Knowledge of Language

It's so natural for us to produce and comprehend language that we often don't think about what an accomplishment this is.

Or how we learned language in the first place.

Jackendoff (1994)

“For the moment, the main thing is to appreciate how hard a problem this is. The fact that we can talk (and cats can’t) seems so obvious that it hardly bears mention. But just because it’s obvious doesn’t mean it’s easy to explain. Think of another perfectly obvious, well-known phenomenon: the fact that metals turn red when you heat them. Why does this happen? It could be otherwise - they might just as well turn green or not change color at all. It's a simple phenomenon, easily observable, but the explanation isn’t simple at all. It turns out to involve at the very least the theories of electromagnetic radiation and quantum mechanics, two of the more amazing intellectual advances in the past century. So it is, I want to suggest, with the human ability to use language.”

About Language

Language is a complex system of knowledge that all children learn by listening to native speakers in their surrounding environment.

It includes sound structure, word structure, word meaning, sentence structure, mapping from sentence structure to meaning, unspoken rules of conversation…

Individual sounds (in IPA)

**g a b l i n z**
About Language
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Some Terminology
Phonology: sounds and sound system of the language

Lexicon: Words and associated knowledge (word forms, word meanings, etc.)

Morphology: system for combining units of meaning together (goblin + [plural] = goblins)

Syntax: system for combining words into sentences

Pragmatics: knowledge of language use

Don’t goblins like children? = surprise if the answer is ‘no’ (expectation is that the answer is ‘yes’) Use this question format to show expectation of a ‘yes’ answer.
So About That Universal Translator…
Languages can differ significantly on how they instantiate this knowledge, particularly the structural knowledge.


Kids Do Amazing Things
Much of the linguistic system is already known by age 3.

…when kids can’t tie their own shoes or reliably recognize "4".

What kids are doing: extracting patterns and making generalizations from the surrounding data mostly without explicit instruction.

Terminology: Patterns or “rules” of language = grammar

A learning analogy: Set

Here are some cards - they have some salient properties associated with them.

Task: Find Sets.
Here’s one:

What generalizations might you make about Sets?

A learning analogy: Set

Task: Find Sets.
Here’s another one:

Does this fit your generalization?

A learning analogy: Set

Task: Find Sets.
Here’s another one:

What about this one?
Task: Find Sets.
Are these Sets?

A learning analogy: Set

Yes
Yes
No
No

Yes
Yes
No
No

A learning analogy: Set

Here are some more examples:

What generalization can you make now?

A learning analogy: Set

Can you guess the rule of Set?

A learning analogy: Set

The Grammar of Set

A Set consists of three cards in which each feature is EITHER the same on each card OR is different on each card. To be a Set, any feature in the Set of three cards is either common to all three cards or is different on each card.

Yes
No
No
Yes
Back to Kids & Language

Children infer rules with this amount of complexity (and more!) from examples of language. And sometimes, even when there’s noise (misleading examples in the input).

Noise Analogy: “All these are Sets.”

Knowledge of Language & Hidden Rules

Some examples from language:

You know that…

...“strop” is a possible word of English, while “stvop” isn’t.

Knowledge of Language & Hidden Rules

Some examples from language:

You know that...

...“Who did you see who did that?” is not a grammatical question in English

(Instead: “Who did you see do that?”)

Knowledge of Language & Hidden Rules

Some examples from language:

You know that...

...“In “She ate the peach while Sarah was reading”, she ≠ Sarah but she can be Sarah in all of these: Sarah ate the peach while she was reading. While she was reading, Sarah ate the peach. While Sarah was reading, she ate the peach.”

Knowledge of Language & Hidden Rules

Some examples from language:

You know that...

...the ‘s’ in ‘cats’ sounds different from the ‘s’ in goblins

cats: ‘s’ = /s/
goblins: “s” = /z/
Harry tells Sam about a tree - this is a fairly involved process.

