Can Chimps (& …) Learn Language?

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< \vartheta, \pi > \rightarrow_{\text{Li}} "proof" \rightleftharpoons
Ok, so what about these guys, and language?

Basic Picture

\[ \langle \theta, \pi \rangle \rightarrow_{Li} \text{“proof”} \]
Ok, so what about these guys, and language?

Basic Picture

< $\theta, \pi \rangle \rightarrow_{Li} \text{“proof”} \checkmark
Springbok Stotting
“...70 distinct vocalizations that range from the celebratory to calls to mount a search and rescue.”
What is communication, anyway?
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- Successful Communication: The idea the communicator wished to convey is understood by the intended listener.
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- Successful Communication: The idea the communicator wished to convey is understood by the intended listener.
- So then, is stotting communication?
Kluger
• “As with all matters animal, it is possible to make too much of even the most remarkable stories of communication among the nonverbal beasts … they do not convey great philosophical insights—or at least there is no evidence that they do.” (78)
“As with all matters animal, it is possible to make too much of even the most remarkable stories of communication among the nonverbal beasts … they do not convey great philosophical insights—or at least there is no evidence that they do.” (78)

So then, what accounts for the difference between animal and human language?
Formal Grammar

- Selmer’s argument: Chimps do NOT have language, in anything like the human sense, because they cannot have conversations in accordance with a formal grammar.
  - Or: The Kolmogorov complexity of animal-to-animal communication and animal-to-human communication is too simple.
- Formal grammar – A set of rules defining how language elements can be combined to produce larger ones.
• The man is here.
• The man is here.
• Is the man here?
• The man is here.
• Is the man here?
• The man who is tall is here.
  – Is the man who tall is here?
  – Is the man who is tall here?
• The man is here.
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Children don’t make this mistake, they don’t even try it out!
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This is evidence that the child is making some use of the “Noun Phrase” grouping “man who is tall” and thinking of it as a formed structure.
Emergence of structure through incremental single-label transfers: NLP
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- Given a string of written characters, how does structure emerge?
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- Word or concept recognition (ambiguous)

The quick brown fox jumps over the lazy dog
Emergence of structure through incremental single-label transfers: NLP

- Given a string of written characters, how does structure emerge?
- Categorization of letters (possible ambiguity)
- Word or concept recognition (ambiguous)
- Part-of-speech
Emergence of structure through incremental single-label transfers: NLP

- Given a string of written characters, how does structure emerge?
- Categorization of letters (possible ambiguity)
- Word or concept recognition (ambiguous)
- Part-of-speech
- Phrases, sentences, etc.
Three properties of *productive* language

- **Systematicity**: Understanding one type of sentence implies you can understand systematic transformations of them.
- **Compositionality**: The meaning of an expression is determined by its constituent parts and the relations used to combine them.
- **Recursion**: We can seemingly produce an infinite number of possible expressions.
Language is systematic...

- Premack:
  - Animals might be able to understand some higher level relations, but “only humans appear capable of reinterpreting the higher-order relations between these perceptual relations in a structurally systematic and infinitely productive fashion...”
Master is going to give me a bath.
Master is going to give me a bath.

It may be argued that some animals can understand something like this.
Master is going to give me a bath.

It may be argued that some animals can understand something like this.

I am going to give a bath to master.
Master is going to give me a bath.

It may be argued that some animals can understand something like this.

I am going to give a bath to master.

Systematicity – Human language is such that if we know someone can express/understand the first, they can at least express/produce some understanding of the second. We wouldn’t expect this of animal “language.”
Language is *recursive*...
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- Infinitely productive (subject to working memory limitations)
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• Selmer can talk more about this, in formal terms …
Language is *recursive*…

- Infinitely productive (subject to working memory limitations)
- Selmer can talk more about this, in formal terms …

John met the girl.
Language is *recursive*…

- Infinitely productive (subject to working memory limitations)
- Selmer can talk more about this, in formal terms …

John met the girl.
John met the girl who met the guy.
Language is recursive...

- Infinitely productive (subject to working memory limitations)
- Selmer can talk more about this, in formal terms ...

John met the girl.
John met the girl who met the guy.
John met the guy who met the guy who ate the hamburger.
Language is *recursive*…

- Infinitely productive (subject to working memory limitations)
- Selmer can talk more about this, in formal terms …

John met the girl.
John met the girl who met the guy.
John met the guy who met the guy who ate the hamburger.
John likes that John met the guy who met the guy who ate the hamburger…
Language is *compositional* …
(Frege’s principle)

- What is the meaning of the phrase “John met the girl”?
- Depends on the meaning of the objects referred to and the relationships between them
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Prairie Dog “Language”

- Believed to have a complex language

“...The animals have word-like phonemes, combining those into sentence-like calls. They have social chatter. They can distinguish between types of predators that are nearby — dogs, coyotes, humans — and seem to have developed warnings that specify the predators’ species and size and color.”
RR Hypothesis: “[Animals do not have] the representational processes necessary for systematically reinterpreting first-order perceptual relations in terms of higher-order, role-governed relational structures akin to those found in a physical symbol system (PSS).”
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It is very difficult (impossible?) to explain the properties of human language without the use of a PSS; i.e., without the use of programs, data structures, circuits, etc.

On the other hand, these properties are precisely the sort of thing that PSS's are good at!
Further thinking …

• How do humans learn sophisticated grammars from limited input??
  • The Language-Learning Game … as a portal to …
  • *computational learning theory* as a way to see how difficult language learning is.

• If you want to further discuss any of the matters touched upon or raised in the present slide deck, contact Prof Licato, at john.Licato@gmail.com. For discussion re the formalization of the level of complexity of nonhuman communication, feel free to contact Selmer at Selmer.Bringsjord@gmail.com.