Ling 566
Oct 16, 2007
How the Grammar Works
Overview

• What we’re trying to do
• The pieces of our grammar
• Two extended examples
• Reflection on what we’ve done, what we still have to do
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
  • 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
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)
How We Construct Sentences

• The Components of Our Grammar
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  • Lexical entries
  • Principles
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• We combine constraints from these components.
How We Construct Sentences

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  • Lexical entries
  • Principles
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Q: What says we have to combine them?
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)

• We combine constraints from these components.

Q: What says we have to combine them?
A: The definition of well-formed structure
An Example

A cat slept.

- Can we build this with our tools?
- Given the constraints our grammar puts on well-formed sentences, is this one?
Lexical Entry for $a$

\[
\begin{array}{c}
\text{word} \\
\text{SYN} \\
\langle a, \ \\
\text{VAL} \\
\text{HEAD} \\
\text{det} \\
\text{AGR} \\
\text{COUNT} \\
\text{+} \\
\text{COMPS} \\
\langle \rangle \\
\text{VAL} \\
\text{POLAR} \\
\text{SPR} \\
\langle \rangle \\
\text{MOD} \\
\langle \rangle \\
\text{SEM} \\
\text{MODE} \\
\text{none} \\
\text{INDEX} \\
\text{j} \\
\text{RESTR} \\
\langle [\text{RELN} a] \rangle \\
\langle [\text{BV} j] \rangle
\end{array}
\]

- Is this a fully specified description?
- What features are unspecified?
- How many word structures can this entry license?
Lexical Entry for *cat*

- Which feature paths are abbreviated?
- Is this a fully specified description?
- What features are unspecified?
- How many word structures can this entry license?
Effect of Principles: the SHAC

\[
\begin{align*}
\text{word} & \quad \text{noun} \\
\text{HEAD} & \quad \text{AGR} \quad 3\text{sing} \\
\text{AGR} & \quad \text{GEND} \quad \text{neut} \\
\text{D} & \quad \text{SPR} \\
\text{SPR} & \quad \text{AGR} \quad 2 \\
\text{COUNT} & \quad + \\
\text{INDEX} & \quad k \\
\text{COMPS} & \quad \langle \rangle \\
\text{MOD} & \quad \langle \rangle \\
\text{MODE} & \quad \text{ref} \\
\text{INDEX} & \quad k \\
\text{RESTR} & \quad \langle \text{RELN} \quad \text{cat} \langle \rangle \rangle \\
\end{align*}
\]
Description of Word Structures for *cat*

```
word
  word
    HEAD  noun
    |    AGR 3
    |    [3sing 2
    |    GEND neut
    SYN
    VAL
    SPR  D
    |  [AGR 2
    |  [COUNT +
    |  [INDEX k
    |  COMPS ⟨ ⟩
    |  MOD  ⟨ ⟩
    SEM
    MODE  ref
    INDEX k
    RESTR ⟨ RELN cat k INSTA
```
Description of Word Structures for $a$

\[
\begin{align*}
\text{word} & \quad \text{SYN} & \quad \text{SEM} \\
& \quad \text{HEAD} & \quad \text{MODE} & \quad \text{INDEX} \\
& \quad \text{det} & \quad \text{none} & \quad j \\
& \quad \text{AGR} & \quad \text{spatial} & \quad \text{RELN} \ a \\
& \quad 3\text{sing} & & \quad \text{RELN} \ a \\
& \quad \text{COUNT} & \quad \text{RELN} \ a \quad \text{BV} \ j \\
& \quad + & & \quad j \\
\end{align*}
\]
Building a Phrase
Constraints Contributed by Daughter Subtrees
Constraints Contributed by the Grammar Rule

\[
\text{phrase} \\
\text{SYN [ VAL [ SPR ⟨ ⟩]]}
\]

\[
\text{word} \\
\text{HEAD} \\
\text{AGR} \\
\text{COMPS ⟨ ⟩} \\
\text{SPR ⟨ ⟩} \\
\text{MOD ⟨ ⟩}
\]

\[
\text{word} \\
\text{noun} \\
\text{AGR} \\
\text{3sing} \\
\text{GEND neut}
\]

\[
\text{word} \\
\text{head} \\
\text{AGR} \\
\text{3sing} \\
\text{GEND neut}
\]

\[
\text{word} \\
\text{noun} \\
\text{AGR} \\
\text{3sing} \\
\text{GEND neut}
\]

\[
\text{word} \\
\text{HEAD} \\
\text{AGR} \\
\text{3sing} \\
\text{GEND neut}
\]

\[
\text{word} \\
\text{noun} \\
\text{AGR} \\
\text{3sing} \\
\text{GEND neut}
\]

\[
\text{word} \\
\text{head} \\
\text{AGR} \\
\text{3sing} \\
\text{GEND neut}
\]
Constraints Contributed by the Grammar Rule

