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Faculty of Philosophy
General Linguistics

Syntax & Semantics WS2019/2020

Lecture 6: Government & Binding I ($\overline{X}$ Theory)

11/11/2019, Christian Bentz

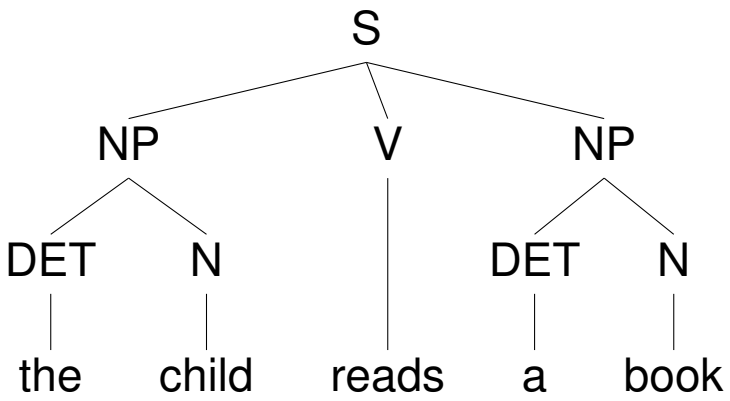
Overview

Comments on Tutorial Week 2

- *They cut Sago palm for her* versus *they gave a book to her* → You can say *they cut sago palm*, but not (or very unlikely) **they gave a book*
- Imonda sentences without explicit mention of arguments: This is what the grammar of Imonda apparently allows (if the participants of the scene were mentioned before in the discourse).
- Is transitivity the same as valency? – In the vast majority of cases yes, but remember the case of *He weighs 120 pounds*. While the verb *weigh* is bivalent, it is not considered transitive according to the passivization test.
- *eat* can be *intransitive* or *transitive* in usage.

Section 1: Recap of Lecture 5

Bracket Notation



Rewrite Notation

S
NP V NP
DET N V NP
DET N V DET N

DET N reads DET N
the N reads DET N
the child reads DET N
the child reads a N
the child reads a book

[S [NP [DET [the]][N [child]]][V [reads]][NP [DET [a]][N [book]]]]

Note: The *Bracket Notation* is yet another equivalent way to visualize the same structure. In fact, the latex code generating this slide takes the bracket notation as input to generate the above tree.

Important Take-Home-Message

One of the most important features of PSGs is that they strongly **restrict the number of possible sentences** via *linearization constraints* in the *non-terminal rules* (inner parts of the tree). The sentences generated by the PSG above are in fact a small subset of the overall possible sentences without any linearization constraints, namely, 4 out of $5! = 120$, or around 3%.

Sentences licensed by PSG:

the child reads a book
a child reads the book
the book reads a child
a book reads the child

Possible permutations:

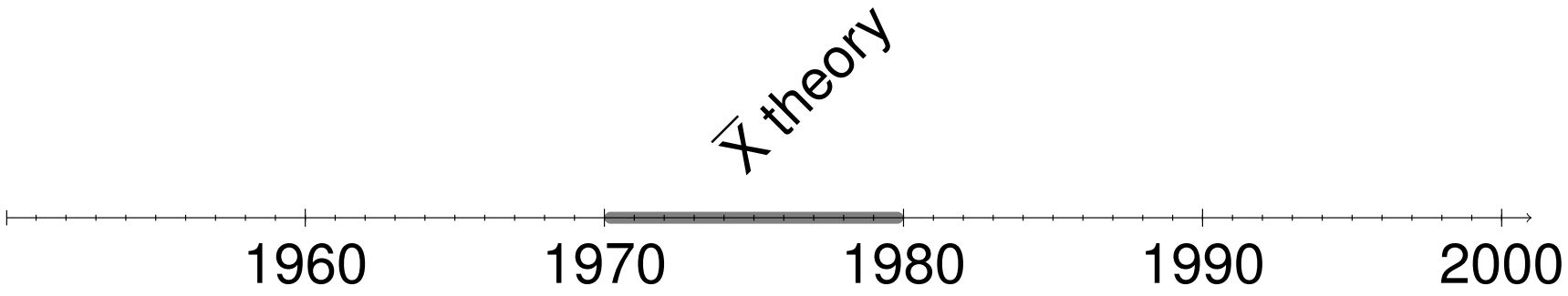
the child reads a book
**book the child reads a*
**a book the child reads*
**reads a book the child*
**child reads a book the*
etc.

