Patterns in Interpretation

PSRs

$$\left\{\begin{array}{c} \text{S} \rightarrow \text{NP VP} \\ \text{NP} \rightarrow \text{(D) N'} \\ \text{N'} \rightarrow \text{(Adj) N} \\ \text{VP} \rightarrow \text{V (NP)} \end{array}\right\}$$

Interpretational Rules

$$\left\{\begin{array}{c} [\![S]\!] = \text{TRUE iff } [\![NP]\!] \in [\![VP]\!] \\ [\![NP]\!] = \text{x, x}\in[\![N']\!]) \\ [\![N']\!] = [\![Adj]\!] \cap [\![N]\!] \\ [\![VP]\!] = \{\text{x: } \langle x, [\![NP]\!]\rangle \in [\![V]\!]\} \end{array}\right\}$$

ELC 231: Introduction to Language and Linguistics

Syntax & Semantics: The Syntax-Semantics Interface

Dr. Meagan Louie

Core Subdomains

Linguistics: The study of Language

- Phonetics
- Phonology
- Morphology
- Syntax
- Semantics
- Pragmatics

Core Subdomains: Last Week - Morphology and Syntax

Linguistics: The study of Language

- Phonetics
- Phonology
- **Morphology**
- **Syntax**
- Semantics
- Pragmatics

Core Subdomains: This Week - Syntax-Semantics

Linguistics: The study of Language

- Phonetics
- Phonology
- Morphology
- **Syntax**
- **Semantics**
- Pragmatics

Core Subdomains: Syntax

- **Syntax:** The study of **phrase**- and **sentence-formation** in language

1 The key notion of Constituency and Structure

2 Phrase Structure Rules (PSRs)

3 Productivity as a Design Feature

Core Subdomains: Semantics

- **Semantics:** The study of **MEANING** in language

1 **Review:** Meaning as Truth and reference

2 **REVIEW:** Compositionality

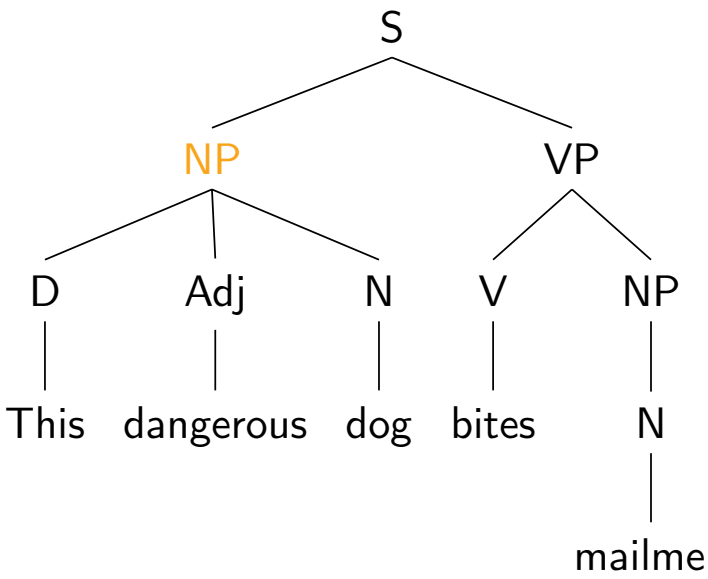
3 A Semantic Interpretation System for Language

(i) The Model/Ontology
(ii) Lexical Entries
(iii) Compositional Rules (i.e., how to semantically interpret PSRs)

Basic Syntactic Theory: Phrase Structure Rules

Q: How are sentences made?

H1: Sentences are made up of CONSTITUENTS



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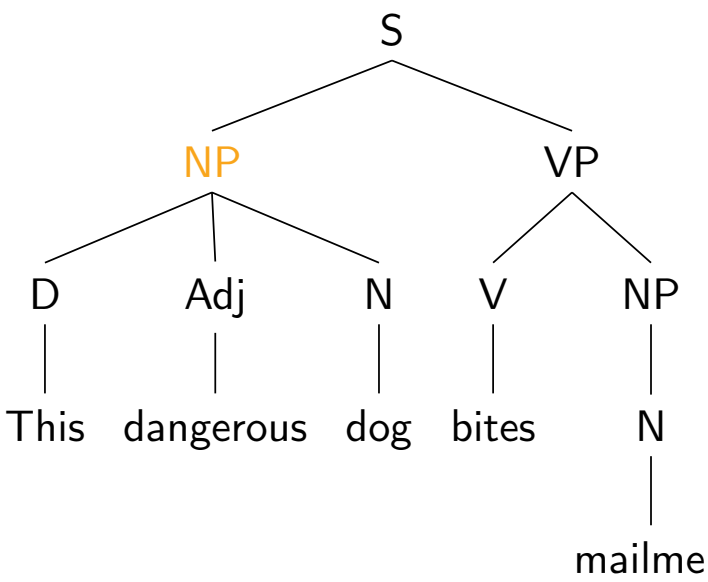

- Constituents are formed from words with PHRASE-STRUCTURE RULES (PSRs)

Basic Syntactic Theory: Phrase Structure Rules

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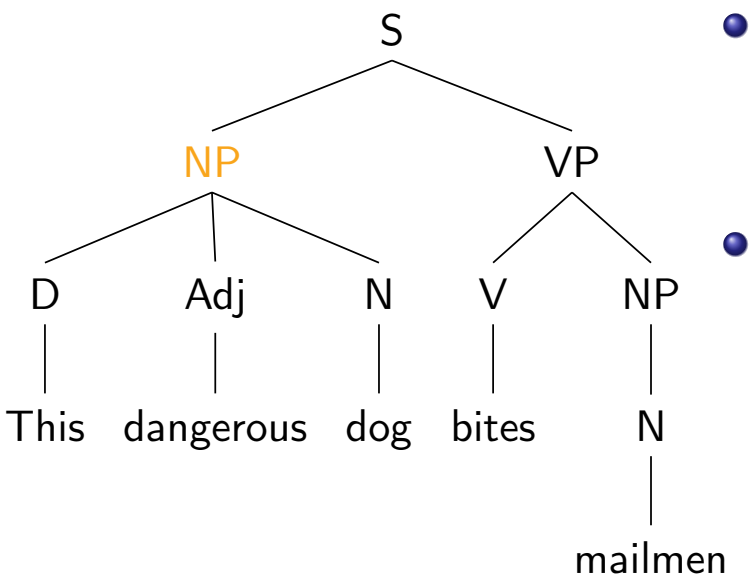

- Constituents are formed from words with PHRASE-STRUCTURE RULES (PSRs)
- PSRs restrict WORD ORDER

eg., English PSRs

$S \rightarrow NP\ VP$

$NP \rightarrow (D)\ (Adj)\ N$

$VP \rightarrow V\ (NP)$

About Phrase Structure Rules (PSRs)

Idea: Each language, X, has a set of **PSRs**:

- Any sentence generated by the PSRs is grammatical in X
- Only the sentences generated by the PSRs are grammatical in X

English PSRs

$$\left\{\begin{array}{c} S \rightarrow NP\ (V_{AUX})\ VP \\ NP \rightarrow (D)\ (ADJ)\ N \\ VP \rightarrow V\ (NP) \end{array}\right\}$$

"The big dog has eaten the raw steak"

D Adj N V_{aux} V_{ptc} D Adj N

Q: Can the English PSRs generate a tree structure for this sentence?

About Phrase Structure Rules (PSRs)

Idea: Each language, X, has a set of **PSRs**:

- Any sentence generated by the PSRs is grammatical in X
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English PSRs

$$\left\{\begin{array}{c} \mathrm{S} \rightarrow \mathrm{NP}\ (\mathrm{V_{AUX}})\ \mathrm{VP} \\ \mathrm{NP} \rightarrow (\mathrm{D})\ (\mathrm{ADJ})\ \mathrm{N} \\ \mathrm{VP} \rightarrow \mathrm{V}\ (\mathrm{NP}) \end{array}\right\}$$

"Le gros chien a mangé le steak cru"

D Adj N V_{aux} V_{ptc} D N Adj

Q: Can the English PSRs generate a tree structure for *this* sentence?

About Phrase Structure Rules (PSRs)

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French PSRs

$$\left\{\begin{array}{c} S \rightarrow NP\ (V_{AUX})\ VP \\ NP \rightarrow (D)\ (ADJ_{SIZE})\ N\ (ADJ) \\ VP \rightarrow V\ (NP) \end{array}\right\}$$

"Le gros chien a mangé le steak cru"

D Adj N V_{aux} V_{ptc} D N Adj

Q: Can these PSRs generate a tree structure for this sentence?

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Idea: Each language, X, has a set of **PSRs**:

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/ookina inu-ga sute:ki-o tabemashita/

Adj N_{nom} N_{acc} V

Q: Can the French PSRs generate a tree structure for *this* sentence?

About Phrase Structure Rules (PSRs)

Idea: Each language, X, has a set of **PSRs**:

- Any sentence generated by the PSRs is grammatical in X
- Only the sentences generated by the PSRs are grammatical in X

Japanese PSRs

$$\left\{ \begin{array}{c} \text{S} \rightarrow \text{NP VP} \\ \text{NP} \rightarrow (\text{Adj}) \text{ N} \\ \text{VP} \rightarrow (\text{NP}) \text{ V} \end{array} \right\}$$

/ookina inu-ga sute:ki-o tabemashita/

Adj $\quad \text{N}_{\text{nom}} \quad \text{N}_{\text{acc}} \quad$ V

Q: Can these PSRs generate a tree structure for the sentence?

Basic Syntactic Theory: Phrase Structure Rules

Q: How are sentences made?