Other things Harry might say:
"There’s a bird in the tree.
“A bird was in the tree yesterday.
“Are there birds in that tree?
“Birds like that tree.”
“That tree looks like a bird.”

These show off the expressive variety of language. (This differs from animal communication.)

“The expressive variety of language use implies that a language user’s brain contains unconscious grammatical principles” - Jackendoff (1994)

Example: Most sentences we have never seen or used before, but we can still understand them.

Question: Can speakers simply memorize all the possible sentences of a language the way they learn vocabulary of their language? Not if there are an infinite number of them...

Linguistic Infinity

An aardvark is not an antelope.

An aardvark is not a zenith.

A penguin is not a goblin.

Another way to get a really large number of sentences...

An aardvark is not an antelope.

Another way to get a really large number of sentences...

If an aardvark is not an antelope, then an aardvark is not an ant.

If an aardvark is not a zenith, then a peach is not an idea.

If a penguin is not a goblin, then a fruit is not a fairy.

And another...

One (dumb) way to get infinity
Linguistic Creativity

What lists include this sentence?

Through dangers untold and hardships unnumbered, I have fought my way here to the castle beyond the goblin city to take back the child you have stolen, for my will is as strong as yours and my kingdom is as great.

Or this one?

In the purple powder room, there lived a grumpy dollop of cream that slept lazily and yelled silently by turns, often scaring the silverware with its fierce pacific nature.

Linguistic Infinity

Sentence Patterns:

- Hoggle has $n$ jewels.
- An $X$ is not a $Y$.
- Since an $X$ is not a $Y$, a $Z$ is not a $W$.

A more complex pattern: X Verbs that [sentence].

This shows recursion because "X Verbs that [sentence]" is itself a [sentence].

Sentence --> X Verbs that Sentence

Two more examples of recursion

Sarah’s friend is a dwarf.
Sarah’s friend’s older brother is a dwarf.
Sarah’s friend’s older brother’s best friend is a dwarf.
...

Noun-Phrase --> Noun-Phrase’s Noun...is a dwarf

Linguistic Infinity

A more complex pattern: X Verbs that [sentence].

This shows recursion because “X Verbs that [sentence]” is itself a [sentence].

Sentence --> X Verbs that Sentence

Sentence --> Hoggle thinks that [Sentence]

- Hoggle thinks that [Sarah has Jareth’s attention].
- Hoggle thinks that [Ludo knows that [Sarah has Jareth’s attention]].
- Hoggle thinks that [Didymus suspects that [Sarah has Jareth’s attention]].

Two more examples of recursion

This is the castle where Jareth lives.
This is the throne that’s in the castle where Jareth lives.
This is the goblin that sits next to the throne that’s in the castle where Jareth lives.
This is the fairy that bites the goblin that sits next to the throne that’s in the castle where Jareth lives...

Sentence --> This is Noun-Phrase

Noun-Phrase --> Noun-Phrase that Sentence
The argument for mental grammar

"In short, in order for us to be able to speak and understand novel sentences, we have to store in our heads not just the words of our language but also the patterns of sentences possible in our language. These patterns, in turn, describe not just patterns of words but also patterns of patterns. Linguists refer to these patterns as the rules of language stored in memory; they refer to the rules as the mental grammar of the language, or grammar for short." - Jackendoff (1994)

Possible objections to a mental rule set

"Why should I believe I store a set of rules unconsciously in my mind? I just understand sentences because they make sense."

Possible objections to a mental rule set

"Why can we recognize patterns even when some of the words are unknown?"

"Twas brillig, and the slithy toves did gyre and gimble in the wabe...

Possible objections to a mental grammar

"What about people who speak ungrammatically, who say things like 'We ain't got no bananas'? They obviously don't have grammars in their heads."

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Prescriptive vs. Descriptive Grammar

Prescriptive: what you have to be taught in school, what is prescribed by some higher "authority"

"Don't end a sentence with a preposition."