[phrase
SYN [ VAL [ SPR ⟨ ⟩]]]

[word
[det
HEAD
AGR [3sing
GEND neut]
COUNT +
COMPS ⟨ ⟩
SPR ⟨ ⟩
MOD ⟨ ⟩]
VAL
MODE none
INDEX k
SEM
RESTR ⟨[RELN a BV k]⟩]

[word
[noun
HEAD
AGR [3sing
GEND neut]
VAL
SPR ⟨ ⟩
INDEX k
COMPS ⟨ ⟩
MOD ⟨ ⟩
MODE ref
INDEX k
SEM
RESTR ⟨[RELN INSTANCE cat k]⟩]

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Constraints Contributed by the Grammar Rule

\[
\begin{align*}
\text{phrase} & \quad \text{SYN [ VAL [ SPR ⟨ ⟩]]]} \\
\text{word} & \quad \text{HEAD} \\
& \quad \text{AGR [ 3sing GEND neut]} \\
& \quad \text{COUNT +} \\
& \quad \text{COMPS ⟨ ⟩} \\
& \quad \text{SPR ⟨ ⟩} \\
& \quad \text{MOD ⟨ ⟩} \\
\text{SEM} & \quad \text{INDEX k} \\
& \quad \text{MODE none} \\
& \quad \text{RELN a BV k} \\
\end{align*}
\]
Constraints Contributed by the Grammar Rule

\[
\begin{align*}
\text{phrase} & \rightarrow \text{SYN [ VAL [ SPR ⟨ ⟩ ]]}
\end{align*}
\]
Constraints Contributed by the Grammar Rule

\[
\text{phrase} \\
\text{SYN} [ \text{VAL} [ \text{SPR} [ \rangle ] ]]
\]

\[
\text{word} \\
\text{SYN} \\
\text{HEAD} \\
\text{AGR} [ 3\text{sing} ] \\
\text{GEND} \text{ neut} \\
\text{COUNT} + \\
\text{COMPS} [ \rangle ] \\
\text{SPR} [ \rangle ] \\
\text{MOD} [ \rangle ]
\]

\[
\text{word} \\
\text{SYN} \\
\text{HEAD} \\
\text{noun} \\
\text{AGR} [ 3\text{sing} ] \\
\text{GEND} \text{ neut} \\
\text{SPR} [ \rangle ] \\
\text{COUNT} + \\
\text{INDEX} \text{ k} \\
\text{COMPS} [ \rangle ] \\
\text{MOD} [ \rangle ]
\]

\[
\text{word} \\
\text{SYN} \\
\text{HEAD} \\
\text{noun} \\
\text{AGR} [ 3\text{sing} ] \\
\text{GEND} \text{ neut} \\
\text{SPR} [ \rangle ] \\
\text{COUNT} + \\
\text{INDEX} \text{ k} \\
\text{COMPS} [ \rangle ] \\
\text{MOD} [ \rangle ]
\]

\[
\text{word} \\
\text{SEM} \\
\text{MODE} \text{ ref} \\
\text{INDEX} \text{ k} \\
\text{RESTR} [ \text{RELN cat} ] \\
\text{INDEX} \text{ k} \\
\text{RESTR} [ \text{RELN instance} ]
\]
Constraints Contributed by the Grammar Rule

```
[phrase
  SYN [ VAL [ SPR ⟨ ⟩]]]
```

```
[word
  SYN
    HEAD
      det
  VAL
    COUNT +
    COMPS ⟨ ⟩
    SPR ⟨ ⟩
    MOD ⟨ ⟩
  MODE none
  INDEX k
  SEM
    RESTR ⟨ [RELN a ⟨ BV k ⟩] ⟩
]
```

```
[word
  SYN
    HEAD
      AGR [ 3sing
        GEND neut ]
    COUNT +
    COMPS ⟨ ⟩
    SPR ⟨ ⟩
    MOD ⟨ ⟩
  MODE none
  INDEX k
  SEM
    RESTR ⟨ [RELN cat ⟨ INSTANCE k ⟩] ⟩
]
```

```
[word
  noun
    AGR [ 3sing
        GEND neut ]
    COUNT +
    COMPS ⟨ ⟩
    SPR ⟨ ⟩
    MOD ⟨ ⟩
  MODE ref
  INDEX k
  SEM
    RESTR ⟨ [RELN cat ⟨ INSTANCE k ⟩] ⟩
]
```
Constraints Contributed by the Grammar Rule

```
[phrase
SYN [ VAL [ SPR ⟨ ⟩]]]
```

```
word

[det
HEAD AGR [3sing
GEND neut]
COUNT +

COMPS ⟨ ⟩
SPR ⟨ ⟩
MOD ⟨ ⟩]

MODE none
INDEX k

RESTR ⟨ [RELN a
BV k] ⟩

SEM

7]
```

```
word

[noun
HEAD AGR [3sing
GEND neut]

SPR ⟨ [COUNT +] ⟩
INDEX k

COMPS ⟨ ⟩
MOD ⟨ ⟩

MODE ref
INDEX k

RESTR ⟨ [RELN INSTANCE k] ⟩

SEM

7D]
```
Constraints Contributed by the Grammar Rule