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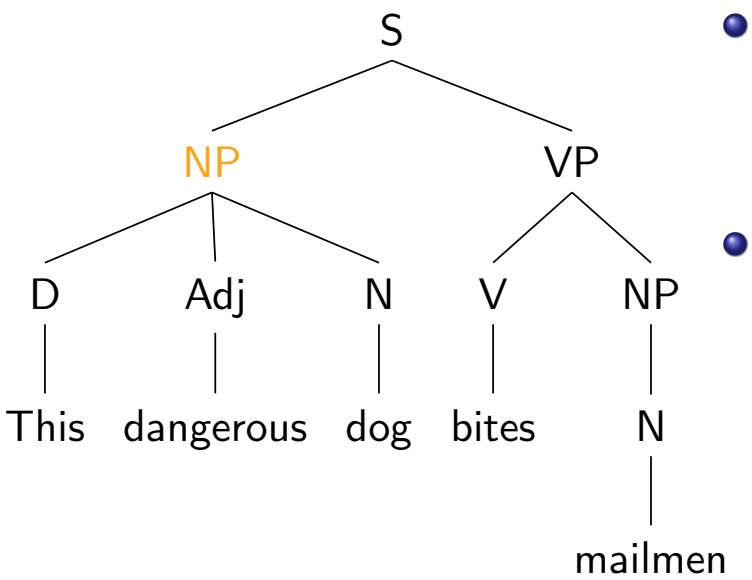


- Constituents are formed from words with PHRASE-STRUCTURE RULES (PSRs)
- PSRs restrict WORD ORDER

eg., English PSRs

$S \rightarrow NP\ VP$

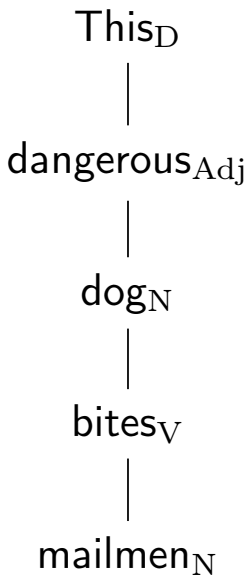
$NP \rightarrow (D)\ (Adj)\ N$

$VP \rightarrow V\ (NP)$

Basic Syntactic Theory: Phrase Structure Rules

Q: How are sentences made?

H2: Sentences are strings of words with a flat structure



Basic Syntactic Theory: Phrase Structure Rules

Q: How are sentences made?

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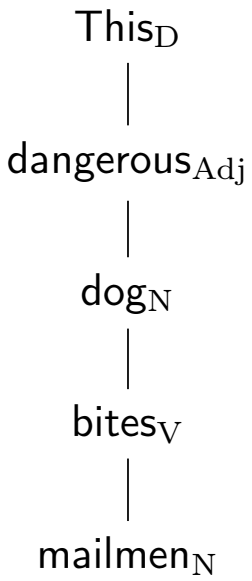

- Strings are formed from words with SENTENCE-STRING RULES

Basic Syntactic Theory: Phrase Structure Rules

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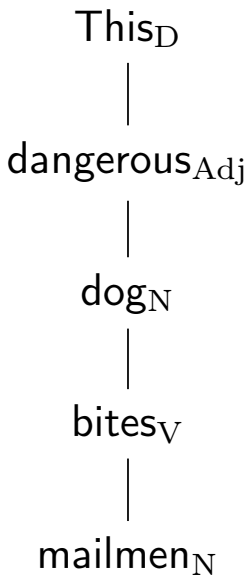


- Strings are formed from words with SENTENCE-STRING RULES
- These rules restrict WORD ORDER

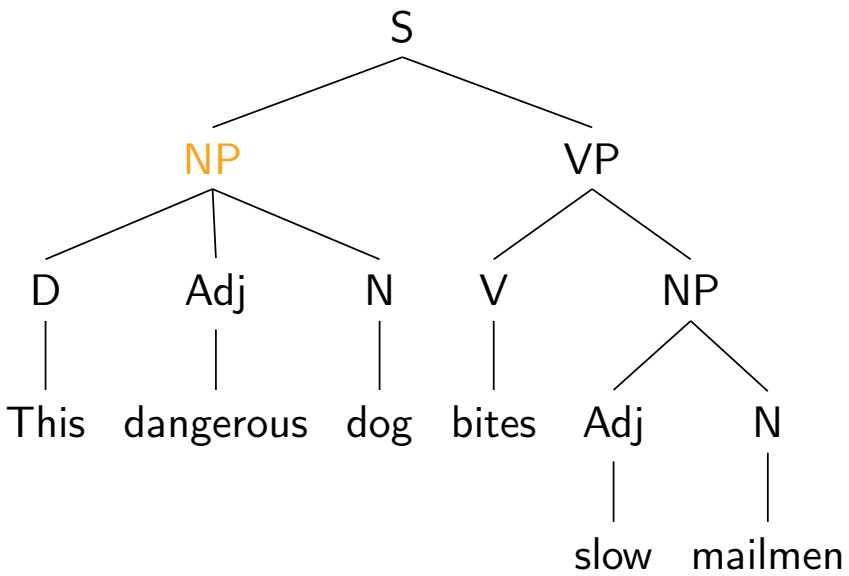
eg., English Sentence-String Rule

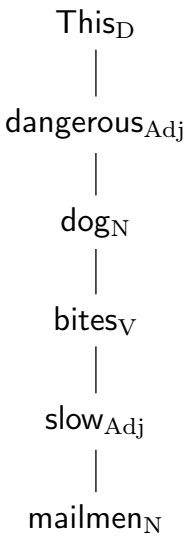
$$S \rightarrow (D)\ (Adj)\ N\ V\ (D)\ (Adj)\ (N)$$

Basic Syntactic Theory: Phrase Structure Rules

Q: Is there any INDEPENDENT evidence for CONSTITUENTS?

H1: Hierarchically-Ordered Constituents H2: Linearly-Ordered Words





Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(1) English Y/N Questions 1

a. Clifford WILL jump over the house

b. WILL Clifford ~~will~~ jump over the house?

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(1) English Y/N Questions 1

a. Clifford WILL jump over the house

b. WILL Clifford ~~will~~ jump over the house?

- H1: A rewrite rule based on linear-order

  1 2 3 4 5 ... $\rightarrow$ 2 1 3 4 5 ... (1) ✓

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(2) English Y/N Questions 2

a. The BIG red dog will jump over the house

b. *BIG the ~~big~~ red dog will jump over the house?

- H1: A rewrite rule based on linear-order

  1 2 3 4 5 ... → 2 1 3 4 5 ... (2) ✗

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(2) English Y/N Questions 2

a. The big red dog WILL jump over the house

b. WILL the big red dog ~~will~~ jump over the house?

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(2) English Y/N Questions 2

a. The big red dog WILL jump over the house

b. WILL the big red dog ~~will~~ jump over the house?

- H2: A rewrite rule based on linear-order, sensitive to lexical category

X Y AUX_1 Z W ... $\rightarrow$ AUX_1 X Y Z W... (2) ✓

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(1) English Y/N Questions 1

a. Clifford WILL jump over the house

b. WILL Clifford ~~will~~ jump over the house?

- H2: A rewrite rule based on linear-order, sensitive to lexical category

X Y AUX_1 Z W ... $\rightarrow$ AUX_1 X Y Z W... (1) ✓

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

(3) English Y/N Questions 3

a. The dog that Beth MIGHT$_1$ buy will$_2$ jump over the house

b. MIGHT$_1$ the dog that Beth ~~might~~ buy will$_2$ jump over the house?

- H2: A rewrite rule based on linear-order, sensitive to lexical category

X Y AUX$_1$ Z W ... $\rightarrow$ AUX$_1$ X Y Z W... (3) ✗

Independent Evidence for Constituents

(1) English Y/N Questions 1: H1 ✓, H2 ✓

a. Clifford WILL jump over the house

b. WILL Clifford ~~will~~ jump over the house?

(2) English Y/N Questions 2: H1 ✗, H2 ✓

a. The big red dog WILL jump over the house

b. WILL the big red dog ~~will~~ jump over the house?

(3) English Y/N Questions 3: H1 ✗, H2 ✗

a. The dog that Beth might buy WILL jump over the house

b. WILL_1 the dog that Bethmight buy ~~will~~ jump over the house?

Observation: The V_{aux} that moves appears after the first NP

(1) English Y/N Questions 1: H1 ✓, H2 ✓

a. [Clifford]$_{NP}$ WILL jump over the house

b. WILL Clifford ~~will~~ jump over the house?

(2) English Y/N Questions 2: H1 ✗, H2 ✓

a. [The big red dog]$_{NP}$ WILL jump over the house

b. WILL the big red dog ~~will~~ jump over the house?

(3) English Y/N Questions 3: H1 ✗, H2 ✗

a. [The dog that Beth might buy]$_{NP}$ WILL jump over the house

b. WILL$_1$ the dog that Bethmight buy ~~will~~ jump over the house?

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**
- H3: Rewrite rule based on constituents, sensitive to lexical category

$$[\text{X Y ...}]_{\text{NP}}\ \text{AUX}_1\ \text{Z W ...} \rightarrow \text{AUX}_1\ [\text{X Y ...}]_{\text{NP}}\ \text{Z W...}$$

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**
- H3: Rewrite rule based on constituents, sensitive to lexical category

$$[\text{X Y ...}]_{\text{NP}}\ \textsc{Aux}_1\ \text{Z W ...} \rightarrow \textsc{Aux}_1\ [\text{X Y ...}]_{\text{NP}}\ \text{Z W...}$$

(3) English Y/N Questions 3: H1 ✗, H2 ✗, H3 ✓

a. [The dog that Beth might buy]$_{\text{NP}}$ WILL jump over the house

b. WILL$_1$ the dog that Beth might buy ~~will~~ jump over the house?

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**
- H3: Rewrite rule based on constituents, sensitive to lexical category

$$[\text{X Y ...}]_{\text{NP}}\ \text{AUX}_1\ \text{Z W ...} \rightarrow \text{AUX}_1\ [\text{X Y ...}]_{\text{NP}}\ \text{Z W...}$$

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Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**
- H3: Rewrite rule based on constituents, sensitive to lexical category

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Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**
- H3: Rewrite rule based on constituents, sensitive to lexical category

  $[\text{X Y ...}]_{\text{NP}}$ AUX_1 Z W ... $\rightarrow$ AUX_1 $[\text{X Y ...}]_{\text{NP}}$ Z W...

