empty list

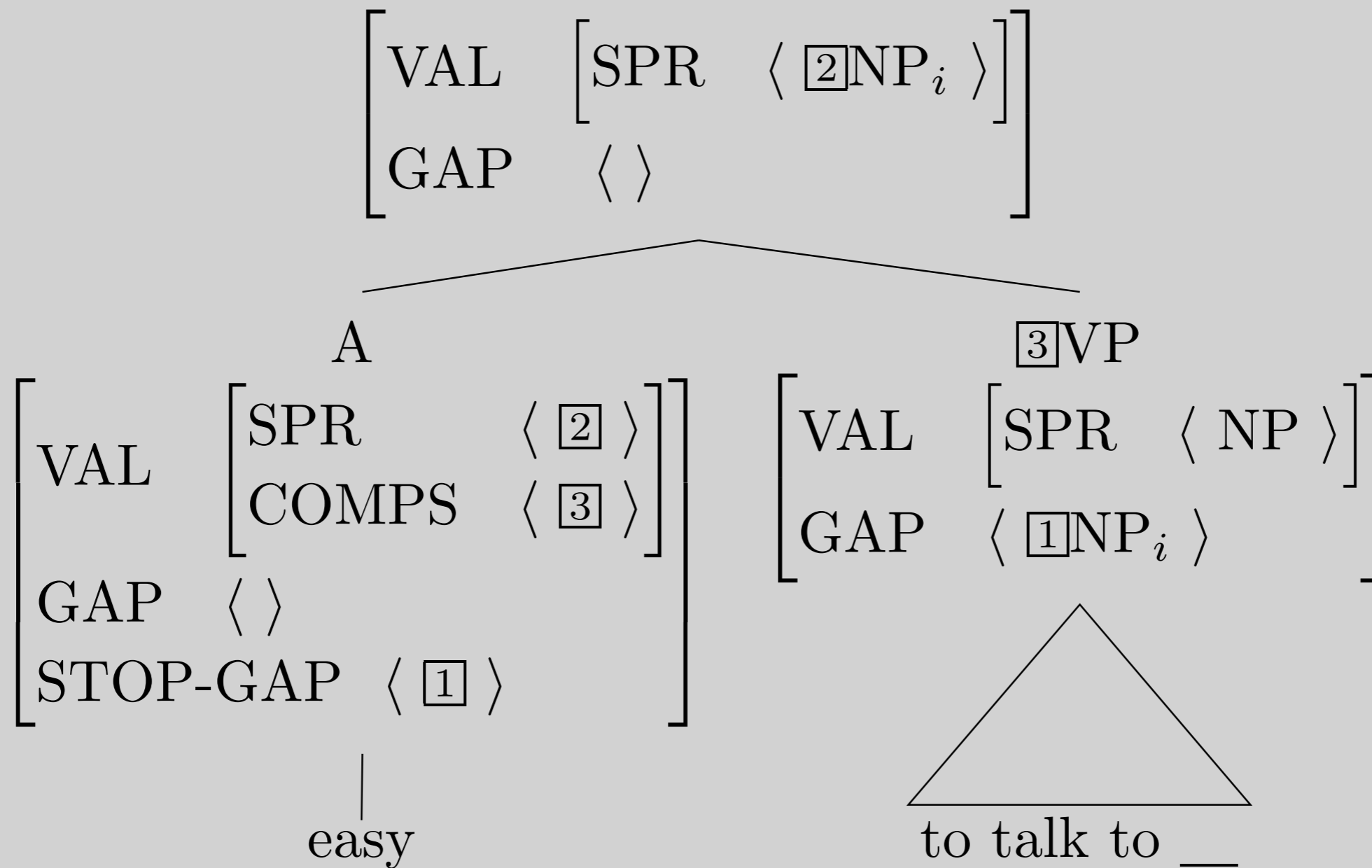


Gap Filling with *easy*-Adjectives



- Because STOP-GAP and GAP have the same value, that value will be subtracted from the mother's GAP value.
- The first argument is coindexed with the GAP value, accounting for the interpretation of the subject as the filler.

A Tree for *easy to talk to*_____



GAP & STOP-GAP Housekeeping

- The initial symbol must say [GAP < >], to block **Pat found* and **Chris talked to* as stand-alone sentences.
- Lexical entries with nonempty STOP-GAP values (like *easy*) are rare, so STOP-GAP is default empty in the lexicon.
- Head-Specifier and Head-Modifier rules need to say [STOP-GAP < >]
- Lexical rules preserve STOP-GAP values.