\[
\text{phrase} \quad \text{SYN} \quad \text{VAL} \quad \text{SPR} \quad \langle \rangle \]

\[
\begin{align*}
\text{word} & \quad \text{det} \quad \text{AGR} \quad \text{COUNT} + \quad \text{COMPS} \quad \text{SPR} \quad \text{MOD} \\
\text{SYN} & \quad \text{head} \quad \text{AGR} \quad \text{3sing} \quad \text{GEND} \quad \text{neut} \\
\text{VAL} & \quad \text{COMPS} \quad \text{SPR} \quad \text{MOD} \\
\text{SEM} & \quad \text{none} \quad \text{k} \quad \text{RELN} \quad \text{a} \quad \text{BV} \quad \text{k} \\
\end{align*}
\]

\[
\begin{align*}
\text{word} & \quad \text{noun} \quad \text{AGR} \quad \text{3sing} \quad \text{GEND} \quad \text{neut} \\
\text{SYN} & \quad \text{head} \quad \text{AGR} \quad \text{COUNT} + \\
\text{VAL} & \quad \text{SPR} \quad \text{INDEX} \quad \text{k} \\
\text{SEM} & \quad \text{rel} \quad \text{RELN} \quad \text{cat} \quad \text{RELN} \quad \text{k} \
\end{align*}
\]
Constraints Contributed by the Grammar Rule

\[
\text{phrase} \\
\text{SYN} [\text{VAL} [\text{SPR} \langle \rangle]]
\]

\[
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{SEM}
\]

\[
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{SEM}
\]

\[
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{SEM}
\]
A Constraint Involving the SHAC

[phrase
SYN [ VAL [ SPR ⟨ ⟩ ] ] ]

[det
HEAD AGR [ 3sing
COUNT +
GEND neut ] ]

[COMPS ⟨ ⟩ ]

[SYN
VAL
SEM

[SPR ⟨ ⟩ ]

MOD ⟨ ⟩ ]

MODE none
INDEX k

RESTR ⟨ [RELN a
BV k ] ⟩ ]

[7]

[HEAD
AGR [ 3sing
GEND neut ] ]

[SYN
VAL
SEM

[SPR ⟨ ⟩ ]

MOD ⟨ ⟩ ]

MODE ref
INDEX k

RESTR ⟨ [RELN cat
INSTANCE k ] ⟩ ]

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Effects of the Valence Principle

\[
\begin{array}{c}
\text{phrase} \\
\text{SYN} \\
\text{VAL} \\
\text{COMPS} 3 \\
\text{MOD} 4
\end{array}
\]

\[
\begin{array}{c}
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{COMPS} \langle \rangle \\
\text{MOD} \langle \rangle
\end{array}
\]

\[
\begin{array}{c}
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{SPR} \langle \rangle \\
\text{COMPS} \langle \rangle \\
\text{MOD} \langle \rangle
\end{array}
\]

\[
\begin{array}{c}
\text{word} \\
\text{SYN} \\
\text{VAL} \\
\text{SPR} \langle \rangle \\
\text{COMPS} \langle \rangle \\
\text{MOD} \langle \rangle
\end{array}
\]

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Effects of the Head Feature Principle
Effects of the Semantic Inheritance Principle
Effects of the Semantic Compositionality Principle

phrase

<table>
<thead>
<tr>
<th>HEAD 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYN</td>
</tr>
<tr>
<td>VAL</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>COMPS 3</td>
</tr>
<tr>
<td>MOD</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>MODE</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>INDEX</td>
</tr>
<tr>
<td>k</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>RESTR</td>
</tr>
<tr>
<td>A ⊕ B</td>
</tr>
</tbody>
</table>

word

<table>
<thead>
<tr>
<th>det</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAD</td>
</tr>
<tr>
<td>AGR</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>COUNT</td>
</tr>
<tr>
<td>+</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>COMPS</td>
</tr>
<tr>
<td>()</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>SPR</td>
</tr>
<tr>
<td>()</td>
</tr>
<tr>
<td>MOD</td>
</tr>
<tr>
<td>()</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>MODE</td>
</tr>
<tr>
<td>none</td>
</tr>
<tr>
<td>INDEX</td>
</tr>
<tr>
<td>k</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>RESTR</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>RELN a</td>
</tr>
<tr>
<td>BV k</td>
</tr>
</tbody>
</table>

word

<table>
<thead>
<tr>
<th>noun</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAD</td>
</tr>
<tr>
<td>AGR</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3sing</td>
</tr>
<tr>
<td>GEND</td>
</tr>
<tr>
<td>neut</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>COMPS</td>
</tr>
<tr>
<td>()</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>SPR</td>
</tr>
<tr>
<td>()</td>
</tr>
<tr>
<td>MOD</td>
</tr>
<tr>
<td>()</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>MODE</td>
</tr>
<tr>
<td>ref</td>
</tr>
<tr>
<td>INDEX</td>
</tr>
<tr>
<td>k</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>RESTR</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>RELN</td>
</tr>
<tr>
<td>cat</td>
</tr>
<tr>
<td>INSTANCE k</td>
</tr>
</tbody>
</table>