Section 2: Historical Notes

Historical Perspective

"[...] so-called $\overline{X}$ theory (or X-bar theory, the term *bar* refers to the line above the symbol), which was developed by Chomsky (1970) and refined by Jackendoff (1977). This form of abstract rules plays an important role in many different theories. For example: Government & Binding (Chapter 3), Generalized Phrase Structure Grammar (Chapter 5) and Lexical Functional Grammar (Chapter 7)."

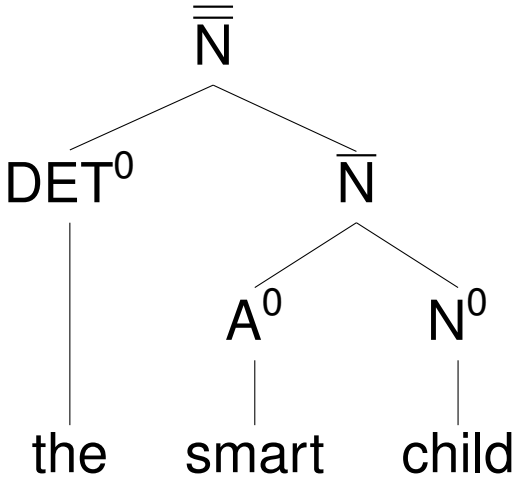
Müller (2019). Grammatical theory, p. 75.



Section 3: Basic Definitions

The bar(s) in X-bar theory

The bar is simply a notational convention to indicate the **level or position of a symbol** in the phrase structure tree – in relation to the level of the symbol that it is dominated by.



Equivalent Notations:

$\overline{\overline{N}}$ = NP

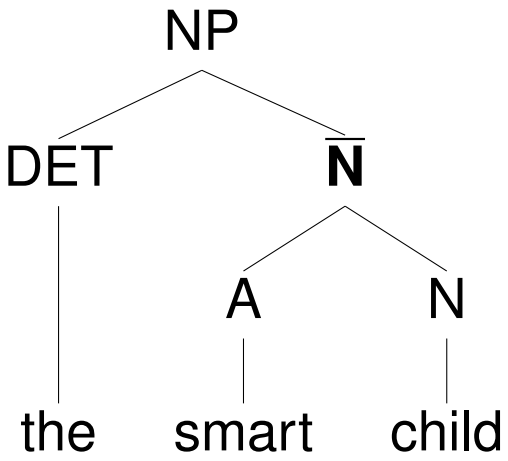
$\overline{N}$ = NP or N

N^0 = N (of terminal rewrite)

Note: The bars represent so-called *projection levels*. Level 0 (no bar), level 1 (one bar), level 2 (two bars).

Beware the Notational Confusion

In Müller (2019) – and other publications working on this framework – the most frequent convention is to only use bars for the symbols in between the highest level phrase and the symbols leading to the terminals. For highest level phrases the phrase notation is used (e.g. NP), and for the terminal level the zero is dropped. We will adopt this notation in this lecture as well.



Equivalent Notations:

$\overline{\overline{N}}$ = NP

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N^0 = N (of terminal rewrite)

Why do we need bars in the first place?

Natural languages are arguably **infinite in their productive potential**. To capture this productivity, we need some structure in our rewrite rules that allows for infinite productivity. For example, we could use the so-called wild card <*>.

Sentences:	**Rule:**	**Creates:**
(1) a child	NP $\rightarrow$ DET N	(1)
(2) a smart child	NP $\rightarrow$ DET A N	(2)
(3) a smart, diligent child	NP $\rightarrow$ DET A A N	(3)
(4) a smart, diligent, quiet, etc. child	NP $\rightarrow$ DET A* N	(1), (2), (3), (4)[1]

[1]The wild card allows for anything from 0 to ∞ realizations of A.

Why do we need bars in the first place?

However, the problem with the rewrite rule involving the wild card[1] is that the adjective-noun combination is not a constituent by itself, since the determiner is required by the rewrite rule. This rewrite rule hence excludes coordination involving adjective-noun phrases without the determiner.[2]

Sentences:	**Rule:**
(5) all [[the smart children] and [the diligent people]]	NP $\rightarrow$ [DET A* N]
(6) all [[smart children] and [diligent people]]	NP $\rightarrow$ DET [A* N]

[1] Some theories would also consider it a problem that the rule does not adhere to the binarization constraint.

[2] The problem could also be sloved by allowing empty determiners, i.e. $DET \rightarrow \epsilon$, but then we would always have to posit an empty determiner when only adjective-noun combinations are used.

Why do we need bars in the first place?