Sentences with Multiple Gaps

- Famous examples:

This violin, sonatas are easy to play____ on____.

**Sonatas, this violin is easy to play____ on____.*

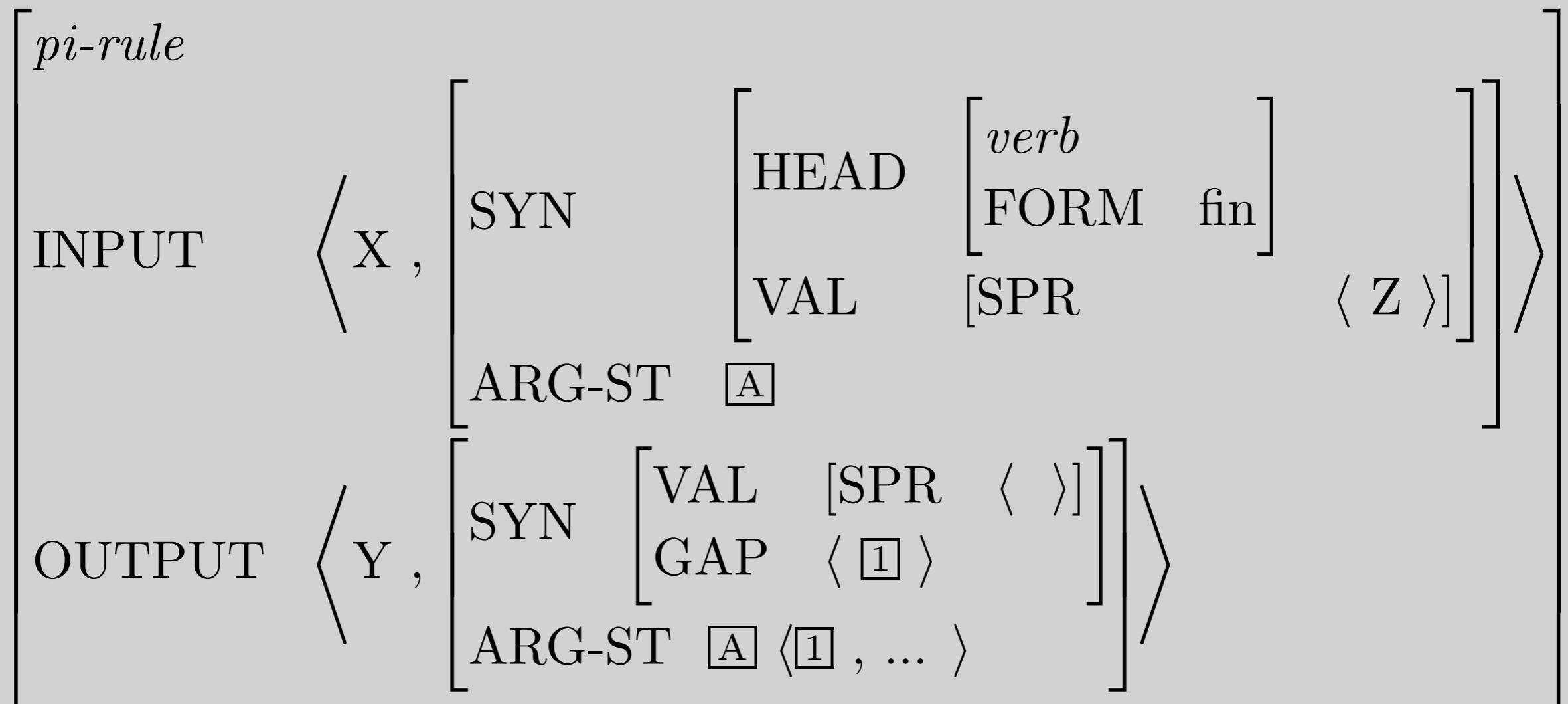
- Our analysis gets this:

- The subject of *easy* is coindexed with the **first** element of the GAP list.
- The Head-Filler rule only allows one GAP remaining.
- This approach has the flexibility to deal with languages that allow multiple gaps more generally.