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Is the Mother Node Now Completely Specified?

```
phrase


word
det

[HEAD [AGR 2 COUNT +] COMPS ⟨ ⟩ SPR ⟨ ⟩ MOD ⟨ ⟩] MODE none INDEX k RESTR [A ⊕ RELN a BV k]]

word
noun

[HEAD [AGR 2 GEND neut] SPR ⟨ ⟩ COMPS ⟨ ⟩ MOD ⟨ ⟩] MODE ref INDEX k RESTR [B ⊕ RELN cat INSTANCE k]]
```
Lexical Entry for *slept*

\[
\langle \text{word} \rangle = \begin{cases} \text{SYN} \left[ \begin{array}{c} \text{HEAD} \ \text{verb} \\ \text{VAL} \ \text{SPR} \left[ \begin{array}{c} \text{AGR} \ [9] \\ \text{CASE} \ \text{nom} \end{array} \right] \\ \text{COMPS} \left[ \langle \rangle \right] \\ \text{MOD} \left[ \langle \rangle \right] \\ \text{INDEX} \ s_1 \\ \text{MODE} \ \text{prop} \end{array} \right] \\ \text{SEM} \left[ \begin{array}{c} \text{RESTR} \left[ \begin{array}{c} \text{RELN} \ \text{sleep} \\ \text{SIT} \ s_1 \\ \text{SLEEPER} \ m \end{array} \right] \end{array} \right] \end{cases}
\]
Another Head-Specifier Phrase

phrase

SYN

HEAD 11

VAL

SPR ⟨ ⟩

COMPS 12

MOD 13

SEM

MODE 10 prop

INDEX s1

RESTRICT A ⊕ B ⊕ C

word

SYN

HEAD 11 verb

AGR 9

VAL

SPR ⟨ ⟩

COMPS 12 ⟨ ⟩

MOD 13 ⟨ ⟩

SEM

MODE 10 prop

INDEX s1

RESTRICT C

RELATION sleep

SIT s1

SLEEPER k

...
Another Head-Specifier Phrase
Another Head-Specifier Phrase

**Key**
- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

```
phrase

[HEAD 11]

[SYN]


[noun]

[VAL]

[SPR ⟨⟩]

[COMPS [12] MOD [13]]

[SEM]

[MODE [10] prop]

[INDEX s₁]

[RESTR A ⊕ B ⊕ C]

word


[SYN]

[SPR ⟨14⟩NPk[ AGR [9], CASE nom ]]

[VAL]

[COMPS [12] ⟨⟩]

[MOD [13] ⟨⟩]

[SEM]

[MODE [10] prop]

[INDEX s₁]

[RESTR C]

[RELN sleep]

[SIT s₁]

[SLEEPER k]

...]
```
Another Head-Specifier Phrase

**Key**
- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

**Phrase**
- **head**: 11
- **specifier**: SYN
- **val**: COMPS 12
- **mod**: MOD 13
- **mode**: prop 10
- **index**: s1
- **restr**: A ⊕ B ⊕ C

**Word**
- **head**: 11
- **verb**: AGR 9
- **specifier**: SYN
- **comps**: COMPS 12
- **mod**: MOD 13
- **mode**: prop 10
- **index**: s1
- **restr**: C
- **reln**: sleep
- **sit**: s1
- **sleeper**: k
Another Head-Specifier Phrase

Key
- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

Diagram:

```
phrase
||| |
|---|---|---|---|
| head | 11 | syn |
| val  | spr ⟨ ⟩ | comps 12 | mod 13 |
| sem  | mode 10 prop | index s1 | restr a ⊕ b ⊕ c |

word
||| |
|---|---|---|---|
| head 11 | verb | agr 9 |
| syn | spr ⟨ 14⟩npk[ agr 9, case nom ] |
| val | comps 12 ⟨ ⟩ | mod 13 ⟨ ⟩ |
| sem | mode 10 prop | index s1 |
| restr ci | reln sleep | sit s1 , ... |
```

Key:
- yellow: HSR
- orange: SHAC
- blue: Val Prin
- magenta: HFP
- green: SIP
- red: SCP

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Another Head-Specifier Phrase

