Language

- a brush with eternity
Language

- a glimpse of **infinity**
Language Acquisition in Humans and Computers
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- **to get credit** –
  1. choose presentation date (not 21/11, 23/1) by Nov. 4 and let me know;
  2. briefly discuss your plans with me ahead of your presentation;
  3. make the presentation on the chosen date.
Language Acquisition in Humans and Computers

themes:

• psycholinguistic studies and their interpretation
• computational studies and their implications
	no prior knowledge of psychology needed or assumed

to be considered:

• in psycholinguistics:
  only empirically obtained data
  (not intuition, either of experts or of lay speakers)
• in computation:
  only methods that are algorithmically tractable
  and effective when applied to realistic data.
Language Acquisition in Humans and Computers

• What does knowledge of language consist of?

“As conceived in the present framework, the grammar of a language is simply an inventory of linguistic units” (Langacker, 1987, p.63).
“The inventory must be seen [...] as structured, in the sense that some units function as components of others” (ibid., p.73).

• How is language acquired?

From exposure to the rich information available in the linguistic environment of a learner; in a manner guided by certain cognition-general principles.

• How should language acquisition and processing be studied?

As any other cognitive function, through a combination of computational theorizing, behavioral experimentation, and modeling.
week by week schedule

- week 1  Oct. 31  Preliminaries

week by week schedule

- week 2  Nov. 7  Computational aspects of grammar acquisition


week by week schedule

• week 3  Nov. 14  A quick introduction to psycholinguistics


week by week schedule

- week 4 Nov. 21 The nature of the Primary Linguistic Data


week by week schedule

- week 5  Nov. 28  Evidence for item-based development


week by week schedule

- week 6  Dec. 5  Evidence for imperfect adult performance


• week 7 Dec. 12 Evidence for imperfect adult “competence”


week by week schedule

- week 8 Dec. 19  Evidence for continuity w/ the rest of cognition

week by week schedule

- week 9 Dec. 26 Evidence for the centrality of experience


week by week schedule

• week 10     Jan. 2     Relying on experience

week by week schedule

• week 11  Jan. 9  Learning grammar


week by week schedule

- week 12  Jan. 16  Learning grammar


week by week schedule

- week 13   Jan. 23   Learning grammar: ADIOS

week by week schedule

• week 14        Jan. 30        Wrap-up


Symptomatic theory aims to explain how people combine words to form sentences, and how children attain knowledge of sentence structure.

For example, speakers of English share the knowledge that dogs chase cats and cats chase dogs are possible sentences of English, but have different meanings. Speakers know that chase dogs cats is not a possible sentence of the language, and that cats dogs chase is possible in specific discourse contexts, as in cats, dogs chase, but mice, they flee.

Speakers’ knowledge of possible word combinations is often referred to as the (mental) grammar.
An accurate model of a speaker's knowledge of his language should minimally be able to **generate all and only** the possible sentences of the language.

For this reason, syntactic theory is often known as **generative grammar**.

“The illiteracy level of our children are appalling.”
Discrete infinity:

Almost all accounts of the discrete infinity property of natural language syntax start from the notion that sentences consist of more than just sequences of words. In the minds of speakers and listeners, sentences are \textit{hierarchically structured}...

(1) 

\begin{itemize}
  \item a.
    \begin{itemize}
      \item \textit{John the man}
      \item \textit{the elderly janitor}
      \item \textit{arrived at an apple}
      \item \textit{looked at his watch}
    \end{itemize}
  
  \item b.
    \begin{itemize}
      \item \textit{S} \rightarrow \textit{NP VP}
    \end{itemize}
\end{itemize}
Productivity:

Even a small number of phrase structure rules and a small lexicon can generate **large numbers of sentences**. With only the 5 phrase structure rules in (2) and a 9-word lexicon (consisting of 3 nouns, 3 determiners, and 3 verbs) 468 different sentences can be generated.

If the lexicon is expanded to contain 10 words in each category, the grammar generates 122,100 different sentences. Such a system can express many different messages, but does not even begin to approach the **creative power** of human language.

(2)  
S → NP VP  
VP → V NP  
VP → V  
NP → Det NP  
NP → N
Recursion:

coordination (3); modification (4); sentential complementation (5); ...

(3) \[ NP \rightarrow NP \text{ Conj} \ NP \]
\[ VP \rightarrow VP \text{ Conj} \ VP \]
\[ \text{Conj} \rightarrow \text{and} \]

(4) \[ VP \rightarrow VP \text{ PP} \]
\[ NP \rightarrow NP \text{ PP} \]

(5) \[ VP \rightarrow V \ S \]
\[ S \rightarrow \text{Comp} \ S \]
\[ \text{Comp} \rightarrow \text{that} \]

Such rules increase the expressive power of the grammar from merely vast to *clearly infinite*. There are obviously practical limitations on the length and complexity of naturally-occurring sentences, but such limitations are standardly attributed to general limitations on attention and memory.
Motivating structures – constituency:

The syntactician's toolbox includes a number of structural tests which can be used as aids in diagnosing the structure of sentences. For example, constituents of sentences can generally be conjuncts in coordinate structures, as is shown for NPs and VPs in (6a-b). Other tests that show the constituency of VPs include substitution of the expression *do so* for a VP (7a), and *fronting* of the VP to a clause-initial position (7b).

(6)  
   a. Wallace fetched *[NP the cheese] and *[NP the crackers]
   b. Wallace *[VP sliced the cheese] and *[VP opened the crackers]

(7)  
   a. Wallace *[VP read the newspaper] and Gromit *[VP did so] too.
   b. Wallace wanted to *[VP impress Wendolene], and *[VP impress Wendolene] he did.