The solution to capture all the noun phrases discussed above is a set of rewrite rules using the bar notation:[3]

1. NP $\rightarrow$ DET $\overline{\text{N}}$
2. $\overline{\text{N}} \rightarrow$ A $\overline{\text{N}}$
3. $\overline{\text{N}} \rightarrow$ N

"These rules state the following: a noun phrase consists of a determiner and a nominal element ($\overline{\text{N}}$). This nominal element can consist of an adjective and a nominal element, or just a noun. Since $\overline{\text{N}}$ is also on the right-hand side of the rule, we can apply this rule multiple times and therefore account for noun phrases with multiple adjectives [...]"

Müller (2019). Grammatical theory, p. 64.

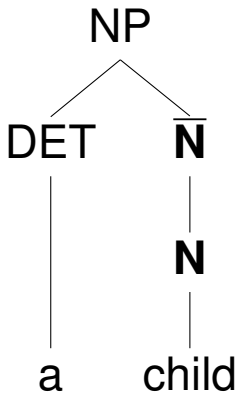
[3] These rewrite rules also adhere to the binarization constraint but they wouldn't have to.

Important Take-Home-Message

The element that is marked by the bar (e.g. $\overline{\text{N}}$) can be either another phrase (NP) or a symbol directly leading to a terminal (N). The rewrite rule where this flexible symbol occurs on both sides is the core part of the set of rewrite rules which allows for **infinite recursive application**:

$$\overline{\text{N}} \rightarrow \text{A}\ \overline{\text{N}}$$

Noun Phrase Examples



Rewrite Notation

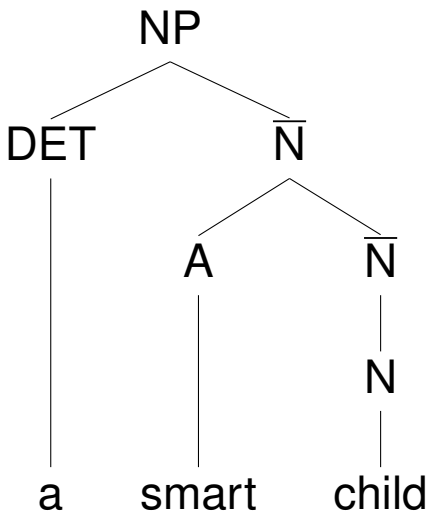
NP
DET $\overline{\mathbf{N}}$
DET **N**

---

a N
a child

Note: Compared to the earlier notation without bars we have an increase in so-called *unary branches*, since we always need to rewrite the element with a bar into an element without the bar.

Noun Phrase Examples



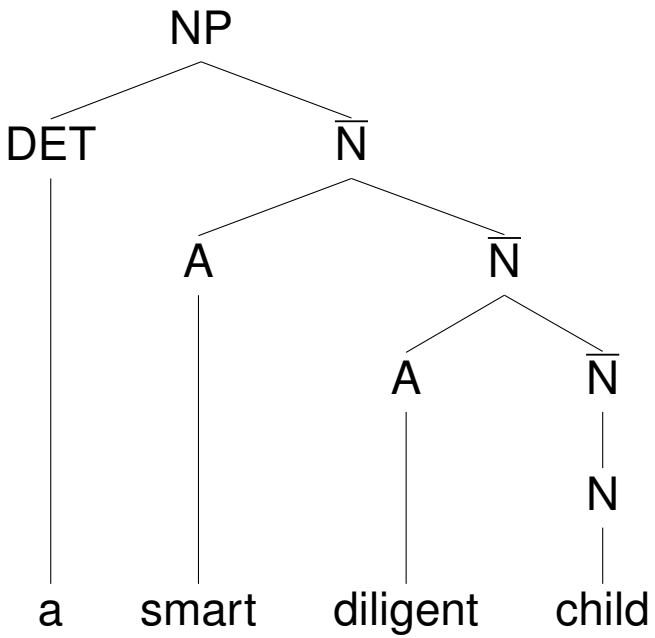
Rewrite Notation

NP
DET $\overline{N}$
DET A $\overline{N}$
DET A N

---

a A N
a smart N
a smart child

Noun Phrase Examples



Rewrite Notation

NP
DET N̄
DET A N̄
DET A A N̄
DET A A N

---

a A A N
a smart A N
a smart diligent N
a smart diligent child

Other Adjuncts (PPs and Relative Clauses)

"Thus far, we have discussed how we can ideally integrate adjectives into our rules for the structure of noun phrases. Other adjuncts such as **prepositional phrases** or **relative clauses** can be combined with N in an analogous way to adjectives [...]"

4. $\overline{\text{N}} \rightarrow \overline{\text{N}}$ PP
5. $\overline{\text{N}} \rightarrow \overline{\text{N}}$ REL

Müller (2019). Grammatical theory, p. 66.