**Key**
- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP

### Diagram

```
phrase

| HEAD [11] |
| SYN |
| VAL |
| SEM |
```

```
word

| HEAD [11] |
| SYN |
| VAL |
| SEM |
```

```
phrase

| noun |
| SYN |
| VAL |
| SEM |
```

```
word

| verb |
| SYN |
| VAL |
| SEM |
```

```
phrase

| HEAD [6] |
| SYN |
| VAL |
| SEM |
```

```
word

| HEAD [9] |
| SYN |
| VAL |
| SEM |
```

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Another Head-Specifier Phrase

Key

- HSR
- SHAC
- Val Prin
- HFP
- SIP
- SCP
Is this description fully specified?

```
[phrase
  [HEAD 11
   SYN
     [SPR ⟨ ⟩
      VAL
        COMPS 12
      MOD 13
     ]
    MODE 10 prop
   INDEX s1
   SEM
     [MODE 10 prop
      MOD 13
     ]
  ]
]
```

```
[SYN
  [nour
    HEAD 6
    AGR
      [3sing
        GEND neut
      ]
    CASE nom
  ]
  [SPR ⟨ ⟩
   COMPS 3( ⟩
   MOD 4( ⟩
  ]
  MODE 8 ref
  INDEX k
  SEM
    [RESTR A ⊕ B]
  14
]
```

```
[word
  [HEAD 11[verb
    AGR 9
  ]
  SYN
    [SPR ⟨ 14NP⟨ AGR 9, CASE nom ⟩ ⟩
    VAL
      COMPS 12( ⟩
    MOD 13( ⟩]
  MODE 10 prop
  INDEX s1
  SEM
    [RESTR C
      [RELN sleep
       SIT s1
      ]
    ]
  ]
]
```

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Does the top node satisfy the initial symbol?
Initial Symbol (Ch 6 version)

\[
\begin{bmatrix}
\text{SYN} \\
\text{VAL}
\end{bmatrix}
\begin{bmatrix}
\text{HEAD} & \text{verb} \\
\text{SPR} & \langle \rangle \\
\text{COMPS} & \langle \rangle
\end{bmatrix}
\]
RESTR of the S node

\[ \langle [\text{RELN} \ a \ \kappa], [\text{RELN} \ \text{cat} \ \kappa], [\text{RELN} \ \text{sleep} \ s_1 \ \kappa], \ldots \rangle \]
Another Example

$S$

$NP$

$D$

the

$NOM$

$N$

photos

$PP$

of

$NP$

$D$

the

suspect

$VP$

$V$

disappeared

$ADV$

yesterday
Head Features from Lexical Entries

The diagram represents a sentence structure with the following constituents:

- **Verb Phrase (VP):** disappeared
- **Noun Phrase (NP):** the suspect
- **Prepositional Phrase (PP):** of the photos

The sentence structure is as follows:

```
S
  / \   /
NP   VP
  /   /  /
[HEADdet] NOM [HEADverb] [HEADadverb]
the [HEADnoun] disappeared yesterday
photos [HEADprep] of [HEADdet] the [HEADnoun] suspect
```
Head Features from Lexical Entries, plus HFP

[HEAD 4]

[HEAD 1]

[HEAD det]

the

[HEAD 1 noun]

photos

[HEAD 2 prep]

of

[HEAD 3]

[HEAD det]

the

[HEAD 3 noun]

suspect

[HEAD 2]

disappeared

[HEAD adverb]

yesterday
Head Features from Lexical Entries, plus HFP

[HEAD 4]

[HEAD 1]

[HEAD det]

the

[HEAD 1 noun]

photos

[HEAD 2 prep]

of

[HEAD det]

the

[HEAD 3 noun]

suspect

[HEAD 2]

disappeared

[HEAD adverb]

yesterday
Head Features from Lexical Entries, plus HFP

```
[HEAD 4]
  [HEAD 1]
    [HEAD det]
      the
    [HEAD 1 noun]
      photos
  [HEAD 1]
    [HEAD 2 prep]
      of
    [HEAD 2]
      disappeared
  [HEAD 4 verb]
    yesterday
[HEAD 3]
  [HEAD det]
    the
  [HEAD 3 noun]
    suspect
```
the
[HEAD 1]
[HEAD det]

photos
[HEAD 1]
[HEAD 1 noun]

of
[HEAD 2]
[HEAD prep]

disappeared
[HEAD 4]
[HEAD verb]

yesterday
[HEAD adverb]

the
[HEAD 3]
[HEAD det]

suspect
[HEAD 3]
[HEAD noun]
Head Features from Lexical Entries, plus HFP

[HEAD det] the

[HEAD 1 noun] photos

[HEAD 2 prep] of

[HEAD 2 verb] disappeared

[HEAD 3 det] the

[HEAD 3 noun] suspect

[HEAD 4 verb] yesterday
Valence Features: Lexicon, Rules, and the Valence Principle