(1) English Y/N Questions 1: H1 ✓, H2 ✓, H3 ✓

a. $[\text{Clifford}]_{\text{NP}}$ WILL jump over the house

b. WILL Clifford ~~will~~ jump over the house?

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

	Data (1)	Data (2)	Data (3)
H1	✓	✗	✗
H2	✓	✓	✗
H3	✓	✓	✓

Basic Syntactic Theory: Constituents

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	Data (1)	Data (2)	Data (3)
H1	✓	✗	✗
H2	✓	✓	✗
H3	✓	✓	✓

- **Observation:** Only the hypothesis that makes reference to a constituent (H3) can account for all of the Y/N question data

  → Y/N Q-formation provides independent evidence for constituents

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

	Data (1)	Data (2)	Data (3)
H1	✓	✗	✗
H2	✓	✓	✗
H3	✓	✓	✓

- **Observation:** Only the hypothesis that makes reference to a constituent (H3) can account for all of the Y/N question data

  → Passive-formation also requires a constituent-sensitive rule

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: How do you form Y/N Questions in English?**

	Data (1)	Data (2)	Data (3)
H1	✓	✗	✗
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- **Observation:** Only the hypothesis that makes reference to a constituent (H3) can account for all of the Y/N question data

  → Using "and" and "or" also provide evidence for constituents

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: What strings of words can be conjoined with "and"?**

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: What strings of words can be conjoined with "and"?**

(4) a. Elizabeth bought a puppy.

b. [Elizabeth and her mother] bought a puppy.

c. Elizabeth [bought a puppy and read a book]

d. *Elizabeth [bought a and hugged the] puppy

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: What strings of words can be conjoined with "and"?**

(4) a. Elizabeth bought a puppy.

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- **Idea:** Only matching CONSTITUENTS can be conjoined with "and"

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Q: What strings of words can be conjoined with "or"?**

(5) a. Elizabeth bought a puppy.

b. [Elizabeth or her mother] bought a puppy.

c. Elizabeth [bought a puppy or read a book]

d. *Elizabeth [**bought a** or **hugged the**] puppy

- **Idea:** Only matching CONSTITUENTS can be conjoined with "or"

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Hypothesis:** Only matching CONSTITUENTS can be conjoined

Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Hypothesis:** Only matching CONSTITUENTS can be conjoined

→ Conjunction (use of "and/or") is
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Basic Syntactic Theory: Constituents

Q: Is there independent evidence for constituents?

- **Hypothesis:** Only matching CONSTITUENTS can be conjoined

  → Conjunction (use of "and/or") is
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- **We can also use conjunction as a DIAGNOSTIC**
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Basic Syntactic Theory: Constituents

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- **Hypothesis:** Only matching CONSTITUENTS can be conjoined

  → Conjunction (use of "and/or") is
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- **We can also use conjunction as a DIAGNOSTIC**
  for whether a string of words is a constituent

- i.e., if a string of lexical categories *A B C* can be conjoined with "and/or," that provides evidence that *A B C* is a constituent

Constituency Tests: Conjunction Test

- **Assumption:** Only matching CONSTITUENTS can be conjoined
- i.e., if a string of lexical categories *A B C* can be conjoined with "and/or," that provides evidence that *A B C* is a constituent

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- **Assumption:** Only matching CONSTITUENTS can be conjoined
- i.e., if a string of lexical categories *A B C* can be conjoined with "and/or," that provides evidence that *A B C* is a constituent

(6) a. Hermione bought the orange cat

b. Hermione bought the [orange cat and expensive book]

c. Hermione bought the [orange cat or expensive book]

Constituency Tests: Conjunction Test

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- Our current PSR NP $\rightarrow$ (D) (Adj) N doesn't account for this data!

Constituency Tests: Conjunction Test

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- Our current PSR NP $\rightarrow$ (D) (Adj) N doesn't account for this data!
- Should we propose a new type of constituent [Adj N]$_{\text{N'}}$?

Revised PSRs: Evidence for N'

(7) a. Hermione bought the orange cat

b. Hermione bought the [orange cat and/or expensive book]

Revised PSRs: Evidence for N'

(7) a. Hermione bought the orange cat

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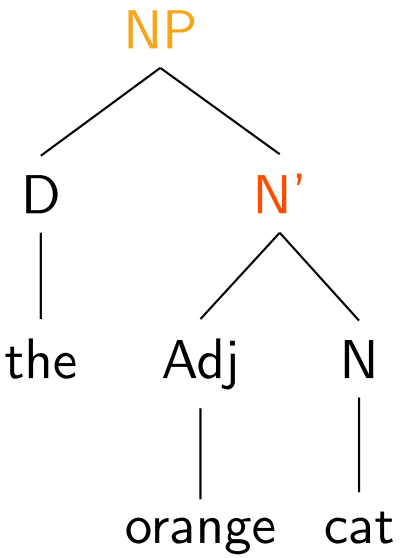
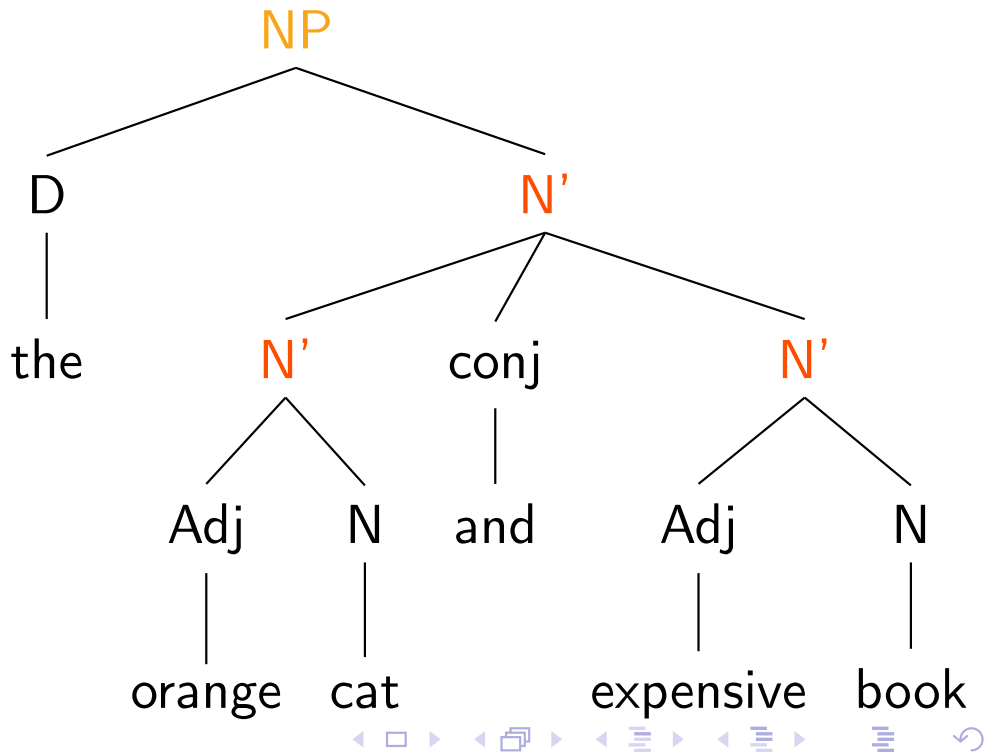
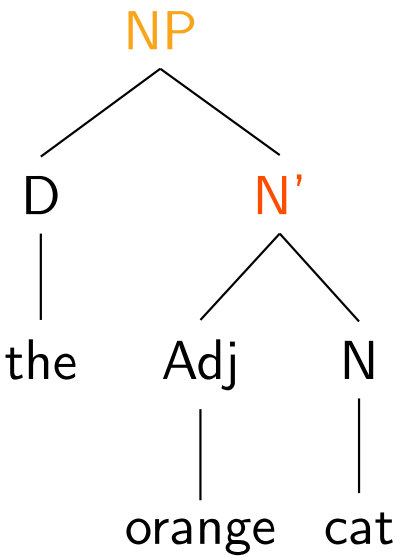
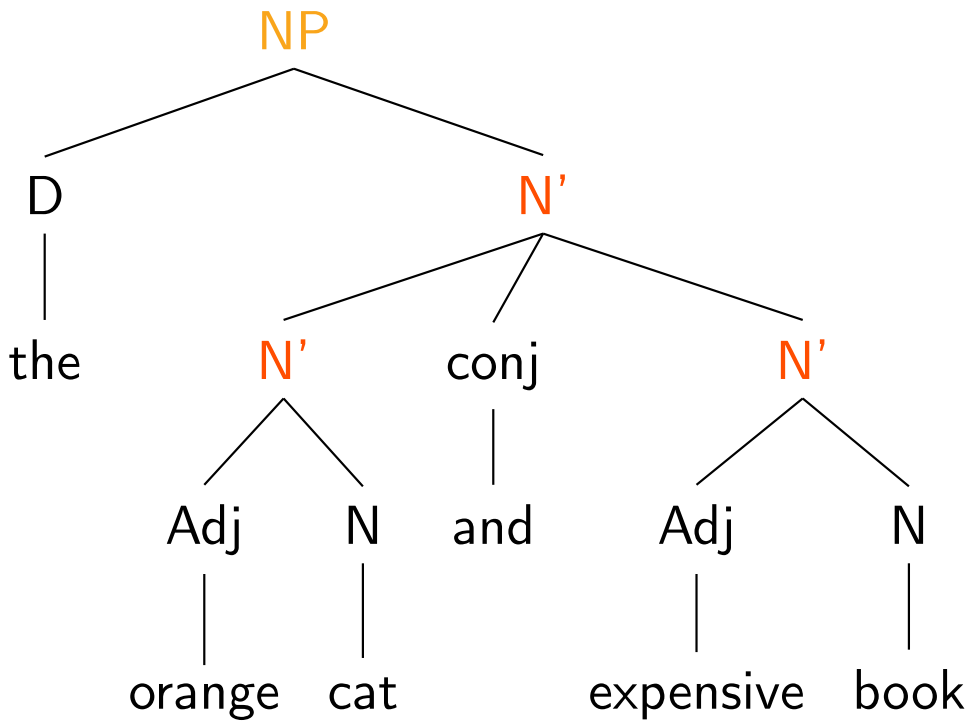




Revised PSRs: Evidence for N'

1. NP $\rightarrow$ (D) N'
2. N' $\rightarrow$ (Adj) N
3. X $\rightarrow$ X conj X (Conjunction Rule)





Basic Syntactic Theory: Constituents

There independent evidence for constituents

→ There are also systematic patterns in MEANING/INTERPRETATION...