Prepositional Phrases

"PPs normally consist of a preposition and a noun phrase whose case is determined by that preposition. We can capture this with the following rule:"

6. PP $\rightarrow$ P NP

Müller (2019). Grammatical theory, p. 71.

However, we also need to cover the following examples:

(7) [PP [**NP one step**] [P before [NP the abyss]]]

(8) [PP [**A shortly**] [P after [NP the take.off]]]

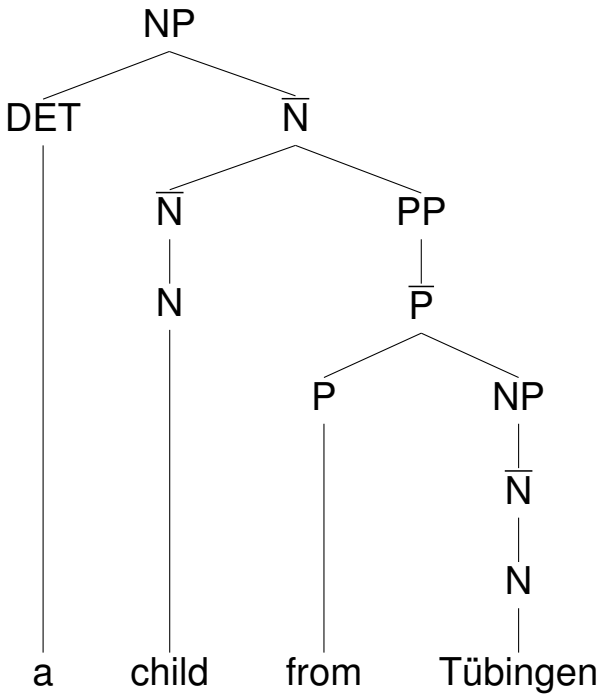
Prepositional Phrases

In order to cover such examples including an indication of measurement (e.g. *shortly*, *one step*) we can choose the following set of X-bar rules:

7. PP $\rightarrow$ NP $\overline{\text{P}}$
8. PP $\rightarrow$ AP $\overline{\text{P}}$
9. PP $\rightarrow$ $\overline{\text{P}}$
10. $\overline{\text{P}}$ $\rightarrow$ P NP

Müller (2019). Grammatical theory, p. 72.

Prepositional Phrase Example



Rewrite Notation

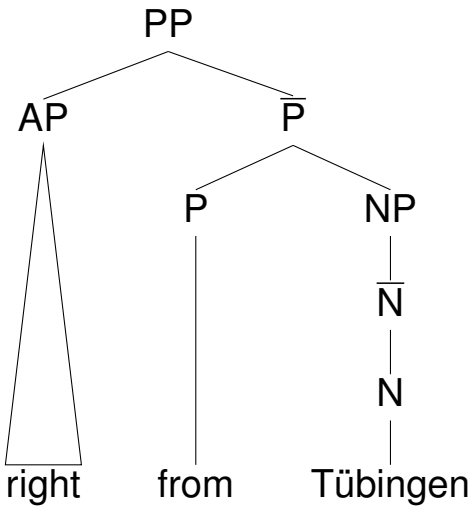
NP
DET $\overline{N}$
DET $\overline{N}$ PP
DET N $\overline{P}$
DET N P NP
DET N P $\overline{N}$
DET N P N

---

a N P N
a child P N
etc.

Note: There is an inflation of non-terminal rewritings due to the fact that X-bar elements have to be rewritten into elements without the bar before being rewritten into the terminals.

Prepositional Phrase Example (with Adjective)



Rewrite Notation

PP
AP $\overline{P}$
AP P NP
AP P $\overline{N}$
AP P N

---

right P N
right from N
right from Tübingen

Note: We haven't defined the structure of adjective phrases (AP) according to X-bar rules yet. Hence, the AP is directly connected to the terminal word *right* by a triangle, which is a placeholder for the actual branching structure.

Adjective Phrases

Müller (2019), p. 74 gives the following examples of adjective phrases that need to be covered by corresponding X-bar rules:

(9) proud

(10) very proud

(11) proud of his son

(12) very proud of his son

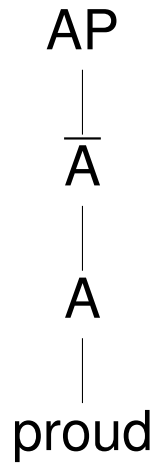
Adjective Phrases

Therefore, he proposes the following rules:

11. $AP \rightarrow \overline{A}$
12. $AP \rightarrow AdvP\ \overline{A}$
13. $\overline{A} \rightarrow A\ PP$
14. $\overline{A} \rightarrow A$

Müller (2019). Grammatical theory, p. 74.

