UG+Stats Approaches to The Linking Problem

The Linking Problem

Pearl 2021, Chomsky Handbook, 1.3

Recap: The Linking Problem

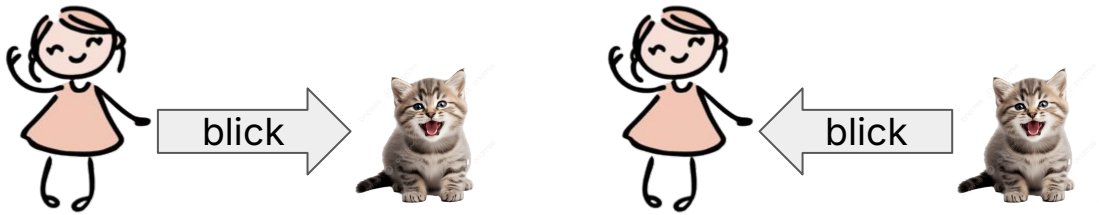
The little girl blicked the kitten on the stairs.

Many possible interpretations, but most people tend to prefer certain ones!

Recap: The Linking Problem

The little girl blicked the kitten on the stairs.

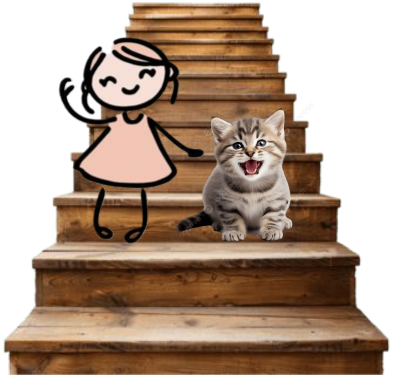
Who is doing the blicking?

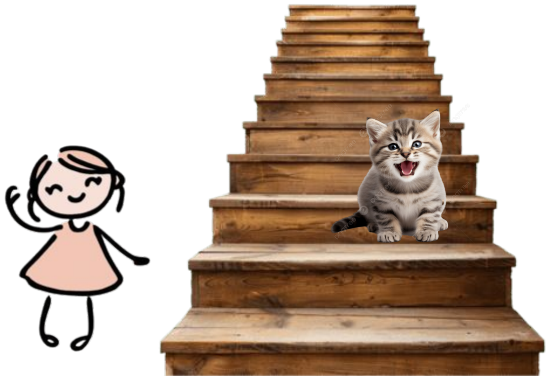


Recap: The Linking Problem

The little girl blicked the kitten on the stairs.

What is on the stairs?





Recap: The Linking Problem

The little girl blicked the kitten on the stairs.

There are many possible interpretations, but we mostly prefer certain ones!
This is accomplished via **linking theories**.

“The reason we as adults have this preferred interpretation is because we have **linking theories** that link the thematic roles specified by a verb's lexical semantics to the syntactic argument positions specified by that verb's syntactic frame. Moreover, our linking theories are so well-developed that they can impose these links even when we don't know a verb's specific lexical semantics (as we see here with *blick*). Developing linking theories is a fundamental component of verb learning for children.”

Recap: Linking Theory Representations

UTAH

Larger thematic categories always map to a specific syntactic position

rUTAH

Relative ordering of thematic roles

Highest role available maps to highest syntactic position

[?] Which linking approach would correctly handle this construction?

The ice broke.

Recap: Linking Theory Representations

UTAH

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[?] Which linking approach would correctly handle this construction?

The ice broke.
AGENT
PATIENT

“There are also two main approaches to how children develop linking knowledge:

(i) it is **innate knowledge** of the specific links between thematic roles and syntactic positions that comes fully-formed in the child’s mind, or

(ii) the specific linking knowledge **develops over time** via an interplay between the input that children receive and the mechanisms (both statistical and otherwise) that underlie verb learning”

Methods Pearl & Sprouse

Linguistic representations defining the hypothesis space (UTAH and rUTAH)

Hierarchical Bayesian inference (derive from input)

Tolerance & Sufficiency Principles (which theory?)