→ These patterns only be described with rules
that make reference to constituents

(i.e., there is *semantic*, as well as *syntactic*
evidence for constituents)

Basic Syntactic Theory: Constituents

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Patterns in Interpretation

Review: Types of Word-Formation

1 **Concatenation**

Combining morphemes together to form new words

- eg., *un-believe-abil-ity* (predictable/compositional meaning)

Patterns in Interpretation

Review: Types of Word-Formation

1 **Concatenation**

Combining morphemes together to form new words

- eg., *un-believe-abil-ity* (predictable/compositional meaning)

2 **Neologism/Coinage**

Combining phonemes together to form new morphemes

- eg., *bikini* **(French coinage)** (arbitrary meaning)

Patterns in Interpretation

Review: Types of Word-Formation

1 **Concatenation**

Combining morphemes together to form new words

- eg., *un-believe-abil-ity* (predictable/compositional meaning)

2 **Neologism/Coinage**

Combining phonemes together to form new morphemes

- eg., *bikini* **(French coinage)** (arbitrary meaning)

3 **Compounding**

Combining entire words together to form new words

- eg., *binge-watch* (non-arbitrary but unpredictable meaning)

4 **Blending**

Combining parts of words together to form new words

- eg., *mansplain* (non-arbitrary but unpredictable meaning)

5 etc....

Patterns in Interpretation: Systematic VS Non-Systematic

Review: Types of Word-Formation

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Q: What's the difference?

Patterns in Interpretation: Systematic VS Non-Systematic

The difference is SYSTEMATICITY

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- The meaning of a word formed by CONCATENATION is **systematic**
- A SYSTEMATIC RULE can describe how the meaning of the parts combine to form a new meaning
- i.e., even if you've never heard the word before, as long as you know what the PARTS mean, you'll know what the new word means

Patterns in Interpretation: Systematic VS Non-Systematic

The SYSTEMATICITY of CONCATENATION

[N-ish]$_{\text{Adj}}$ Concatenation

(8)

clown	clownish	"Having properties of a clown"
snob	snobbish	"Having properties of a snob"
freak	freakish	"Having properties of a freak"
nightmare	nightmarish	"Having properties of a nightmare"
hawk	hawkish	"Having properties of a hawk"
wolf	wolfish	?

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wolf	wolfish	?

Systematic Semantic Rule:

[N-ish]$_{\text{Adj}}$ means "having properties of a N"

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- The meaning of a word formed by COMPOUNDING is not **systematic**
- We can't use a systematic rule to explain how the meaning of the word is derived from its parts
- i.e., If you've never heard the word before, you might guess wrong about what it means

Patterns in Interpretation: Systematic VS Non-Systematic

The NON-SYSTEMATICITY of COMPOUNDING

$[N+N]_N$ Compounds

(9)

street	streetcar	"A car that runs on tracks on in the streets"
clown	clowncar	"A car that contains lots of clowns"
soapbox	soapbox car	"A small car made out of a soapbox"
bait	bait car	"A car used by police as bait for car thieves"
cable	cable car	"A car suspended by cables"

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NO Systematic Semantic Rule:

$[N\text{-car}]_N$ means "A car that is located on N"
$[N\text{-car}]_N$ means "A car that contains a lot of N"
$[N\text{-car}]_N$ means "A car that is made out of N"
$[N\text{-car}]_N$ means "A car that is used as N"
...

Patterns in Interpretation: Systematic VS Non-Systematic

Q: Concatenation or compounding?

i.e., systematic or non-systematic meaning change?

/ri:an^{M}/	เรียน	"study"	/nak^{H}ri:an^{M}/	นักเรียน	"student"
/k^{h}it^{H}/	คิด	"think"	/nak^{H}k^{h}it^{M}/	นักคิด	"thinker"
/sɯ:p^{L}/	สืบ	"investigate"	/nak^{H}sɯ:p^{L}/	นักสืบ	"detective"
/bin^{M}/	บิน	"fly"	/nak^{H}bin^{M}/	นักบิน	"pilot"
/rɔ:ŋ^{H}/	นักร้อง	"sing"	/nak^{H}rɔ:ŋ^{H}/	นักร้อง	"singer"

→Can you formulate a systematic rule?

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/laaj^{M}/	ลาย	"striped"	/laaj^{M}taa^{M}/	ลายตา	"be dazzling"
/klaj^{M}/	ไกล	"far"	/klai^{M}taa^{M}/	ไกลตา	"out of sight"
/naa^{R}/	หนา	"thick"	/naa^{R}taa^{M}/	หนาตา	"dense/crammed"
/loŋ^{R}/	หลง	"lost"	/loŋ^{R}taa^{M}/	หลงตา	"overlooked"
/tit^{H}/	ติด	"stuck"	/tit^{L}taa^{M}/	ติดตา	"fresh in one's memory"

→Can you formulate a systematic rule?

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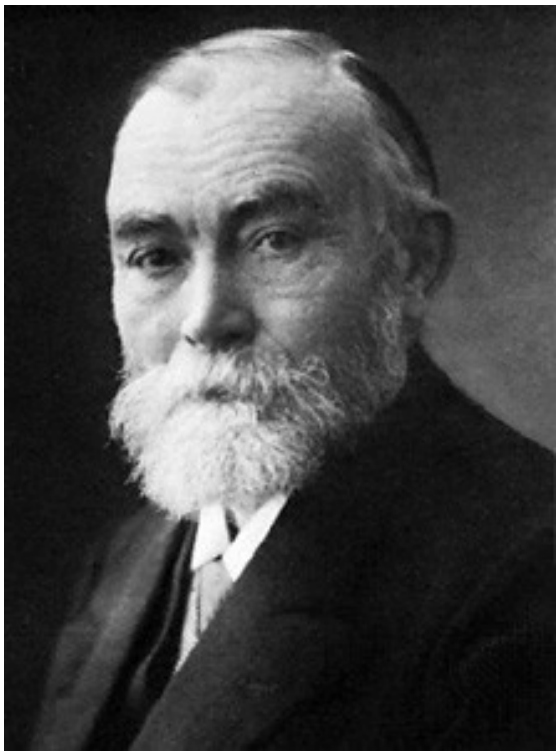
Is the meaning fully COMPOSITIONAL?

The Principle of Compositionality



Gottlob Frege (1848-1925)

The Principle of Compositionality

> *"...meaning of a complex expression is a function of the meaning of its parts and the way those parts are combined."*

The meaning of a complex phrase or sentence is based on

(i) the meaning of its parts and

(ii) the way that the parts are combined (e.g., which PSRs are used)

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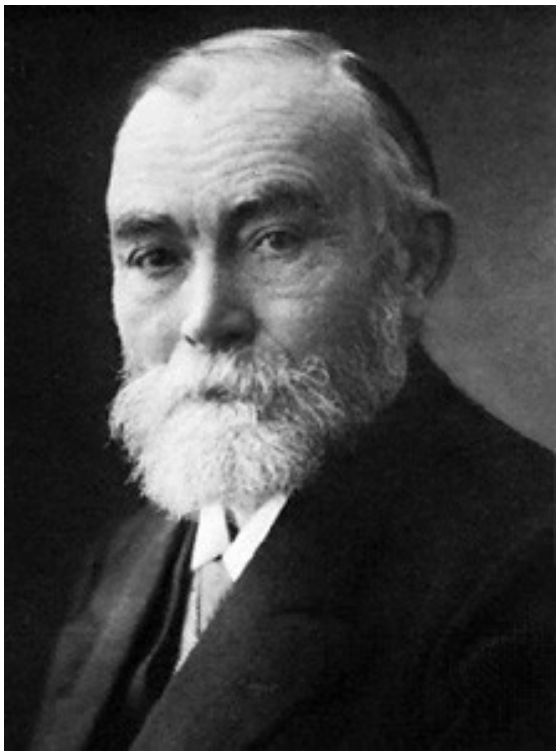

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The meaning of a complex phrase or sentence is derived from

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Semantic Interpretation Rules for PSRs

→ Before we can talk about interpretation rules for phrases...

Q: What are the basic building blocks of MEANING?

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The meaning of a sentence is its TRUTH-CONDITIONS -

i.e., what the world would have to look like, in order for it to be true

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REVIEW: What is Meaning?

The meaning of a sentence is its TRUTH-CONDITIONS -
i.e., what the world would have to look like, in order for it to be true

The meaning of a WORD or PHRASE is its REFERENCE -
i.e., what it refers to

Q: What do you KNOW...

...when you know what something MEANS?

REVIEW: What is Meaning?

The meaning of a SENTENCE is its TRUTH-CONDITIONS - i.e., under what conditions the sentence is TRUE

(10) Seriemas are a kind of bird

- If I tell you one of these are a Seriema, and you know what (10) means, then you know in which case (10) would be true

Q: What do you KNOW...

...when you know what something MEANS?

REVIEW: What is Meaning?