Subject Gaps

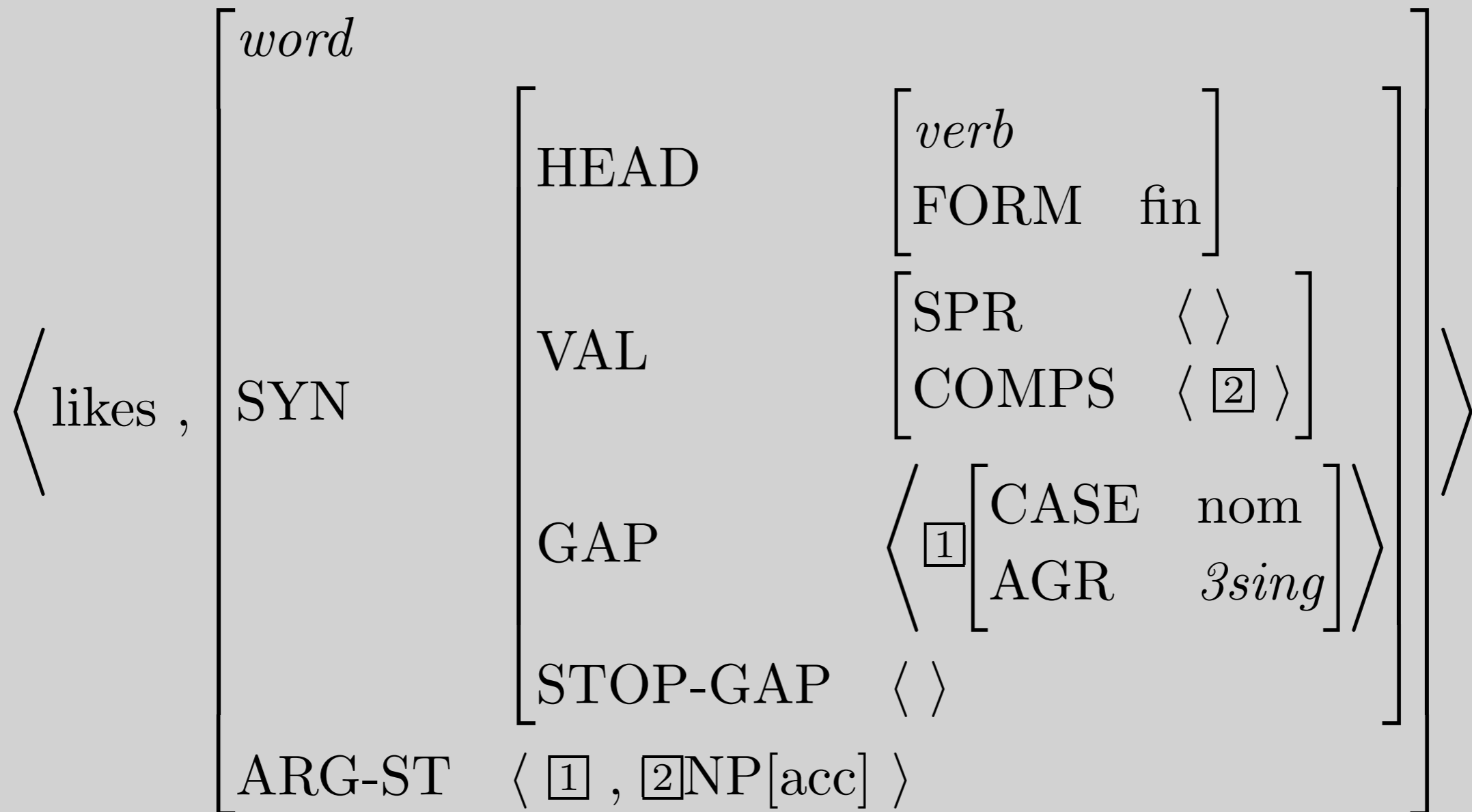
- The ARP revision only allowed missing complements.
- But gaps occur in subject position, too:
This problem, everyone thought ____ was too easy.
- We handle these via a lexical rule that, in effect, moves the contents of the SPR list into the GAP list

