Origins and Evolution of Language
Week 6 tutorial
Tutor notes

Comments for tutors are in italics.

As usual week, two aims for today:

1. *Read and talk about an interesting paper from one of our own.*
2. *More generally, practice reading, summarising, and evaluating research papers, with a bit of encouragement from questions are intended to help think critically about the paper's methods and conclusions. This paper is particularly interesting because it models really careful evaluation and critique of other papers in the literature.*

One additional note: you could easily do 2 tutorials on this paper, it's very rich. I'll leave it up to you whether you try to tackle both the Fitch & Hauser stuff or the Kanzi stuff evenly, or focus more on one that the other. The Kanzi stuff comes with a video activity that might be interesting and a good break after the slightly drier AnBn stuff.

This week's tutorial picks up on a topics we discussed last week, on the grammar learning capacities of non-humans. In this tutorial you'll read and discuss Truswell (2017), which is a short critique of a well-known monkey artificial grammar learning experiment, plus an interesting analysis of the comprehension abilities of a language-trained ape. The author, Prof. Rob Truswell, is based here in Edinburgh, you might know him.

The first part of the paper provides a discussion and critique of Fitch & Hauser (2004). The description is quite brief (although the 2004 paper is quite brief, so if you are interested just read it!), so to elaborate a little bit: Fitch & Hauser exposed cotton-top tamarins (small new world monkeys) and humans to one of two sets of sequences generated by simple artificial grammars. Both grammars involved sequences of syllables spoken by a female and male speaker - A syllables were spoken by the female and were ba, di, yo, tu, la, mi, no, or wu; B syllables were spoken by the male and were pa, li, mo, nu, ka, bi, do, or gu. In the (AB)^n condition sequences consisted of repetitions of AB pairs - e.g. you might hear "*di* mo *yo* pa" and "*di* pa *wu* bi *tu* nu" where syllables in italics were spoken by the female. In the A^nB^n condition sequences consisted of a sequence of A syllables followed by a sequence of B syllables, e.g. you might hear "*di yo* gu do" and "*no tu wu* ka mo gu". Participants were then tested on whether they could differentiate between novel (i.e. unheard) (AB)^n and A^nB^n sequences. Humans trained on either grammar could do this, and tamarins trained on the (AB)^n grammar succeeded; however, the tamarins trained on the A^nB^n sequences did not differentiate between sequences generated by the grammar they were trained on and the other sequence type, i.e. they appear not to have learned the AnBn grammar. Fitch & Hauser conclude "the current findings suggest that tamarins suffer from a specific and fundamental computational limitation on their ability to spontaneously recognize or remember hierarchically organized acoustic structures."

One rather sad footnote to this paper: Marc Hauser was found to have committed scientific misconduct in other scientific papers. I am not aware of any suggestion that this particular paper is unreliable, and the first author (Tecumseh Fitch) is an extremely careful and

rigorous scientist whose work I trust implicitly. But the data in this case comes from the Hauser lab. That's not actually very relevant in evaluating Truswell's critique of this paper, but worth knowing in general.

The second part of the paper is an evaluation of Savage-Rumbaugh et al.'s (1993) data on Kanzi's interpretation of spoken English commands, with a focus on what they tell us about Kanzi's knowledge of English grammar, specifically his sensitivity to linear order and hierarchical structure. Kanzi is a male bonobo (a species closely related to common chimpanzees) who was raised by humans in a research lab in quite unusual circumstances. You can see a video of Kanzi performing a similar task (or maybe this is some of the actual data?) on youtube, worth watching all the way through once you have read the paper, applying Truswell's eye to Kanzi's actions!

There's some stuff in there you could solve with a semantic soup strategy – "cut onions knife", "put pine-needles refrigerator", "carry TV outdoors" can only be interpreted one way – but some stuff that shows sensitivity to linear order ("put soap water", "pour coke water") – might be worth watching and discussing these when you get to that section of the tutorial.

Questions for discussion:

- Why is Truswell skeptical that Fitch & Hauser's method (learning to differentiate (AB)^n and A^nB^N) is diagnostic of the capacity (or absence of the capacity) to acquire context-free grammars of the sort involved in human language?

The crucial issue seems to be that there are grammars that are not as powerful as context-free grammars (specifically, counter grammars) that can deal with this AnBn stringset – so even if the tamarins had succeeded on that task, it wouldn't tell us they could represent the same sort of grammar required for natural language (where you definitely need something more powerful than a counter grammar). By the same token, you can actually deal with (AB)^n with something simpler than finite state, so we can't infer from the tamarins' success there that they can acquire any finite state/regular grammar.

- What is dendrophilia? What is dendrophobia?

The idea is that dendrophiles will be predisposed to infer hierarchical structure over stringsets (i.e. they might run ahead of the evidence and hallucinate hierarchical structure from inconclusive evidence) whereas dendrophobes will be reluctant to do so (and might not do so even given very convincing evidence that they should). You could relate in a general way this to the learning bias we saw in last week's tutorials on zebra finch song – the learning bias we are talking about here is different (what kind of abstract grammar you infer that is consistent with your data, rather than preference for e.g. shorter notes and better rhythm where you depart from your training data), but the general idea that you can have expectations about how your communication system will work is the same.

- What is "semantic soup" as an interpretation strategy, and why does Truswell consider it? What evidence is there against Kanzi applying a semantic soup strategy?

In a semantic soup strategy "the meanings of the individual content words are formed into a coherent action description in whatever way they fit best, without attention to any syntactic information in the signal. " Truswell considers it because he is essentially applying Morgan's Cannon – look for the simplest possible explanation to account for the observed behaviour, and here we assume that semantic soup is a simpler interpretative strategy because it involves less grammar (but on the other hand, it does involve more interpretation!). The main evidence against this in the Kanzi data is his sensitivity to linear order – e.g. sentences like "pour coke water" in the video above seem to be interpreted fairly reliably.

- What is structure sensitivity, and what evidence is there that Kanzi does not exhibit structure sensitivity? What evidence is there that human infants exhibit structure sensitivity? How does this relate to dendrophilia and dendrophobia?

Structure sensitivity involves being sensitive to factors beyond linear order, understanding that the word string is composed of constituents: in the case of this paper the critical example are conjoined NPs, where you have to realise that the action given in the verb should be applied to both nouns in the conjoined NP, i.e. they form a complex argument to the verb. Inferring these abstract hierarchical groupings indicates dendrophilia, or the capacity to overcome dendrophobia, because they involve inferring hierarchical structure over strings.

- More generally, what do you think about the prospects of this kind of experimental data (like that from Fitch & Hauser or Savage-Rumbaugh et al.) to tell us something about the evolution of the human capacity for language? Are there particular studies you'd like to see run? If so, what studies? If not, why not?

This is one for general discussion. Personally I think this stuff is very promising, but challenging, and to be done well it really needs a keen eye on the design of the target strong sets and the interpretation on the results. I think its most useful possible finding is helping us to narrow down exactly what the difference is between human and animal cognition in terms of ability/propensity to infer particular grammar types. Are we completely off the charts relative to our closest relatives, or can we see some continuity in these abilities? Have other species (e.g. birds) independently evolved grammar-learning abilities that are closer to humans, and if so what shared selection pressures might have lead to this convergent evolution?