The meaning of a WORD is its REFERENCE - i.e., what it REFERS to

eg., A word like...

- [dɑg] "dog" refers to the **set** of **objects** that we consider dogs
- If you know what "dog" means,
  then you know how to categorize objects as dog VS non-dog


A


B


C


D

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eg., A word like...

- [ɹɛd] "red" refers to the **set** of **objects** that we consider red
- If you know what "red" means,
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Q: What do you KNOW...

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REVIEW: What is Meaning?

The meaning of a WORD is its REFERENCE - i.e., what it refers to

- If you know what "endemic" means, then you know how to categorize $\langle object, place \rangle$ **pairs** as endemic VS non-endemic

A $\langle bermuda\ petrels, Bermuda \rangle$

B $\langle glacier\ bears, southeast\ Alaska \rangle$

C $\langle elephants, Asia \rangle$

Q: What are the basic building blocks of MEANING?

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(i) OBJECTS/INDIVIDUALS: **a**, **b**, **c**, **d**

eg., "Bao-Bao"=**a**, "Taz"= **d**, ...


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(ii) SETS OF OBJECTS/INDIVIDUALS: **{a, b}**, **{a, b, c}**, **{a, c}** ...

eg., "animal" = **{a, b, c, d}**, "dog"= **{b, c}**, "caniformia"=**{a,b,c}**

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eg., "animal" = {**a, b, c, d**}, "dog"= {**b, c**}, "caniformia"={**a,b,c**}

(iii) PAIRS OF OBJECTS/INDIVIDUALS: ⟨**a,b**⟩, ⟨**b,a**⟩, ⟨**a,c**⟩...

eg., "is the same species as" = {⟨**b,c**⟩, ⟨**c,b**⟩}

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  - A SET is defined by its members (the elements inside the brackets)
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  - i.e., {a, b, c, d} = {a, c, d, b} = {a, d, c, b} etc.

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- These things, ⟨⟩, are angled **TUPLE BRACKETS**
  - An N-TUPLE is defined by its members...
  - ...and the order of the members
  - i.e., $\langle a, b \rangle \neq \langle b, a \rangle$
    (A 'pair' is the name of an n-tuple where n=2)

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  i.e., to describe natural language meaning, we need something like *ordering*

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- It's important that $\langle$**a**,**b**$\rangle \neq \langle$**b**,**a**$\rangle$!

Describing unrequited love requires ordered pairs

"Echo and Narcissus" (1903) by John William Waterhouse

$\langle$**e, n**$\rangle$, $\langle$**n,n**$\rangle$ $\quad$ ~~$\langle$**n,e**$\rangle$~~, ~~$\langle$**e,e**$\rangle$~~

Describing unrequited love requires ordered pairs

Young Lily Evans, James Potter and Severus Snape from "Harry Potter and the The Deathly Hallows" (Part 2)

$\langle s,l \rangle$, $\langle l,j \rangle$, $\langle j,l \rangle$ $\quad$ ~~$\langle s,j \rangle$~~, ~~$\langle j,s \rangle$~~, ~~$\langle l,s \rangle$~~

Basic Semantic Elements: The Ontology

The semantic elements are called the ONTOLOGY

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a = Harry Potter,

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3 OPERATIONS: Set-formation {}, pair/tuple-formation ⟨⟩

The LEXICON: The Repository of MORPHEMES

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A MORPHEME is the smallest unit of language that **has/contains** meaning - i.e., it is a systematic $\langle form, meaning, category \rangle$ mapping

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- Now that we have established some basic building blocks of meaning (i.e., an ontology)...

  ... we can formalize the meaning of various kinds of lexical categories as **referring** to elements in the ontology

The Lexical Entries of Lexical Categories

Semantic Ontology

1. **Truth-Values**: **T**, **F**
2. **Individuals**:
   - **a** = Harry
   - **b** = Hermione
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   - **e** = Buckbeak
   - **f** = Luna
   - **g** = Ginny
   - **h** = Hedwig
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3. **Operations**: $\{\}$, $\langle\rangle$

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eg., $[\![Harry]\!] = \mathbf{a}$

- These things, $[\![]\!]$, are DENOTATION BRACKETS
- $[\![Harry]\!]$ is basically a shorthand way of writing "the meaning of *Harry*"

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eg., $[\![girl]\!] = \{\mathbf{b}, \mathbf{f}, \mathbf{g}\}$

BASIC ADJECTIVES

refer to **sets of individuals**

eg., $[\![tall]\!] = \{\mathbf{c}, \mathbf{i}\}$

The Lexical Entries of Lexical Categories

Semantic Ontology

1. **Truth-Values**: **T**, **F**
2. **Individuals**:
   - **a** = Harry
   - **b** = Hermione
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3. **Operations**: $\{\}$, $\langle\rangle$

Exercise

(1) What set does *wizard*$_{\mathrm{N}}$ refer to?

(2) What set does *animal*$_{\mathrm{N}}$ refer to?

(3) What set does *Gryffindor*$_{\mathrm{Adj}}$ refer to?

(4) What set does *blond*$_{\mathrm{Adj}}$ refer to?

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Lexical Entries for

INTRANSITIVE VERBS

(verbs that involve a single individual)

refer to **sets of individuals**

eg., $[\![\textit{flies}]\!] = \{\mathbf{e}, \mathbf{h}\}$

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INTRANSITIVE VERBS

(verbs that involve a single individual)

refer to **sets of individuals**

eg., $[\![\textit{flies}]\!] = \{\mathbf{e}, \mathbf{h}\}$

Unless you count flying via broomsticks, magical motorcycles and airplanes, in which case

$[\![\textit{flies}]\!] = \{\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}, \mathbf{e}, \mathbf{f}, \mathbf{g}, \mathbf{h}, \mathbf{i}\}$

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Lexical Entries for

TRANSITIVE VERBS

(verbs that involve two individuals)

refer to **sets of pairs of individuals**

eg., $[\![\textit{loves}]\!] = \{\langle \mathbf{a,q}\rangle, \langle \mathbf{a,h}\rangle, \langle \mathbf{a,g}\rangle, \langle \mathbf{b,\ c}\rangle, \langle \mathbf{c,\ b}\rangle, \langle \mathbf{c,\ q}\rangle, \langle \mathbf{g,a}\rangle, \langle \mathbf{g,q}\rangle, \langle \mathbf{i.e}\rangle, \ldots\}$

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Exercise

(1) What set does $studies_{\mathrm{V}}$ refer to?

(2) What set does $feeds_{\mathrm{V}}$ refer to?

(3) What set does $marries_{\mathrm{V}}$ refer to?

(4) What set does $plays_{\mathrm{V}}$ refer to?

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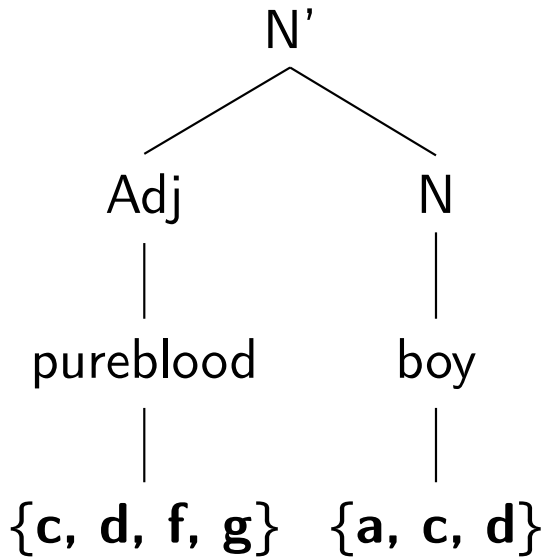
- What about higher constituents?



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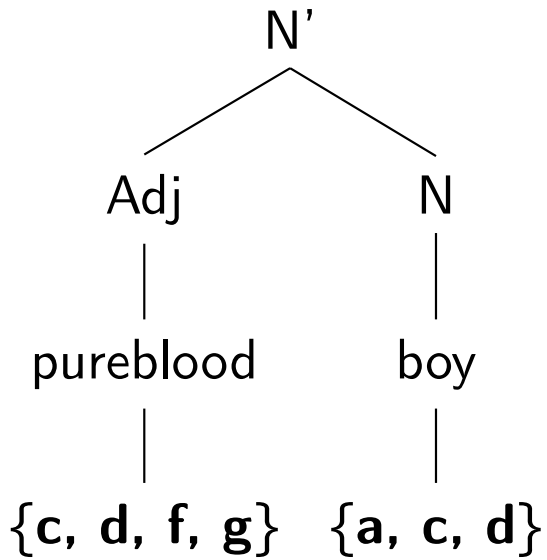
Q: If *pureblood* refers to **{c, d, f, g}** and *boy* refers to **{a, c, d}**...

... what would *pureblood boy* refer to?



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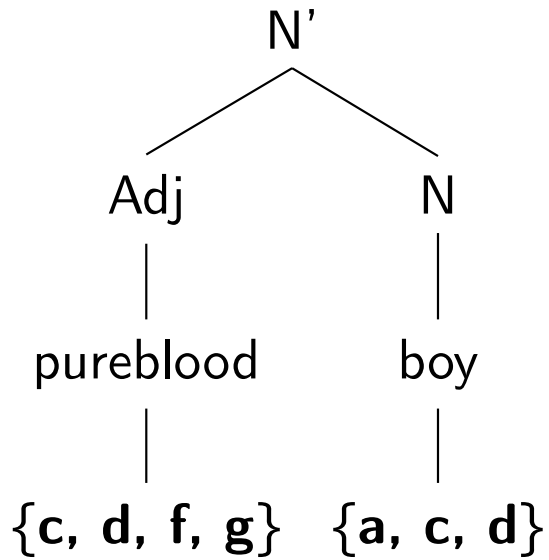
If *pureblood* refers to **{c, d, f, g}** and *boy* refers to **{a, c, d}**...