The Subject Extraction Lexical Rule



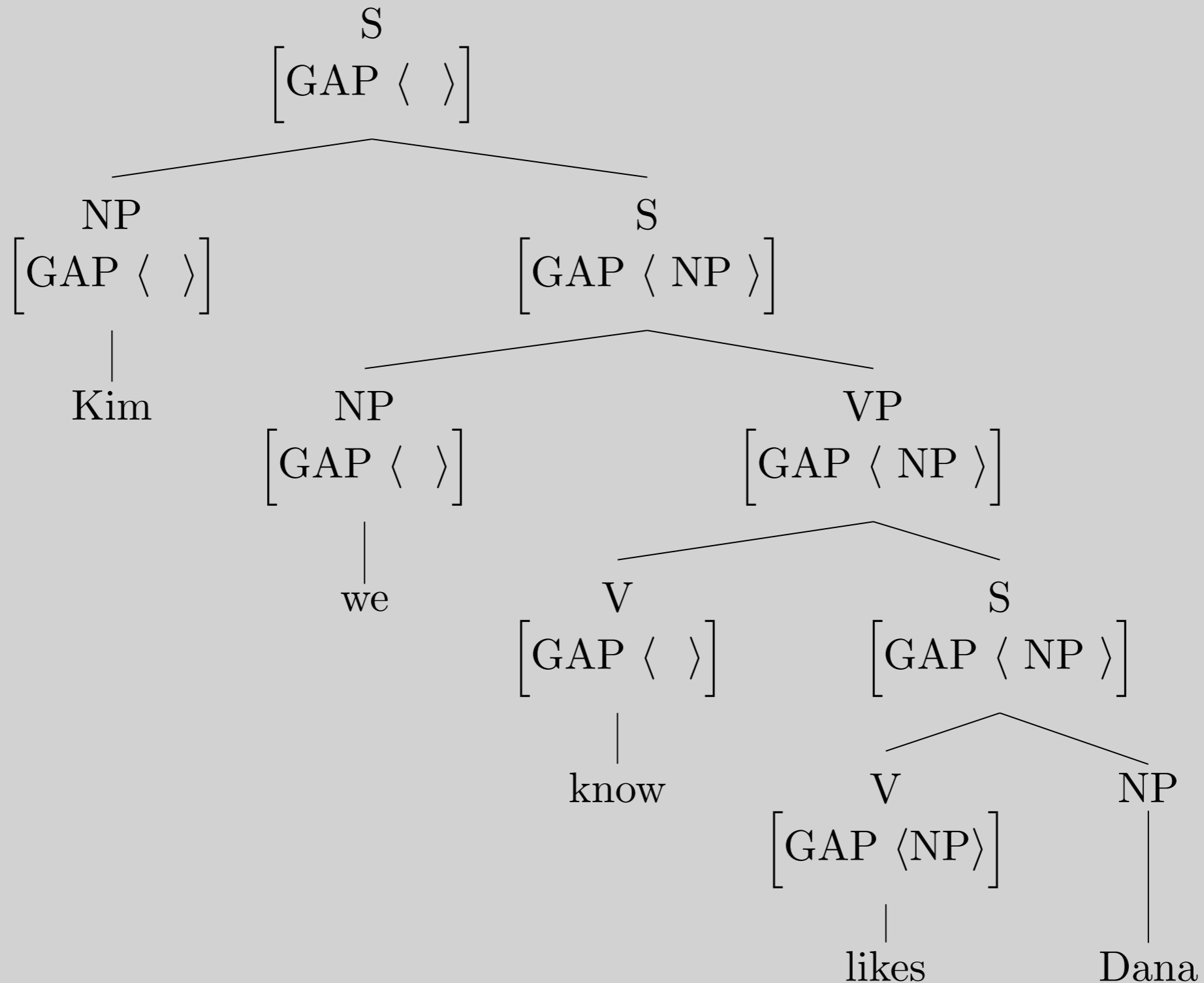
- Note: This says nothing about the phonology, because the default for *pi-rules* is to leave the phonology unchanged.

A Lexical Sequence This Licenses



- Note that the ARP is satisfied

A Tree with a Subject Gap



The Coordinate Structure Constraint

In a coordinate structure,

- no conjunct can be a gap (conjunct constraint),
and
- no gap can be contained in a conjunct if its filler is outside of that conjunct (element constraint)
-unless each conjunct has a gap that is paired with the same filler (across-the-board exception)

HPSG Treatment of the Coordinate Structure Constraint

- Based on ideas of Gerald Gazdar, first developed within GPSG
- In our analysis, the conjunct constraint is an immediate consequence: individual conjuncts are not on the ARG-ST list of any word, so they can't be put on the GAP list
- The element constraint and ATB exception suggest that GAP is one of those features (along with VAL and FORM) that must agree across conjuncts.
- Note: There is no ATB exception to the conjunct constraint.
**This problem, you can compare only _____ and _____.*