Key

- Lexicon
- Val.
- Rules

```
the
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩

photos
SPR ⟨ D ⟩
COMPS ⟨ PP ⟩
MOD ⟨ ⟩

disappeared
SPR ⟨ NP ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩

of
SPR ⟨ NP ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩

of
SPR ⟨ NP ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩

the
SPR ⟨ D ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩

suspect
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
```
Valence Features:
Lexicon, Rules, and the Valence Principle

Key
Lexicon  Val.
Rules

```
the
photos
of

SPR COMPS MOD

SPR COMPS MOD

SPR COMPS MOD

SPR COMPS MOD

SPR COMPS MOD

SPR COMPS MOD

SPR COMPS MOD

SPR COMPS MOD
```
Valence Features:
Lexicon, Rules, and the Valence Principle

Key

- **Orange**: Lexicon
- **Yellow**: Val.
- **Gray**: Rules

```
the [SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
]
photos [SPR ⟨ D ⟩
COMPS ⟨ ⟩
MOD ⟨ PP ⟩
]
of [SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
]
the [SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
]
suspect [SPR ⟨ D ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
]
disappeared [SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ NP ⟩
]
disappeared [SPR ⟨ NP ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
]
yesterday [SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ VP ⟩
]
yesterday [SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
]
```
Valence Features:
Lexicon, Rules, and the Valence Principle

Key

Lexicon
Val.
Rules

the
photos

of
the

disappeared
yesterday

of the suspect
Valence Features:
Lexicon, Rules, and the Valence Principle

Key

Lexicon
Val.  Rules

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Valence Features: Lexicon, Rules, and the Valence Principle

Key

- Lexicon
- Val.
- Rules

```
the
photos
disappeared
yesterday
```

```
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
SPR ⟨ ⟩
COMPS ⟨ ⟩
MOD ⟨ ⟩
```
Valence Features: Lexicon, Rules, and the Valence Principle

Key

- Lexicon
- Val.
- Rules

The diagram illustrates the valence features of the sentence "the photos disappeared yesterday."
Valence Features: Lexicon, Rules, and the Valence Principle

Key
- Lexicon
- Val.
- Rules

```
the (D)
COMPS (PP)
MOD ()
```

```
photos
```
Required Identities: Grammar Rules

\[
S \\
\quad \downarrow \\
\quad \downarrow \\
1NP \quad VP \\
\quad \downarrow \quad \downarrow \\
2D \quad NOM \quad [SPR \quad 2] \quad [SPR \quad 1] \\
\quad \downarrow \quad \downarrow \\
the \quad N \quad disappeared \quad yesterday \\
\quad \downarrow \quad \downarrow \\
[COMPS \quad 3] \quad [COMPS \quad 4] \\
\quad \downarrow \quad \downarrow \\
photos \quad P \\
\quad \downarrow \\
of \\
\quad \downarrow \\
[COMPS \quad 4] \\
\quad \downarrow \\
the \\
\quad \downarrow \\
[SPR \quad 5] \\
\quad \downarrow \\
suspect
\]
Required Identities: Grammar Rules

```
S
  ↓
 [1] NP
    ↓
   [2] D
    ↓
   the
    ↓
   N
[COMPS ⟨3]>
   ↓
photos
   ↓
   P
[COMPS ⟨4]>
   ↓
   of
   ↓
   [5] D
    ↓
   the
[SPR ⟨5]>
    ↓
   N
[SPR ⟨6]>
   ↓
   [6] V
[SPR ⟨1]>
   ↓
   disappeared
   ↓
   ADV
[MOD ⟨6]>
   ↓
yesterday
```
Required Identities: Grammar Rules

\[
S \\
\quad \downarrow \\
1NP \\
\quad \downarrow \\
2D \quad NOM \quad [SPR \ (2)] \\
\quad \downarrow \quad \downarrow \\
\quad \text{the} \quad N \quad [COMPS \ (3)] \\
\quad \quad \downarrow \\
\quad \quad \text{photos} \\
\quad \quad \downarrow \\
\quad \quad P \quad [COMPS \ (4)] \\
\quad \quad \quad \downarrow \\
\quad \quad \quad \text{of} \\
\quad \quad \quad \downarrow \\
\quad \quad \quad \text{the} \\
\quad \quad \quad \downarrow \\
\quad \quad \quad \text{suspect} \\
\quad \quad \downarrow \\
\quad \quad \text{of} \\
\quad \quad \downarrow \\
\quad \quad \text{the} \\
\quad \quad \downarrow \\
\quad \quad [SPR \ (5)] \\
\quad \quad \downarrow \\
\quad \quad \text{of} \\
\quad \quad \downarrow \\
\quad \quad \text{the} \\
\quad \quad \downarrow \\
\quad \quad [SPR \ (1)] \\
\quad \quad \downarrow \\
\quad \quad \text{disappeared} \\
\quad \quad \downarrow \\
\quad \quad \text{ADV} \\
\quad \quad \downarrow \\
\quad \quad [MOD \ (6)] \\
\quad \quad \downarrow \\
\quad \quad \text{yesterday} \\
\]
Required Identities:  Grammar Rules