...N' *pureblood boy* refers to **{c, d}**



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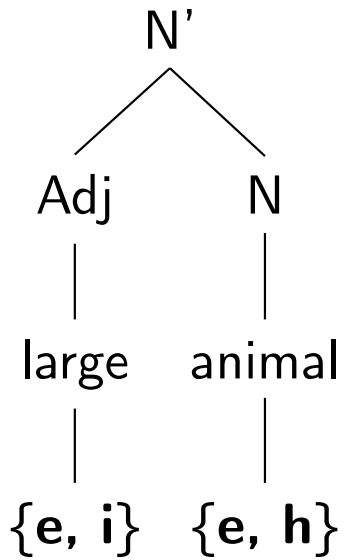
Q: If *large* refers to **{e, i}** and *animal* refers to **{e, h}**...

... what would *large animal* refer to?



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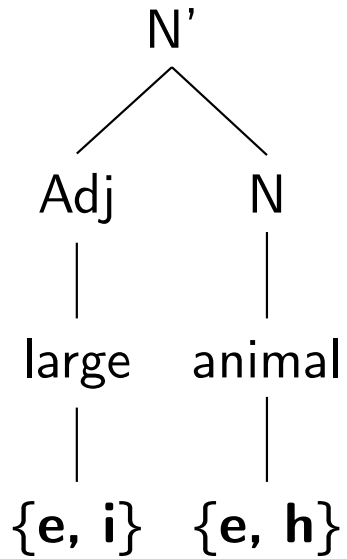
If *large* refers to **{e, i}** and *animal* refers to **{e, h}**...

... N' *large animal* refers to **{e}**



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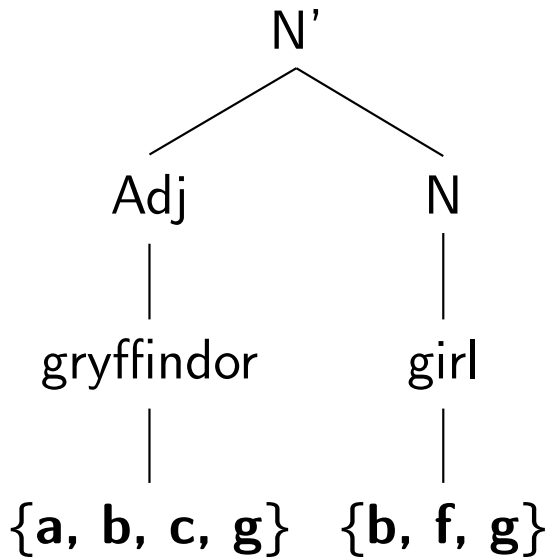
Q: If *gryffindor* refers to **{a, b, c, g}** and *girl* refers to **{b, f, g}**...

... what would *gryffindor girl* refer to?



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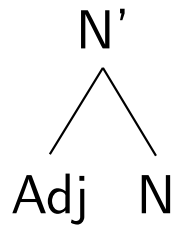
Observation: Constituents are systematic in terms of what they refer to

- N', like Adj and N,
  refers to **sets of individuals**



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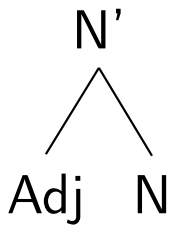
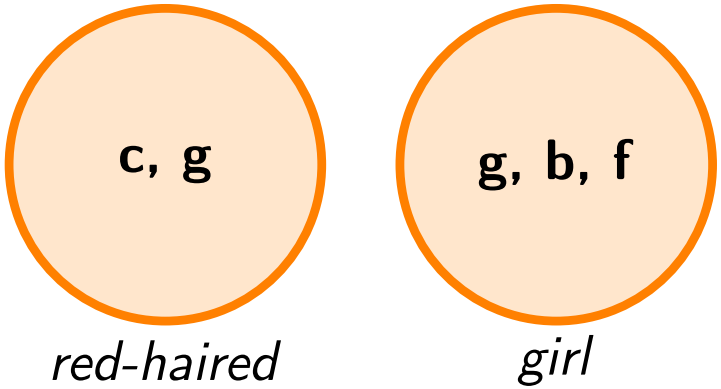
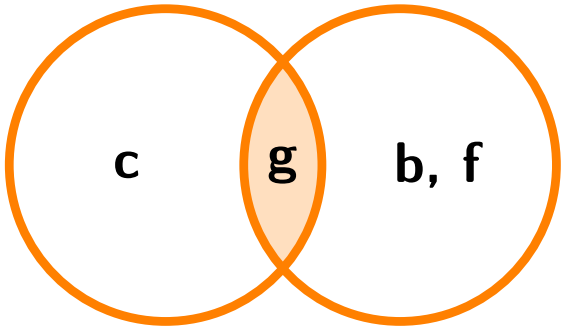


$\rightarrow$ the set with members that belong to both Adj and N

$$[\![N']\!] = [\![Adj]\!] \cap [\![N]\!]$$

Semantic Composition Rule: $[\![N']\!] = [\![Adj]\!] \cap [\![N]\!]$





The set denoted by *red-haired girl*

- $[\![N']\!] = [\![Adj]\!] \cap [\![N]\!]$ is a COMPOSITIONAL RULE (call it MODIFICATION)
- This rule describes how we interpret the PSR N' $\rightarrow$ (Adj) N

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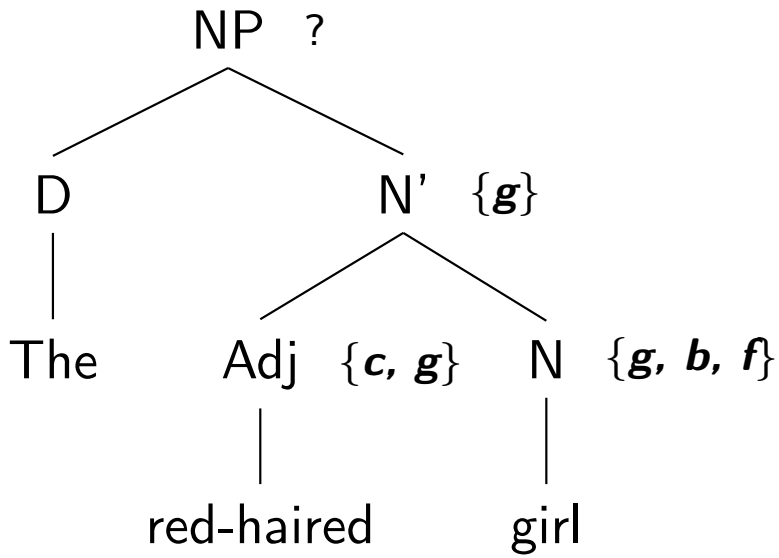

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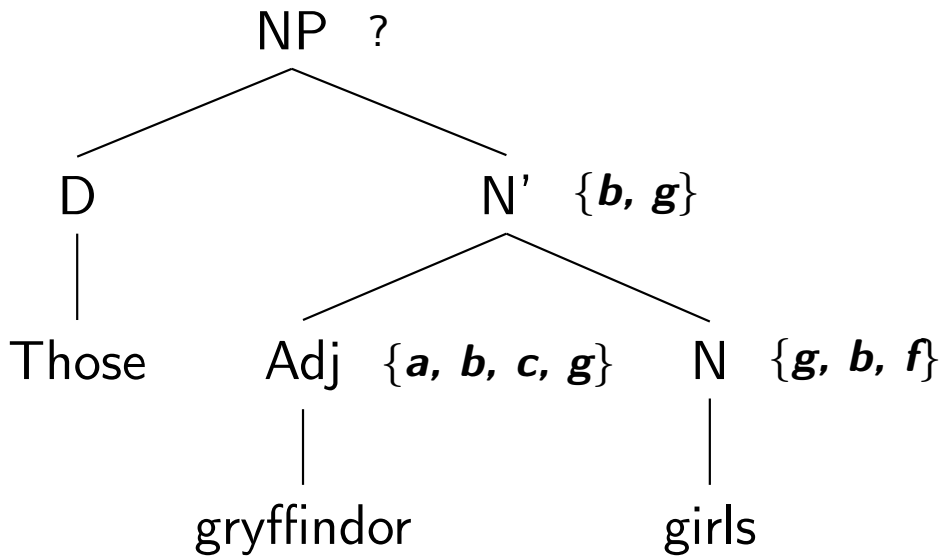

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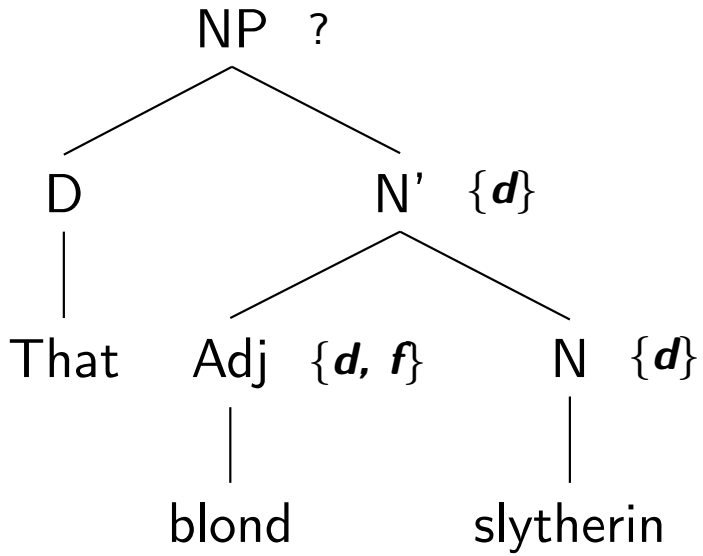