"Ain't is not a word."
Possible objections to a mental grammar

“What about people who speak ungrammatically, who say things like ‘We aint got no bananas’? They obviously don’t have grammars in their heads.”

Prescriptive vs. Descriptive Grammar

Descriptive: what you pick up from being a native speaker of the language, how people actually speak in their day-to-day interactions

Who does Sarah first talk with?

“You’re horrible!” “No, I aint’ - I’m Hoggle!”

Possible objections to an unconscious rule set

“When I talk, the talk just comes out - I’m not consulting any rule set.”

Analogy: wigging your fingers

When you want to wiggle your fingers, you “just wiggle them”.

But your finger-wiggling intention was turned into commands sent by your brain to your muscles, and you’re never conscious of the process unless something interferes with it. Nonetheless, there is a process, even if you’re not aware of it.

The argument for prior knowledge

Suppose we have mental grammars in our heads - how did they get there?

“Many people immediately assume that the parents taught it. To be sure, parents often engage in teaching words to their kids: “What this, Amy? It’s a BIRDIE! Say ‘birdie, Amy’! But language learning can’t entirely be the result of teaching words. For one thing, there are lots of words that it is hard to imagine parents teaching, notably those one can’t point to: ‘Say ‘from’, Amy!’ ‘This is ANY, Amy!’ - Jackendoff (1994)

Possible objections to an unconscious rule set

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The argument for prior knowledge

Not so clear that children learn grammatical patterns from their parents

(From Martin Braine)

Child: Want other one spoon, Daddy.
Father: You mean, you want the other spoon.
Child: Yes, I want other one spoon, please Daddy.
Father: Can you say “the other spoon”?
Child: Other…one…spoon.
Father: Say “other”.
Child: Other.
Father: “Spoon.”
Child: Spoon.
Father: “Other spoon.”
Child: Other…spoon. Now give me other one spoon.

The argument for prior knowledge

Suppose we have mental grammars in our heads - how did they get there?

What about children of immigrants, ex: Americans who move to Israel?

“The adults often never feel comfortable with the language of the adopted country…speak with an accent…their children become fully fluent native speakers of the new language. Evidently the children have learned something their parents don’t know. So the parents couldn’t have taught them.” - Jackendoff (1994)
The argument for prior knowledge

Some other things that are hard to teach: interpretations

Joan appeared to Moira to like herself.
Joan appeared to Moira to like her.
Joan appealed to Moira to like herself.
Joan appealed to Moira to like her.

Joan M thinks J likes J
M thinks J likes M
J wants M to like M
J wants M to like J

How do we come to understand these sentences this way? It obviously depends somehow on the difference between ordinary pronouns such as “her” and reflexive pronouns such as “herself,” and also on the differences between the verbs “appear” and “appeal.” But how?...sure no one is ever taught contrasts like this by parents or teachers...” - Jackendoff (1994)

The argument for prior knowledge

“...we can draw another conclusion about human nature: We can acquire unconscious patterns unconsciously, with little or no deliberate training.” - Jackendoff (1994)

Paradox of Language Acquisition: “...an entire community of highly trained professionals, bringing to bear years of conscious attention and sharing of information, has been unable to duplicate the feat that every normal child accomplishes by the age of ten or so, unconsciously and unaided.” - Jackendoff (1994)

Conclusion: “Children have a headstart on linguists”

The big fuss about Universal Grammar

“Suppose there is some aspect of language that children couldn’t possibly figure out from the evidence in the speech they hear around them. Then this aspect can’t be learned; it has to fall under the innate part of language [UG].” - Jackendoff (1994)

While the necessity of some kind of bias is generally granted by even the most ardent critics of the UG hypothesis, the nature of the necessary biases is the subject of considerable debate.

- what cognitive objects the bias operates over:
  hypothesis space, data interpretation, learning algorithm
- whether the necessary bias is specific to language learning (i.e. domain-specific) or applies generally to any kind of cognitive learning (domain-general).