Our Coordination Rule, so far

$$\begin{array}{l} \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{IND} & s_0 \end{array} \right] \end{array} \rightarrow \begin{array}{l} \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{IND} & s_1 \end{array} \right] \dots \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{IND} & s_{n-1} \end{array} \right] \left[\begin{array}{ll} \text{HEAD} & conj \\ \text{IND} & s_0 \\ \text{RESTR} & \langle \left[\text{ARGS} \langle s_1 \dots s_n \rangle \right] \rangle \end{array} \right] \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{IND} & s_n \end{array} \right] \end{array}$$

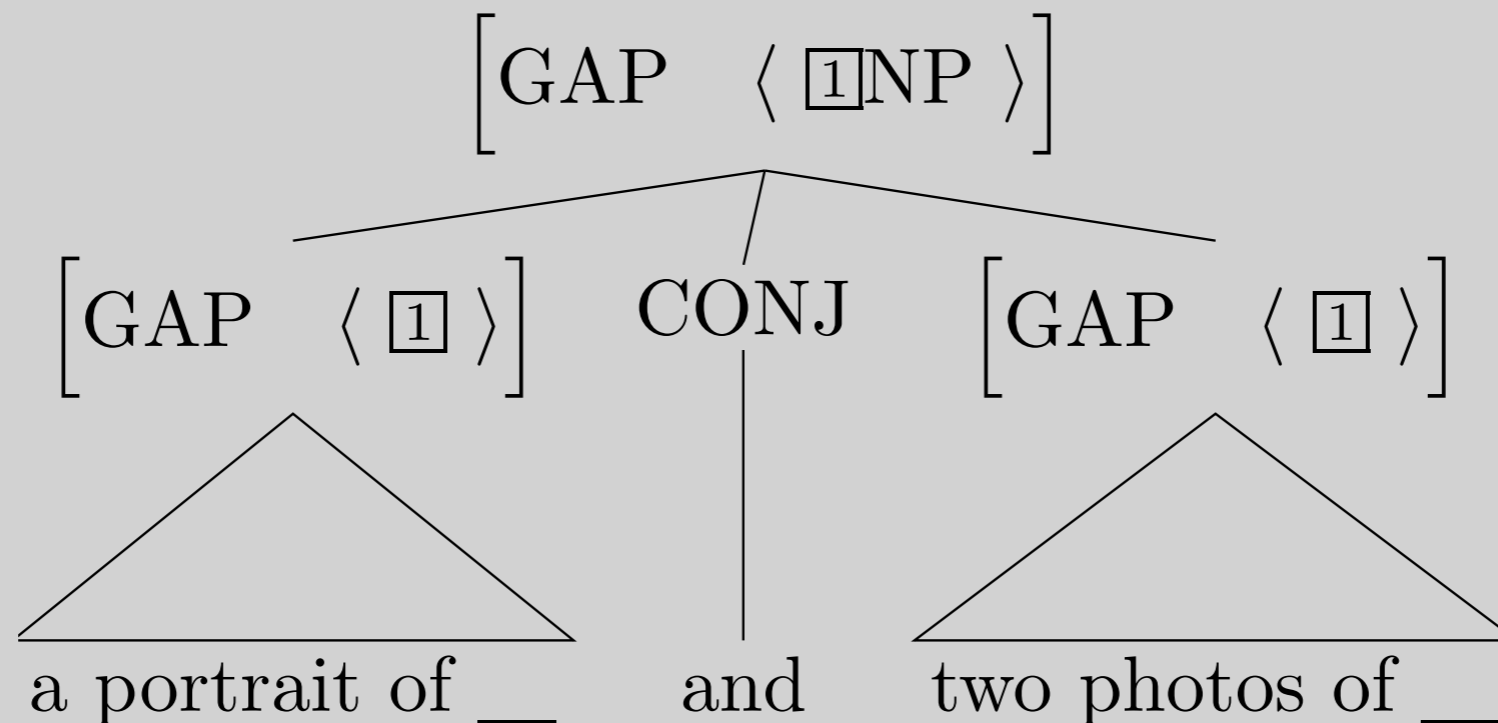
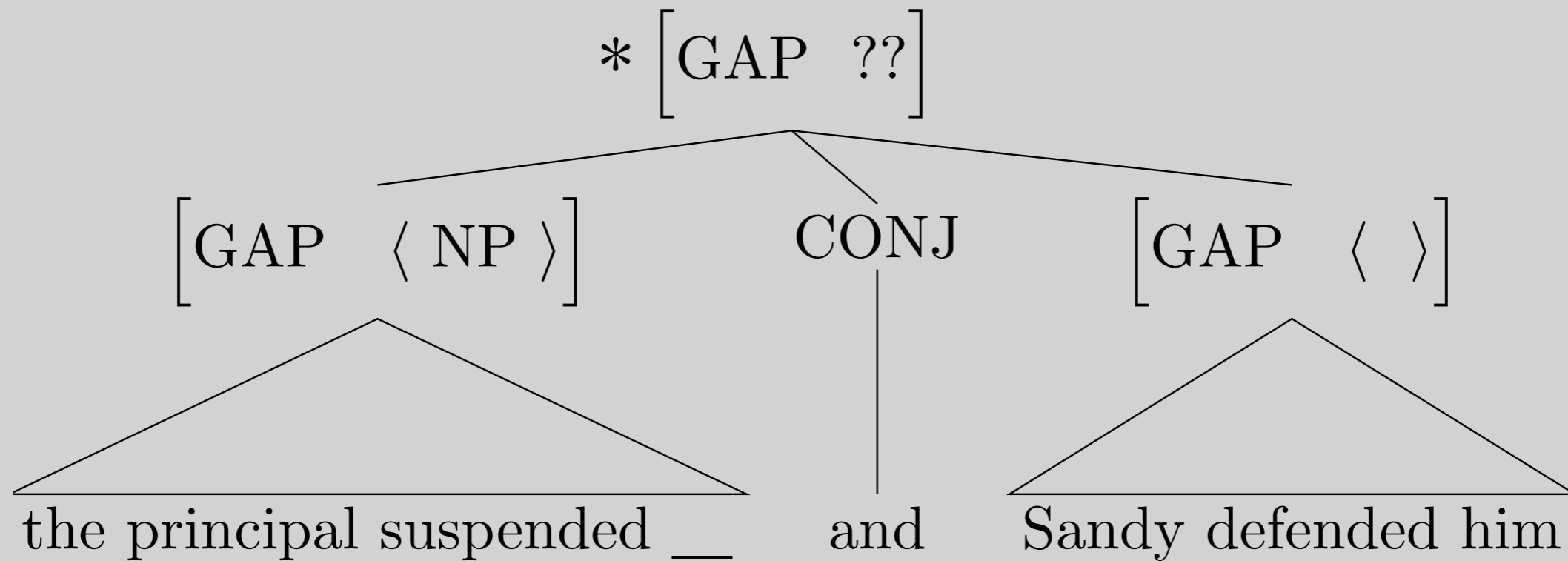
- Recall that we have tinkered with what must agree across conjuncts at various times.
- Now we'll add GAP to the things that conjuncts must share