\[
S \\
\downarrow \\
1 \text{NP} \\
\downarrow \\
2 \text{D} \\
\text{the} \\
\downarrow \\
\text{N} \\
\text{photos} \\
\downarrow \\
\text{P} \\
\text{of} \\
\downarrow \\
4 \text{NP} \\
\downarrow \\
\text{N} \\
\text{the} \\
\downarrow \\
\text{SPR} \\
\text{2} \\
\downarrow \\
\text{COMPS} \\
\text{3} \\
\downarrow \\
\text{SPR} \\
\text{2} \\
\downarrow \\
\text{COMPS} \\
\text{3} \\
\downarrow \\
\text{SPR} \\
\text{1} \\
\downarrow \\
\text{NOM} \\
\text{the} \\
\downarrow \\
\text{SPR} \\
\text{2} \\
\downarrow \\
\text{COMPS} \\
\text{4} \\
\downarrow \\
\text{SPR} \\
\text{1} \\
\downarrow \\
\text{ADV} \\
\text{yesterday} \\
\downarrow \\
\text{MOD} \\
\text{6} \\
\downarrow \\
\text{V} \\
\text{disappeared} \\
\downarrow \\
\text{COMPS} \\
\text{4} \\
\downarrow \\
\text{SPR} \\
\text{5} \\
\downarrow \\
\text{COMPS} \\
\text{4} \\
\downarrow \\
\text{SPR} \\
\text{5} \\
\downarrow \\
\text{N} \\
\text{the suspect}
Required Identities: Grammar Rules

S

[1] NP

[2] D

[3] PP

[4] NP

[5] D

NOM

[SPR (2)]

[COMPS (3)]

the

photos

P

of

[COMPS (4)]

[SPR (5)]

the

[SPR (1)]

[MOD (6)]

disappeared

yesterday

[COMPS (3)]

[SPR (4)]

[SPR (5)]

[COMPS (4)]

[SPR (6)]

[COMPS (3)]

[SPR (2)]

[SPR (1)]

[MOD (6)]

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Required Identities: Grammar Rules

The NOM [SPR ⟨ 2 ⟩]
N
[COMPS ⟨ 3 ⟩]
photos

3 PP disappeared
ADV [MOD ⟨ 6 ⟩]
yesterday

4 NP
of

5 D

the suspect

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the NOM [SPR ⟨2⟩]
N [COMPS ⟨3⟩] photos
P [COMPS ⟨4⟩] of
[SPR ⟨5⟩]
N [SPR ⟨5⟩] the suspect
6 V disappeared
ADV [MOD ⟨6⟩] yesterday

Required Identities: Grammar Rules
Two Semantic Features: the Lexicon & SIP

\[
\begin{array}{c}
\text{MODE prop} \\
\text{INDEX } s_3 \\
\end{array}
\]

\[
\begin{array}{c}
\text{MODE ref} \\
\text{INDEX } j \\
\end{array}
\]

\[
\begin{array}{c}
\text{MODE none} \\
\text{INDEX } j \\
\end{array}
\]

\[
\begin{array}{c}
\text{MODE prop} \\
\text{INDEX } s_3 \\
\end{array}
\]

\[
\begin{array}{c}
\text{MODE none} \\
\text{INDEX } s_4 \\
\end{array}
\]

\text{the} \quad \text{disappeared} \quad \text{yesterday}

\[
\begin{array}{c}
\text{MODE ref} \\
\text{INDEX } j \\
\end{array}
\]

\[
\begin{array}{c}
\text{MODE ref} \\
\text{INDEX } k \\
\end{array}
\]

\text{photos} \quad \text{of} \quad \text{the} \quad \text{suspect}

\[
\begin{array}{c}
\text{MODE none} \\
\text{INDEX } k \\
\end{array}
\]

\[
\begin{array}{c}
\text{MODE ref} \\
\text{INDEX } k \\
\end{array}
\]
Two Semantic Features: the Lexicon & SIP

The network diagram illustrates the semantic features of a sentence, specifically focusing on the lexicon and SIP (Semantic Interpretation Phases). Each node in the diagram represents a semantic feature, with the mode (MODE) and index (INDEX) of each feature indicated. The sentence "the photos disappeared of the suspect yesterday" is analyzed to show how these features interact to form the meaning of the sentence. The nodes are color-coded to distinguish between different types of features: 
- Orange nodes represent the lexicon (MODE prop).
- Brown nodes represent references (MODE ref).
- Beige nodes represent none (MODE none).