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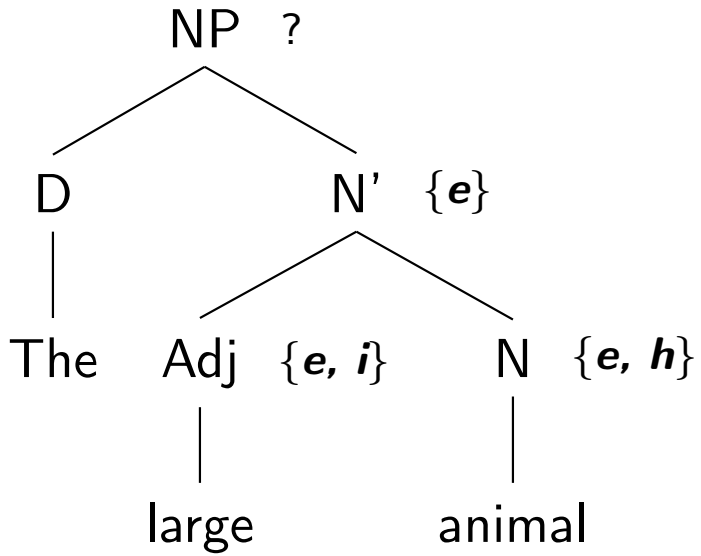

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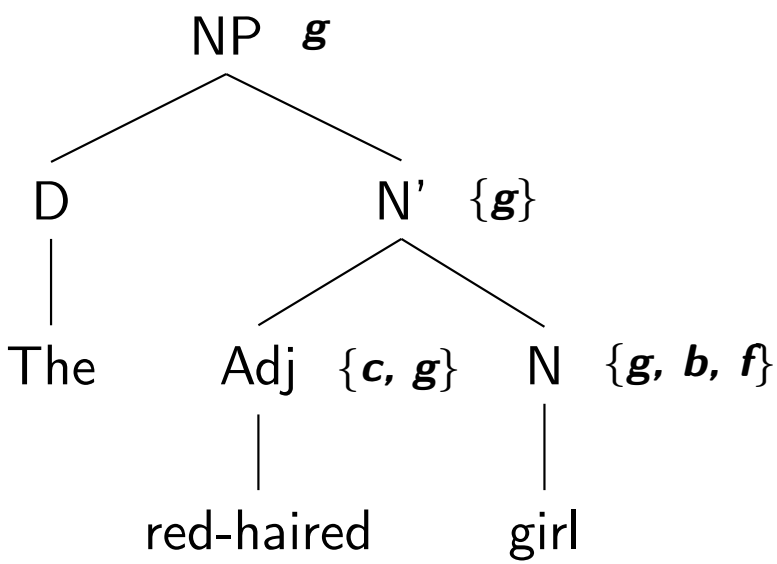
Intuition: The NP *the red-haired girl* refers to the same thing as the name *Ginny*

- i.e., **g**



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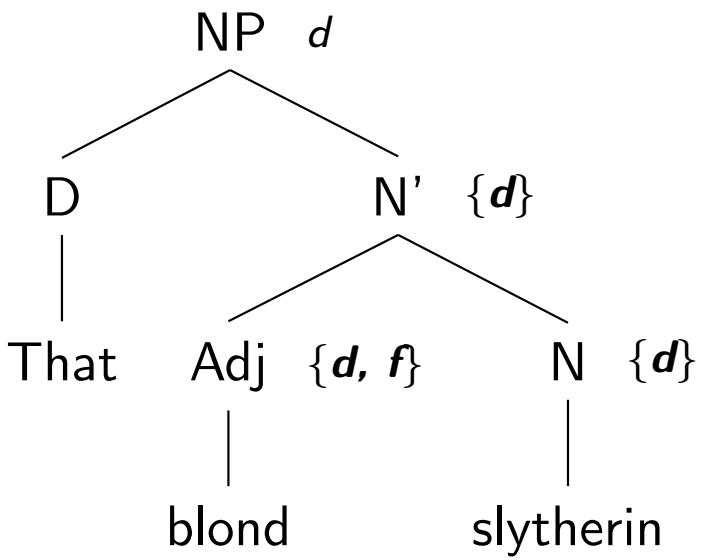
Intuition: The NP *that blond slytherin* refers to the same thing as the name *Draco* - i.e., **d**



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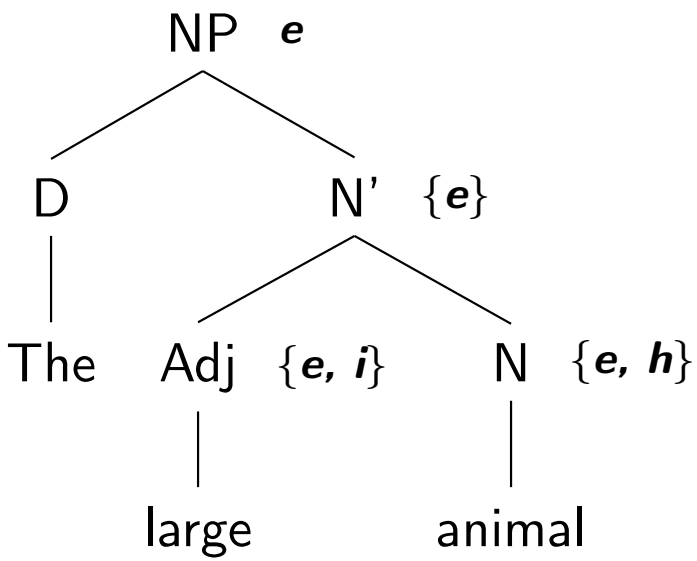
Intuition: The NP *the large animal* refers to the same thing as the name *Buckbeak* - i.e., **e**



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Semantic Evidence for Phrases

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- The NP refers to an **individual**

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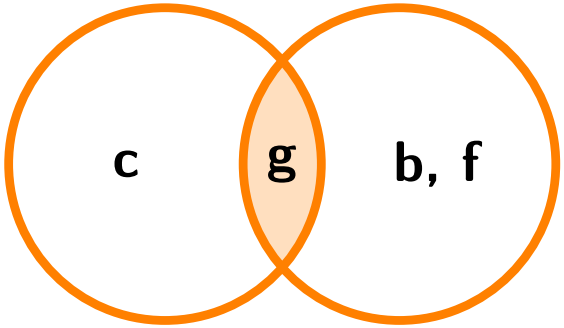
- The NP refers to an **individual**

$\rightarrow$ The/an individual member of the set that N' refers to[1]

$$[\![NP]\!] = x,\ x \in [\![N']\!]$$

[1] An over-simplification, but don't worry about the details!

Semantic Composition Rule: $[\![NP]\!] = x,\ x \in [\![N']\!]$



The set denoted by *red-haired girl*

- $[\![NP]\!] = x,\ x \in [\![N']\!]$ is a COMPOSITIONAL RULE (call it SELECTION)
- This rule describes how we interpret the PSR NP $\rightarrow$ D N

g

The individual denoted by *the red-haired girl*

Semantic Composition Rules

Semantic Interpretation/Composition Rules

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Semantic Interpretation/Composition Rules

1. Modification:

$[\![N']\!] = [\![Adj]\!] \cap [\![N]\!]$ N' $\rightarrow$ (Adj) N

N' refers to the set with members in both $[\![Adj]\!]$ and $[\![N]\!]$

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   $[\![NP]\!] = x, x \in [\![N']\!]$ NP $\rightarrow$ D N'

   NP refers to an/the individual in $[\![N']\!]$

3. Predication:

   $[\![S]\!] = \mathbf{T}$ iff, $[\![NP]\!] \in [\![VP]\!]$ S $\rightarrow$ NP VP

   NP is true if and only if the individual $[\![NP]\!]$ is in $[\![VP]\!]$

Compositional Rules: Interpreting PSRs

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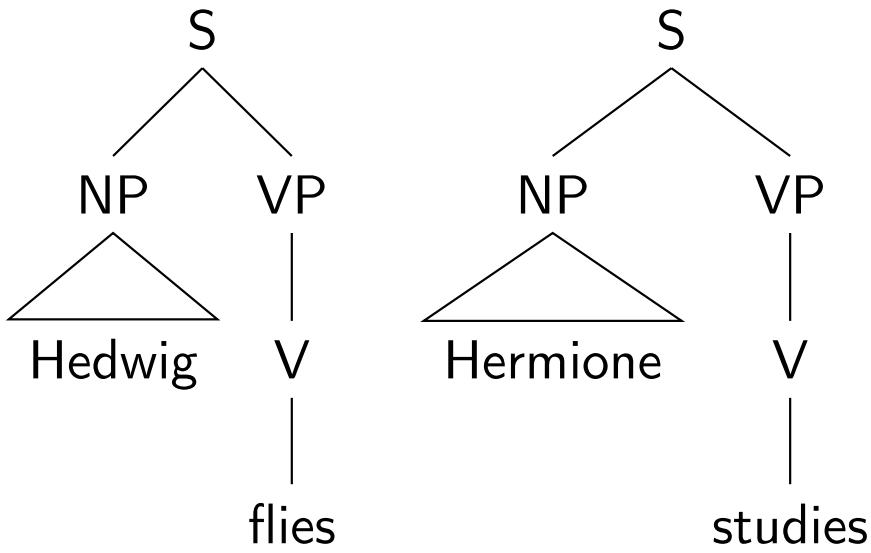
Consider sentences like



Are these sentences true?