Adjective Phrase Examples

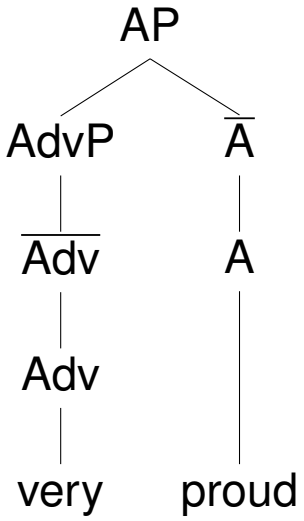


Rewrite Notation

AP
Ā
A

---

proud



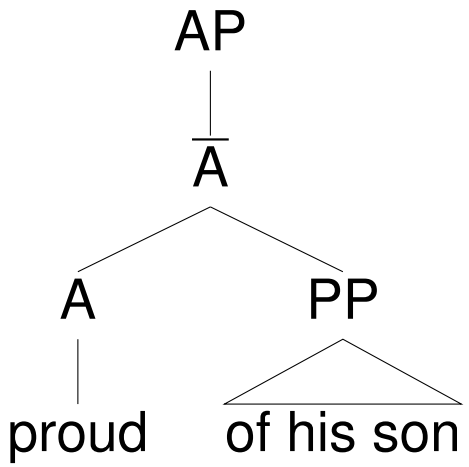
Rewrite Notation

AP
AdvP Ā
AdvP A

---

very A
very proud

Adjective Phrase Examples

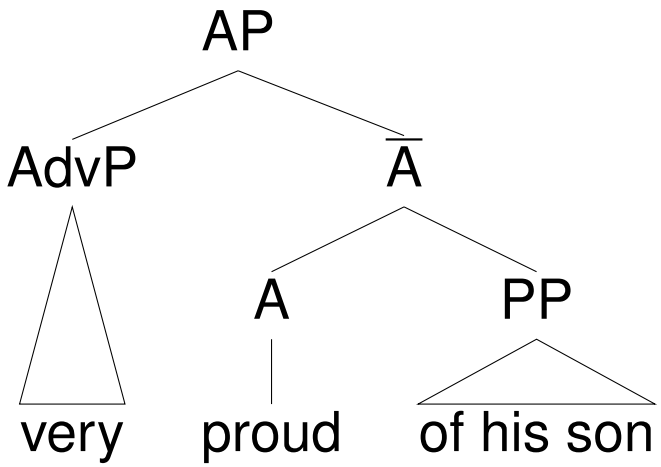


Rewrite Notation

AP
Ā
A PP

---

proud PP
etc.



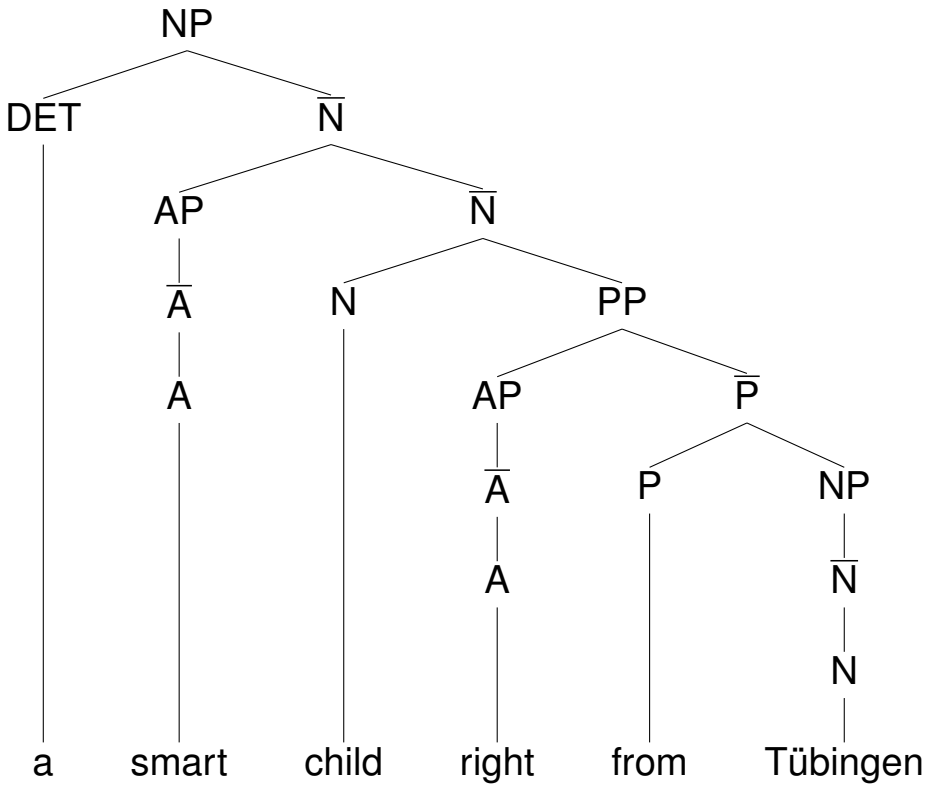
Rewrite Notation

AP
AdvP Ā
AdvP A PP

---

very A PP
etc.