The diagram shows how the nouns and verbs are linked through references and propositions to form a coherent meaning.
Two Semantic Features: the Lexicon & SIP

the

photos

of

the

suspect

disappeared

yesterday

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Two Semantic Features: the Lexicon & SIP

```
[MODE prop
INDEX s3]
[MODE ref
INDEX j]
[MODE none
INDEX j]
[MODE ref
INDEX j]
[MODE prop
INDEX s3]
[MODE none
INDEX s4]
the
[MODE ref
INDEX j]
photos
of
[MODE none
INDEX k]
[MODE ref
INDEX k]
[MODE ref
INDEX k]
disappeared
yesterday
[MODE prop
INDEX s3]
[MODE ref
INDEX k]
[MODE ref
INDEX k]
the
suspect
```

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Two Semantic Features: the Lexicon & SIP

MODE prop
INDEX s3

MODE ref
INDEX j

MODE prop
INDEX s3

MODE none
INDEX s4

the

MODE ref
INDEX j

photos

MODE ref
INDEX k

of

MODE none
INDEX k

MODE ref
INDEX k

MODE none
INDEX s4

disappeared

yesterday

the

suspect
Two Semantic Features: the Lexicon & SIP

the photos of the suspect disappeared yesterday.
RESTR Values and the SCP

\[ A \oplus B \oplus C \oplus D \oplus E \oplus F \oplus G \]

\[ A \oplus B \oplus C \oplus D \oplus E \]

\[ B \oplus C \oplus D \oplus E \]

\[ F \oplus G \]

\[ \langle [\text{RELN the BV } j] \rangle \]

\[ \text{the} \]

\[ \langle [\text{RELN photo INST } j \text{ CONTENT } k] \rangle \]

\[ \text{photos} \]

\[ \langle [\text{RELN disap. SIT } s_3 \text{ D-ER } j] \rangle \]

\[ \text{disappeared} \]

\[ \langle [\text{RELN yest. ARG } s_3] \rangle \]

\[ \text{yesterday} \]

\[ \langle [\text{RELN the BV } k] \rangle \]

\[ \text{of} \]

\[ \langle [\text{RELN suspect INST } k] \rangle \]

\[ \text{the} \]

\[ \text{suspect} \]
An Ungrammatical Example

* S

NP  VP

them  V  NP  NP

sent  us  D  N

a  letter
An Ungrammatical Example

What’s wrong with this sentence?
An Ungrammatical Example

What’s wrong with this sentence?
An Ungrammatical Example

What’s wrong with this sentence?

So what?
An Ungrammatical Example

The Valence Principle

\*S

NP  [CASE acc]  VP  [SPR \langle 1 \rangle ]
  |  
  them  V  NP  NP
    |         |  
    sent  us  D  N
      |  
      a  letter
An Ungrammatical Example

The Valence Principle

*S

NP
[CASE acc]

them

VP

[SPR ⟨1⟩]

V

sent

NP

[SPR ⟨1⟩NP[nom]]

us

NP

D

a

N

letter
An Ungrammatical Example

HeadSpecifier Rule

*S

\[\begin{array}{c}
\text{NP} \\
\text{[CASE acc]} \\
\text{them} \\
\end{array}\]

[SPR \langle\text{1}\rangle]

\[\begin{array}{c}
\text{VP} \\
\text{V} \\
\text{sent} \\
\end{array}\]

\[\begin{array}{c}
\text{NP} \\
\text{us} \\
\end{array}\]

\[\begin{array}{c}
\text{NP} \\
\text{D} \\
\text{a} \\
\end{array}\]

\[\begin{array}{c}
\text{N} \\
\text{letter} \\
\end{array}\]
An Ungrammatical Example

Head Specifier Rule

*S

1 NP
[CASE acc]

them

1 NP
[SPR ⟨1⟩ ]

sent

us

NP

NP

D

N

a

letter
An Ungrammatical Example

HeadSpecifier Rule

*S

 VP
[NP [CASE acc] them] [SPR ⟨1⟩]

 V
[sent] [SPR ⟨1NP[nom]⟩] [NP us] [NP]

 NP
[SPR ⟨1⟩]

 NP
[SPR ⟨1⟩]

 D N
[a letter]
Exercise in Critical Thinking
Exercise in Critical Thinking

• Our grammar has come a long way since Ch 2, as we've added ways of representing different kinds of information:
  • generalizations across categories
  • semantics
  • particular linguistic phenomena: valence, agreement, modification
Exercise in Critical Thinking

• Our grammar has come a long way since Ch 2, as we've added ways of representing different kinds of information:
  • generalizations across categories
  • semantics
  • particular linguistic phenomena: valence, agreement, modification

• What else might we add? What facts about language are as yet unrepresented in our model?
Overview

• What we’re trying to do
• The pieces of our grammar
• Two extended examples
• Reflection on what we’ve done, what we still have to do
• Next time: Review