$[\![\textit{flies}]\!] = \{\mathbf{e}, \mathbf{h}\}$

$[\![\textit{studies}]\!] = \{\mathbf{b}, \mathbf{f}\}$

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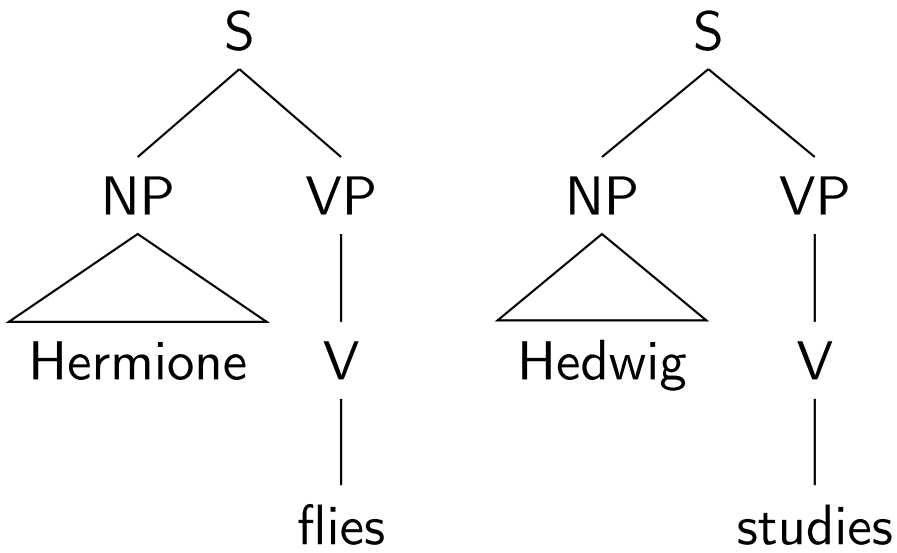

What about these sentences?

$[\![\textit{flies}]\!] = \{\mathbf{e}, \mathbf{h}\}$

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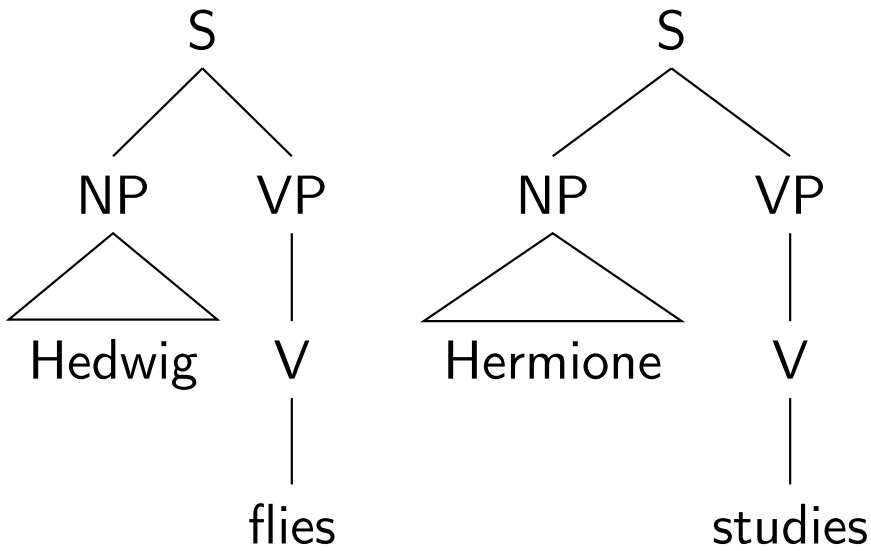
True sentences:



Observation: $\mathbf{h} \in [\![\textit{flies}]\!]$

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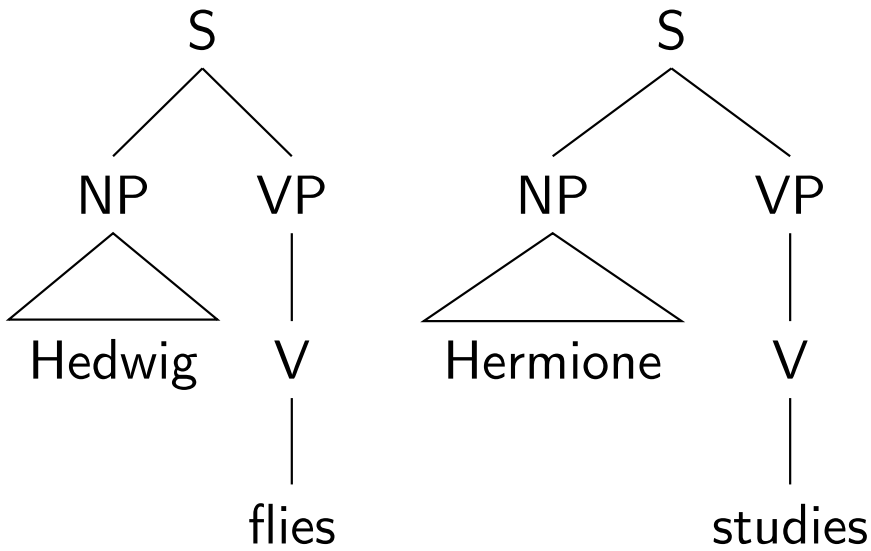

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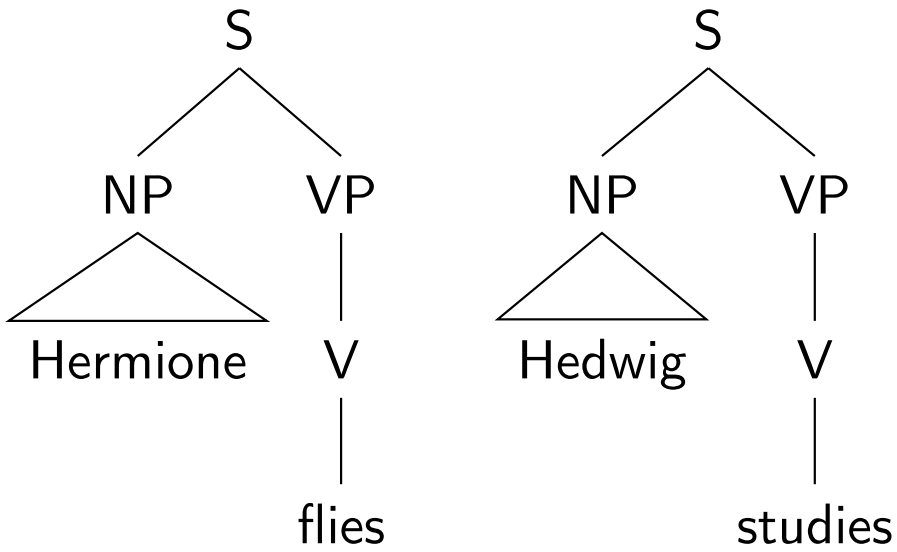

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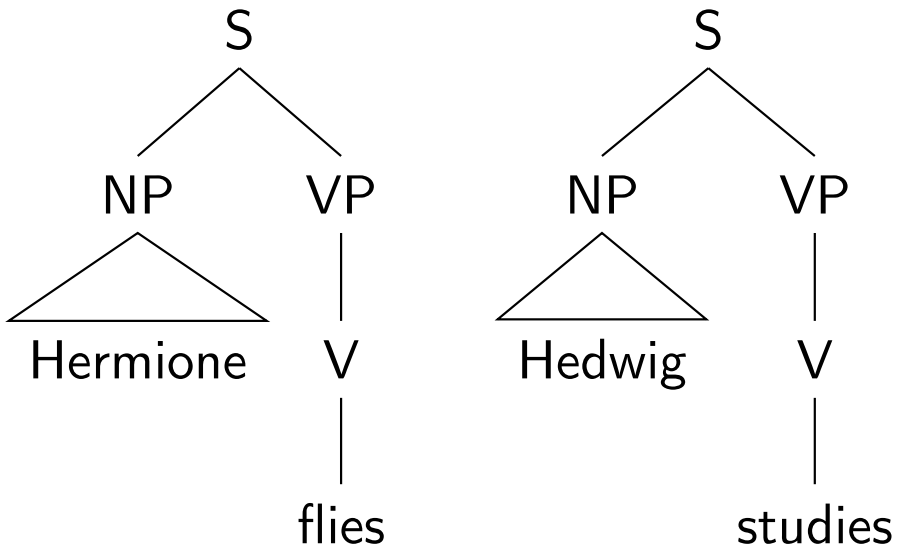

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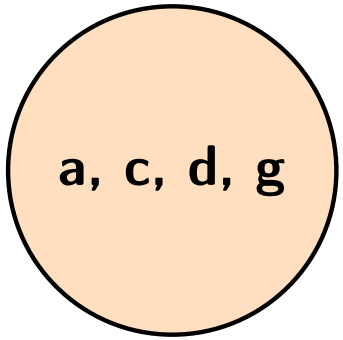

The set denoted by *plays quidditch*

g

The individual denoted by *the red-haired girl*

$\mathbf{g}\in\{\mathbf{a}, \mathbf{c}, \mathbf{d}, \mathbf{g}\}$

$\therefore$ "The red-haired girl plays quidditch" is **T**

- $[\![S]\!]=\mathbf{T}$ iff $[\![NP]\!]\in[\![VP]\!]$ is a COMPOSITIONAL RULE (call it PREDICATION)
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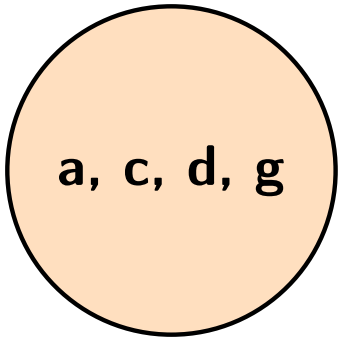

The set denoted by *plays quidditch*

b

The individual denoted by *the curly-haired girl*

$\mathbf{b}\notin\{\mathbf{a}, \mathbf{c}, \mathbf{d}, \mathbf{g}\}$

$\therefore$ "The curly-haired girl plays quidditch" is **F**

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  (2) Systematic interpretations for PSRs
  (i.e., semantic compositional rules)
- These interpretation rules can be mathematically formalized in terms of SET MEMBERSHIP ($\in$, $\notin$) or SET INTERSECTION ($\cap$)

Next Time: Semantics and Pragmatics

Meaning as TRUTH VS Meaning as USE

1. **Homework:** A005 - Semantics and Pragmatics
2. **Instagram Homework:** Semantic Minimal Pair AND/OR
   Find and post an example (or non-example) of a Design Feature
   - Discreteness
   - Semanticity
   - Arbitrariness
   - Productivity

References I

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