Full Example



Rewrite Rules

1. NP → DET $\bar{N}$
2. $\bar{N}$ → AP $\bar{N}$
3. $\bar{N}$ → N
4. $\bar{N}$ → $\bar{N}$ PP
5. $\bar{N}$ → $\bar{N}$ REL
7. PP → NP $\bar{P}$
8. PP → AP $\bar{P}$
9. PP → $\bar{P}$
10. $\bar{P}$ → P NP
11. AP → $\bar{A}$
12. AP → AdvP $\bar{A}$
13. $\bar{A}$ → A PP
14. $\bar{A}$ → A

Notes: The rule number two was modified (A → AP). Rule number six is not included here as it was replaced by other rules of the X-bar notation.

Notation Glossary

A: adjective
AP: adjective phrase
Adv: adverb
AdvP: adverbial phrase
COMPL: complementizer (i.e. *that*)
DET: determiner
N: noun
NP: noun phrase
P: preposition
PP: prepositional phrase
PRON: pronoun
REL: relative clause
V: verb
VP: verb phrase

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Section 4: $\overline{X}$ Theory

$\overline{X}$ rules

Grammarians (mostly working with English) realized that different phrase structure rules have structural similarities and can hence be capture in more abstract form by using **X as a placeholder** for other non-terminal symbols.

See also discussion in Müller (2019), p. 75.

$$\overline{\overline{X}} \equiv XP \rightarrow NP, VP, AP, PP, \text{etc.}$$

$$\overline{X} \rightarrow \overline{N}, \overline{V}, \overline{A}, \overline{P}, \text{etc.}$$

$$X \rightarrow N, V, A, P, \text{etc.}$$

Examples of $\overline{X}$ rules

Rewrite Rules

1. **NP** → **DET** $\overline{\mathbf{N}}$
2. $\overline{N}$ → AP $\overline{N}$
3. $\overline{N}$ → N
4. $\overline{N}$ → $\overline{N}$ PP
5. $\overline{N}$ → $\overline{N}$ REL
7. **PP** → **NP** $\overline{\mathbf{P}}$
8. **PP** → **AP** $\overline{\mathbf{P}}$
9. PP → $\overline{P}$
10. $\overline{P}$ → P NP
11. AP → $\overline{A}$
12. **AP** → **AdvP** $\overline{\mathbf{A}}$
13. $\overline{A}$ → A PP
14. $\overline{A}$ → A

Bar-notation:

1. $\overline{\overline{N}} \rightarrow \overline{\overline{DET}}^{1}\ \overline{N}$
7. $\overline{\overline{P}} \rightarrow \overline{N}\ \overline{P}$
8. $\overline{\overline{P}} \rightarrow \overline{A}\ \overline{P}$
12. $\overline{\overline{A}} \rightarrow \overline{\overline{Adv}}\ \overline{A}$

X-bar rule:

$$\overline{\overline{\mathbf{X}}} \rightarrow \overline{\overline{\mathbf{specifier}}}\ \overline{\mathbf{X}}$$

[1] Note that we have previously assumed that determiners do not head phrases, hence this rule is strictly speaking not valid within our definitions.

Examples of $\overline{X}$ rules

Rewrite Rules

1. NP $\rightarrow$ DET $\overline{N}$
2. **$\overline{N}$ $\rightarrow$ AP $\overline{N}$**
3. $\overline{N}$ $\rightarrow$ N
4. **$\overline{N}$ $\rightarrow$ $\overline{N}$ PP**
5. **$\overline{N}$ $\rightarrow$ $\overline{N}$ REL**
7. PP $\rightarrow$ NP $\overline{P}$
8. PP $\rightarrow$ AP $\overline{P}$
9. PP $\rightarrow$ $\overline{P}$
10. $\overline{P}$ $\rightarrow$ P NP
11. AP $\rightarrow$ $\overline{A}$
12. AP $\rightarrow$ AdvP $\overline{A}$
13. $\overline{A}$ $\rightarrow$ A PP
14. $\overline{A}$ $\rightarrow$ A