Takeaways Pearl & Sprouse

“In particular, Pearl and Sprouse offers insight into the development of linking theory knowledge, suggesting that derivation of specific linking theory knowledge may occur over time from children's input. More specifically, their results argue against early maturation of innate linking theory knowledge. So, **deriving that linking theory knowledge from the input** becomes a plausible option to explore.”

Takeaways Pearl & Sprouse

rUTAH is more compatible:

1. Much easier to generate from the available input
2. Can be successfully generated from English children's input using the Tolerance & Sufficiency Principles

“It is interesting to consider how refining the understanding of Universal Grammar through statistical learning actually **reduces the "neurobiological explanatory work" that is required to understand language acquisition**. By proposing a less dense UG, we potentially align our linguistic theories more closely with the realities of evolutionary biology and developmental neurobiology.”

– Kevin

Movement

Pearl 2021, JoCL UG+Stats, 3.5

What is Movement?

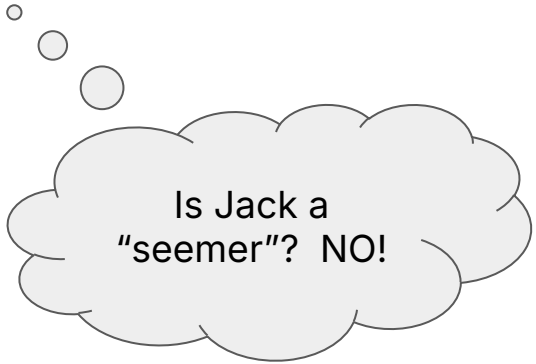
“A more sophisticated type of syntactic knowledge involves "**movement**", where *linguistic elements are understood in certain positions of an utterance and yet don't appear to be in those positions*. So, the idea is that the linguistic elements have moved from the positions where they're understood.”

Raising vs. Control Structures

The subject of the main clause does not have a thematic role for the main verb.

Jack **seemed** to kiss Lily.

AGENT?



Raising vs. Control Structures

The subject of the main clause does not have a thematic role for the main verb.

The sentence can be rephrased with an expletive it to show that the subject is **raised** (i.e. moves) from an embedded clause.

It seemed that Jack **kissed** Lily.
AGENT

Jack seemed _Jack **to kiss** Lily.
AGENT

Raising vs. **Control** Structures

The subject connects to **two distinct thematic roles**. No movement is involved.

Jack **wanted** _Jack **to kiss** Lily.
AGENT AGENT

Raising vs. **Control** Structures

Jack seemed **to kiss** Lily.
AGENT

Jack **wanted to kiss** Lily.
AGENT
AGENT

How do children distinguish between these???

Methods Mitchener & Becker; Pearl & Sprouse

UG

The **linguistic features** that children use to sort verbs into relevant classes (i.e. animacy, thematic roles, syntactic contexts)

Stats

Bayesian inference for clustering verbs into classes involving raising vs. control interpretations

“When we say innate linguistic knowledge, it's not about handing the right answer, but instead **pointing the attention toward the linguistically meaningful features** in the input.”

– Maria

“The Bayesian approaches cluster verbs into classes, where the classes allow different raising and control constructions; these Bayesian approaches can then predict the classes that children of different ages ought to cluster their verbs into. These predicted verb classes can then be **checked against behavioral data from children of different ages**. For example, if children treat two verbs the same way (e.g., both verbs allowing subject-raising, but not subject-control, object-raising, or object-control), then the Bayesian approaches ought to have clustered those two verbs together into the same class. This prediction check can be done for all verbs where we have empirical data about how children treat the verbs (i.e., as belonging to the same class or not).”

Takeaways & Future Work Pearl & Sprouse

Accurate predictor

"The Bayesian approaches to clustering verbs into classes that involve raising vs. control interpretations appear to match children's verb classifications fairly well"

Easy to evaluate

"A useful aspect of a model predicting verb classes is that we have a variety of ways to evaluate if children in fact have similar verb classes."

Quantitative framework

"However, another way is to use the model's predicted verb classes to predict child behavior in specific experiments. [...] This quantitative prediction about interpretation rate can be compared against the rates children actually do interpret a verb a particular way in a context."