“Our enemies are innovative and resourceful, and so are we. They never stop thinking about new ways to harm our country and our people, and neither do we.”
Motivating structures – hierarchy:

In addition to tools that show which groups of words form constituents, other tests diagnose the **hierarchical relations** among positions in a structure. A striking finding of syntactic research is that many grammatical phenomena are sensitive to a structural relationship known as **c-command**, which is similar to the logical notion of scope. A node c-commands its sister and any nodes contained inside its sister. Thus, in the structure in (13), node B c-commands node E, its sister, and nodes F and G contained inside its sister.

(13)  

\[
\text{C-Command} \\
\text{A node c-commands its sister and all nodes dominated by its sister.}
\]

```
      A
     / \  
    B   E
   /\  /\  
  C  D  F  G
```
c-command – interaction with Negative Polarity Items:

(14) a. Wallace didn’t find any cheese.
b. Nobody found any cheese.
c. Wallace didn’t think that he would ever refuse cheese.
d. Nobody thought that Wallace would ever refuse cheese.

e. * [NP The fact that Wallace didn’t like the cheese] amazed anybody.
f. * [NP The fact that nobody liked the cheese] amazed anybody.
g. * [NP The person that Wallace didn’t notice] thought that Gromit would ever return.
h. * [NP The person that nobody noticed] thought that Gromit would ever return.
c-command – interaction with binding:

In order for a pronoun to receive a **bound-variable** interpretation, the pronoun must be c-commanded by a quantificational NP. Thus, a bound-variable interpretation is available in (15a), but not in (15b), where the c-command requirement is not met. (15c-d) show that when the pronoun corefers with an NP that refers to an individual, the c-command requirement no longer applies.

(15)    a. Every boy$_i$ loved the party that was thrown for him$_i$.
b. * The party for every boy$_i$ made him$_i$ very happy.

c. Harry$_i$ loved the party that was thrown for him$_i$.
d. The party for Harry$_i$ made him$_i$ very happy.
Multiple roles: transformations

Since speakers must distinguish for any NP a representation of its thematic role, its grammatical relation and its scope, it is important to ask how these different structural positions are related to one another.

The most well-known answer to this question is that speakers represent multiple structures for each sentence, one structure that encodes the thematic role assignments of a sentence, and one or more additional representations that encode grammatical relations and scope relations.

The thematic representation is known as the deep structure (or \textit{d-structure}) of the sentence, and it is related to the other levels of representation – surface structure (or \textit{s-structure}) and logical form (\textit{LF}) – by means of transformational processes which move NPs from thematic positions to positions associated with grammatical relations, and from there to scope positions.
Multiple roles: transformations

(22) shows a sample derivation of a *wh*-question under this approach. The theme NP who receives the theme thematic role as the sister of the verb in the *d-structure* representation in (22a). In (22b) it moves to subject position of the embedded passive clause. Finally, in (22c) it moves from subject position to its clause initial scope position. Following a now-standard elaboration of the transformational approach, introduced in the 1970s, (22) represents the residue of movement as *phonologically null elements* known as *traces* *(t).*
Dependencies:

(23) a. Every Englishman$_i$ thinks he$_i$ is a great cook.  \hspace{1cm} \text{variable binding}
    b. Wallace$_i$ thinks he$_i$ is a great cook.  \hspace{1cm} \text{coreference}

(24) a. Wallace$_i$ likes himself$_i$  \hspace{1cm} \text{local}
    b. * Wallace$_i$ thinks that Wendolene likes himself$_i$  \hspace{1cm} *\text{non-local}
    c. * Wallace$_i$ likes him$_i$  \hspace{1cm} *\text{local}
    d. Wallace$_i$ thinks that Wendolene likes him$_i$  \hspace{1cm} \text{non-local}

Constraints on dependencies:

It has been found that there are many syntactic environments which *wh*-extraction cannot cross. [...] environments that block extraction are known as **islands**. Relative clauses create islands for extraction (28a), as do indirect questions (28b), complements of NPs (28c), subjects (28d) and adjunct clauses (28e).

(28)  
a.  * Who_i did the court upset the voters [who favored t_i ]  
b.  * Who_i did Bill wonder [whether his new outfit would shock t_i ]  
c.  * What_i did Sarah believe [the rumor that Ed was willing to spend t_i ]  
d.  * Who_i did [the fact that the president nominated t_i ] upset the opposition party?  
e.  * What_i did Wallace eat the cheese [while he was reading t_i ]

(29)  
a.  Who_i did Sally hear a story about t_i ?  
b.  ? Who_i did Sally hear the story about t_i ?  
c.  * Who_i did Sally hear Helen's story about t_i ?

(30)  
a.  *What_i did [Gromit read the newspaper] and [Wallace eat t_i ]  
b.  What_i did [Gromit read t_i ] and [Wallace eat t_i ]
week 1 – preliminaries – syntax (C. Phillips, 2001)

Universals
- specific to language?
- absolute?

Principles and Parameters
- comprehensive?
- learnable?
Varieties of syntactic theories:

Over the past 40 years, syntactic theory has undergone a number of changes, and has spawned a variety of different grammatical theories, each with a different title, such as Relational Grammar (RG), Head-Driven Phrase Structure Grammar (HPSG), Lexical-Functional Grammar (LFG), Categorial Grammar (CG), Government-Binding Theory (GB), Tree Adjoining Grammar (TAG), etc.

The important dimensions of difference:

- syntactic atoms and how they combine
- types of structural dependencies
- alternatives to transformations

(53)

[which boy do you think [ seems [ to have been healed ]]]

[scope]  [case]  [thematic role]
The greatest challenge:

unification with cognitive science.
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unification with cognitive science.

The only sound and complete methodology for understanding cognition:

- behavioral analysis
- neurobiology
- computational theory
- computational modeling
- behavioral analysis
- neurobiology