Bar-notation:

2. $\overline{N} \rightarrow \overline{A}\ \overline{N}$
4. $\overline{N} \rightarrow \overline{N}\ \overline{PP}$
5. $\overline{N} \rightarrow \overline{N}\ \overline{REL}$

X-bar rule:

$\overline{X} \rightarrow \overline{\text{adjunct}}\ \overline{X}$

or

$\overline{X} \rightarrow \overline{X}\ \overline{\text{adjunct}}$

Examples of $\overline{X}$ rules

Rewrite Rules[1]

15. $\overline{V} \rightarrow$ V NP
16. $\overline{V} \rightarrow$ V NP NP
etc.

Bar-notation:

15. $\overline{V} \rightarrow V\ \overline{\overline{N}}$
16. $\overline{V} \rightarrow V\ \overline{\overline{N}}\ \overline{\overline{N}}$

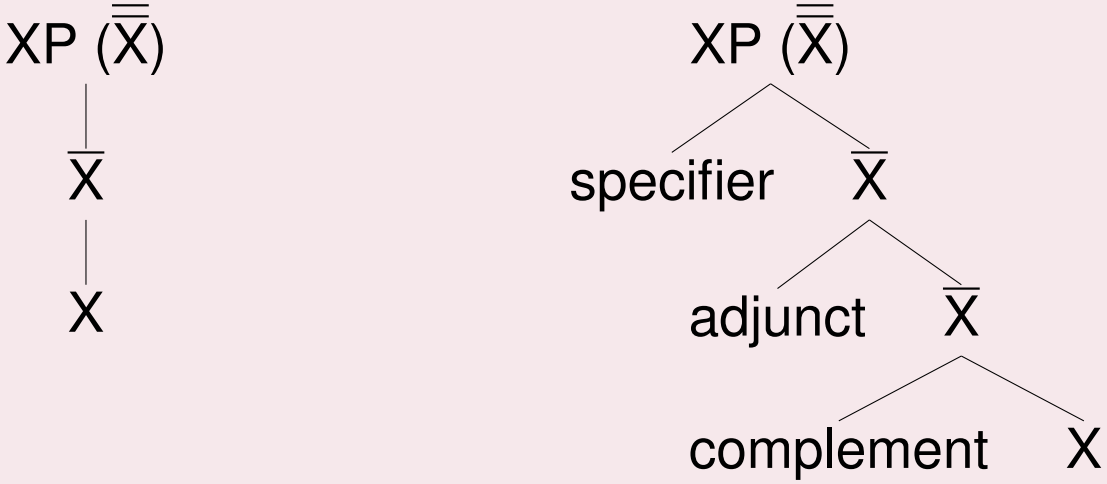
X-bar rule:

$\overline{X} \rightarrow X\ \overline{\text{complement}^*}$

[1]We haven't introduced VPs and their X-bar structure in this lecture, but here are two possible rewrite rules involving verbs and their complements as proposed within the Government & Binding framework.

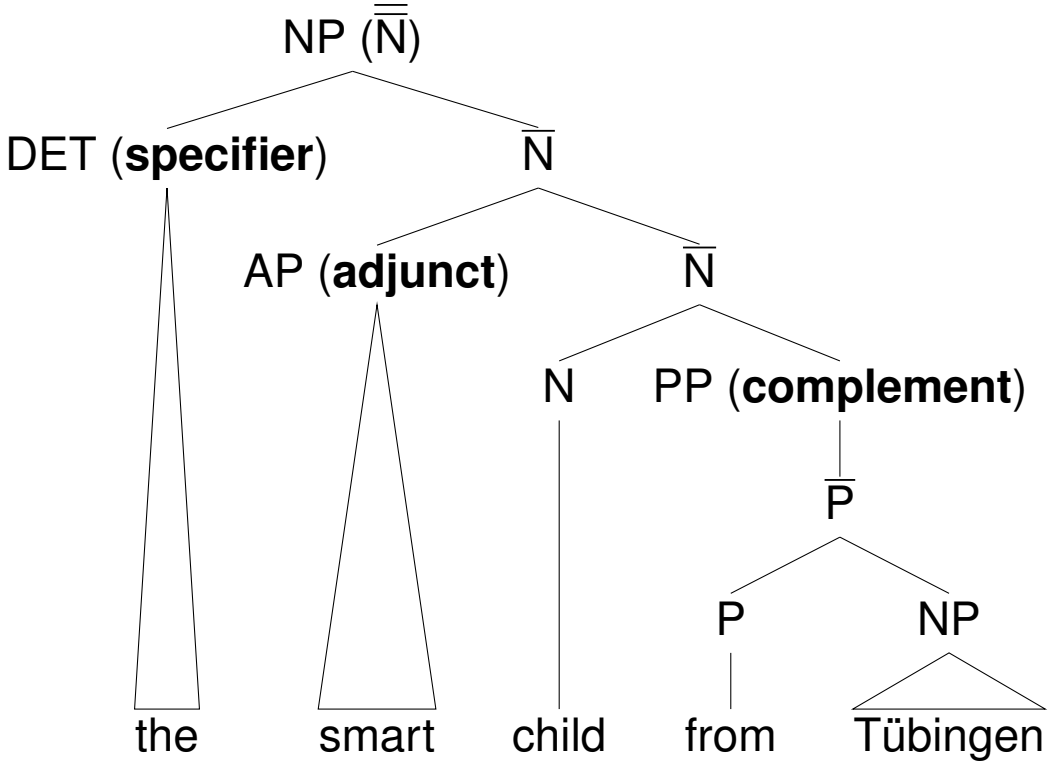
Maximal and Minimal $\overline{X}$ phrases

