Natural Language Processing:
How do humans process language?

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Outline

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Motivation

What does NLP have to do with humans, at all?

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Too much theory is bad? But why?

- "Every time I fire a linguist, the performance of the speech processing system goes up." (Frederick Jelinek)

- Does it mean we should refrain from linguistic inspiration?

  - (NLP already does that. Ask a linguist.)

- Cf. the good, bad, and ugly parts of artificial neural networks

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Linguists and Engineers tend to have different focus

- Computational: what is explained?
    - Description of linguistic performance vs. explanation of linguistic competence
- Algorithmic: how is it done?
    - Cognitive realism, computational complexity/efficiency
- Implementational: how is is realized?
    - Neurological plausibility

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Insights *from* linguistics

Get a better understanding of what should work in language processing

- After all, it's <u>natural language</u> processing

- Comparison gives confidence:

    - NLU system behaviour vs. L1 acquisition
    - Observation of similar effects/errors, e.g., garden path sentences
    - Human performance is the ultimate (utopic?) benchmark!
    - We're not inventing something <u>new</u>…

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We don't yet know how human language really works

- Very conflicting hypotheses, most of which work only on a computational level

- New ideas:
  - Shallow processing
  - Distributed, implicit, usage-based knowledge
  - Computational construction grammar
  - Computational semantics (λ calculus)

Be warned!

- This is will be an extremely rough, simplified, and incomplete overview

- It is biased in favour of Cognitive Linguistics (and a bit against Generative Grammar)

- Linguistic theory is not completely scientific
  - "Theory" = "proposed descriptive model", not "axiomatic system"

- If you're interested: go to the linguistics department
  - Sprache und Kognition, Sprachen der Welt, …
  - Learn more languages (for grammar, not talking)

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Models of human language

Some examples from different areas of linguistics and cognitive science

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Cognitive & Linguistic Development

Cognitive abilities develop in similar ways

- Typical progress:

    - Statistical learning (expectation & surprise)
    - Inductive learning (categorization & abstraction)
    - Social learning (imitation, intention, theory of mind)

- Sensomotory system has an important influence in learning!

- Critical periods vs. extreme robustness

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Language learning tends to follow a U-shaped progress

- Phases:
    - Simplification: How do you do dese…work/tortillas/in English
    - Overgeneralization: Yesterday I didn't painting
    - Restructuring How do you…make this/like it; how…do cut it
- Cf. exploration vs. exploitation in reinforcement learning
- Computational and associative learning

Creolization processes

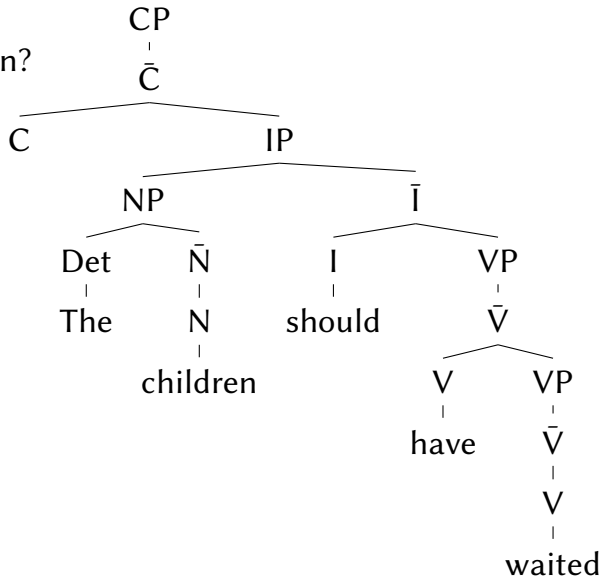Figure: Hotel room signs in Tok Pisin (Papua New Guinea)

https://en.wikipedia.org/wiki/Subject%E2%80%93object%E2%80%93verb

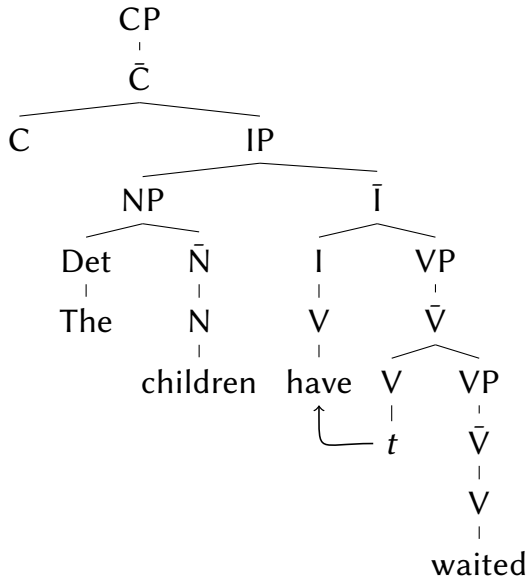Philipp Gabler <pgabler@student.tugraz.at>
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Generative Grammar = trees + transformations

- Grammatical construal in terms of rules
  - from <u>deep structure</u> to <u>surface structure</u>
- Exlaining all languages in terms of <u>principles and parameters</u>
  - Solution to fast, one-shot L1 acquisition

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Triangles in the brain?

The syntax tree:

- CP
  - C̄
    - C
    - IP
      - NP
        - Det — The
        - N̄ — N — children
      - Ī
        - I — should
        - VP
          - V̄
            - V — have
            - VP
              - V̄
                - V — waited

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Criticism of this kind of analysis

- Explicitely not empirical (at least by Chomsky)

    - Against "behaviourism", focus on competence
    - Tends to categorize everything in terms of recursive symbolic structures
    - Good for English – what about Chinese? Pirahã?

- Computationally complex, cognitively…difficult to explain

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Language is conveying mental state through symbols

- Semantics from a cognitive perspective: meaning is…
    - perspectivic (relative to utterance context)
    - dynamic (system changes with environment)
    - encyclopedic (association with experiences & culture)
    - determined by usage (a system derived from concrete experience)

- Grammar is only an "artifact" to structure the transportation of mental state
    - Or only an instrument for performative utterance

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Thank You!

Next: ???

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