Our Final Coordination Rule

$$\begin{array}{l}
 \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{GAP} & \boxed{A} \\ \text{IND} & s_0 \end{array} \right] \rightarrow \\
 \\
 \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{GAP} & \boxed{A} \\ \text{IND} & s_1 \end{array} \right] \dots \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{GAP} & \boxed{A} \\ \text{IND} & s_{n-1} \end{array} \right] \left[\begin{array}{ll} \text{HEAD} & conj \\ \text{IND} & s_0 \\ \text{RESTR} & \langle \left[\text{ARGS} \langle s_1 \dots s_n \rangle \right] \rangle \end{array} \right] \left[\begin{array}{ll} \text{FORM} & \boxed{1} \\ \text{VAL} & \boxed{0} \\ \text{GAP} & \boxed{A} \\ \text{IND} & s_n \end{array} \right]
 \end{array}$$

- We've just added GAP to all the conjuncts and the mother.
- This makes the conjuncts all have the same gap (if any)

CSC & ATB Illustrated



Conclusions

- Filler-Gap dependencies have been analyzed through a new feature GAP.
- The distribution of GAP is controlled by the GAP Principle and its interaction with lexical and constructional constraints.
- This analysis derives as a theorem Ross's Coordinate Structure Constraint, its Across-the-Board exceptions, and the exceptions to those exceptions.
- This approach has been extended to the analysis of many other filler-gap constructions in English and other languages.