Given all the generalized $\overline{X}$ rules above we get to the **minimal** and **maximal phrase structure** possible within $\overline{X}$ theory:



Müller (2019). Grammatical theory, p. 76.

Example of Maximal $\overline{X}$ Phrase



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Section 5: Pros and Cons of $\overline{X}$ theory

Pros (Advantages)

- Explicitely models the productiveness of natural language by recursively applying rules (though note that recursive application is also possible in classical PSGs)
- Abstracts away from ideosyncrasies of particular phrase types and formulates more general rules
- While we haven't discussed morphological features in this lecture, these can be implemented (similar to PSG)

Cons (Disadvantages)

- The bar-notation leads to an inflation of unary branches, and, more generally, makes the analyses of even relatively simple sentences quite daunting.

Section 6: Current Research

A Language Without Recursion?

PLOS ONE

RESEARCH ARTICLE

A Corpus Investigation of Syntactic Embedding in Pirahã

Richard Futrell[1]*, Laura Stearns[1], Daniel L. Everett[2], Steven T. Piantadosi[3☯], Edward Gibson[1☯]

1 Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA, United States of America, **2** Dean of Arts and Sciences, Bentley University, Waltham, MA, United States of America, **3** Department of Brain and Cognitive Sciences, University of Rochester, Rochester, NY, United States of America

A Language Without Recursion?

- Embedded possessives: *[[[the woman]'s sister]'s husband]*
- Reported Speech: *He said [that she said [that . . .]]*
- Sentential complements: *I dreamed that the Brazilian woman was there last night*
- Adverbials: *because x, x*
- Relative clauses: *the food that the man devoured*
- Coordination: *John and Mary and Bill and ...*

Futrell at al. (2016). A corpus investigation of syntactic embedding in Pirahã.

A Language Without Recursion?

"Our analysis has failed to find strong support for syntactically embedded structures in Pirahã. We emphasize that any conclusions that can be drawn from this corpus evidence must be highly tentative, due to the difficulty of working with a language whose speakers are so difficult to access, as well as the computational challenges of characterizing linguistic complexity."

Futrell at al. (2016). A corpus investigation of syntactic embedding in Pirahã.

A Language Without Recursion?

"We found no unambiguous evidence for sentential or NP embedding in Pirahã in our corpus. The corpus is consistent with the hypothesis that Pirahã is a regular language; [...] In order to flesh out our claim that the corpus is consistent with a regular grammar, we give here a regular expression (technically an egrep expression) which is consistent with the corpus. The symbol `S` matches all sentences in the corpus:

```
 S = NPtopic?  NPtopic?  NPvoc?  NPsubj NPsubj?  NPsubj?
NPtmp?  NPloc?  NPiobj?  (JJobj | NPobj NPobj?)?  NPiobj?  V
JJobj?  NPvoc?  NPtopic?
```

where `X?` means optional `X` , `(X|Y)` means `X` or `Y`, and each of the symbols above expand into other regular expressions (ignoring morphology and null nouns/verbs) [...]"

Futrell at al. (2016). A corpus investigation of syntactic embedding in Pirahã, p. 17.

Section 7: References

References

Futrell at al. (2016). A corpus investigation of syntactic embedding in Pirahã. *Plos One.*

Müller, Stefan. 2019. *Grammatical theory: From transformational grammar to constraint-based approaches. Third revised and extended edition.* ***Volume I****.* Berlin: Language Science Press.

Thank You.

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