Sean Rogers
APSC 450

Other Minds Talking – 3 Levels of Speculations on Language and the Octopus

Consider an octopus that could talk. How could that happen and what would that look like? Why haven't we found one? It's natural to ask why humans are so privileged in their "language faculty" in our section of the animal kingdom, and we could perhaps try to find a neurobiological reason that imparts to the human brain the irresistible proclivity (barring significant pathologies) to pick up and use a language, both externally and internally, without a particularly keen conscious understanding of all the little, nitty-gritty rules governing our phonology or morphosyntax. Perhaps there's some critical circuitry that's needed, or some number of neurons or scheme of coding. Perhaps some mutation in early humans resulted in some new type of computation – a new algorithm – becoming possible on the existing structure. Given their radically different nervous system, could there be some completely different mutation or evolution in a population of octopuses that would allow their nervous system to perform this 'new' kind of computation? After all, if an octopus had a language, it would surely have at least a couple of differences in their brain, since their neuroanatomy is dissimilar to vertebrate neuroanatomy.

We might suppose that an octopus doesn't have a language because it's not a particularly social animal. As Godfrey-Smith highlights, octopuses live relatively solitary and short lives. Consider the human in contrast – we're a social creature that lives in groups, and language is particularly relevant for managing this kind of structure. Perhaps language evolved in humans as a consequence of this; indeed, we cannot learn a language without other people around us. A baby will take completely arbitrary phonetic input and extrapolate/construct an extremely robust syntactic and grammatical system from it. And if a child is deprived of any linguistic input at all, then it will (sadly) fail to ever learn a language later in life. There's some very finely-tuned learning going on around critical time periods, and we'd hope to eventually have a comprehensive description of the ultimate neural mechanisms that underly and govern this. So there we have it – humans have language because they're social animals and octopuses don't because they're not.

But of course it's not that easy – other social animals don't have the capacity for language (though they may have advanced communication systems). Why should this be the case? We have a similar thematic architecture to our brains, at least in mammals and vertebrates. Is it because they don't have enough neurons? Do they not have the right kind of circuitry? If there is a neural basis for language (as we should think there would be), we'd expect to be able to describe it in such a way that distinguishes it from 'mere' communication. Indeed, songbirds and humans (both capable of 'vocal learning') have connections between brain regions that chickens and macaques ('nonvocal learners') don't have. Maybe once you aggregate all of the special circuitry and genetic differences, you'll eventually find a point where language naturally arises at the neural level. But let's leave the question of implementation aside; after all, given an octopuses radically different neurobiology, we might expect to find a different implementation of a language (or perhaps it would look similar – they convergently evolved a camera-like eye after all).

What is the algorithmic level for language? This is a very complicated question to ask, by my estimation. There's a lot of linguistic debate on the subject in grammar and syntax and though there are leaders in the field, I'm unaware of there being One True Theory in theoretical syntax. Noam Chomsky would hold that language and syntax must be minimally 1) hierarchical, and this hierarchical structure must 2) affect interpretation, with a necessary 3) generativity – the recursive structure should allow infinite expressions. Language must be based on a "recursive generative structure" that takes elementary units (lexical items) to which it applies its rules to generate structured expressions without bound. Language and its syntax have words and rules, and grammar and syntax form a computational system (Bernwick & Chomsky, 2016, p. 66). (There must also be a way to externalize and articulate these internal computations too, of course). What's interesting is that exactly what these computations are is not directly apparent to us, even as native speakers of a language. If someone asked you for a comprehensive list of all the rules of your grammar for your language, could you give them one? Are we even aware of all of the rules behind our day-to-day grammaticality judgments? There are plenty of competing theories for the ultimate syntactic structure across all languages, but Chomsky (in his minimalist approach) holds that the optimal and minimally necessary computational procedure is something he calls "Merge" – the syntactic operation of combining syntactic elements/units into sets, which can be merged as larger units (as many times as you like, recursively). Once you have Merge (and items to use it on), the 3 necessary criteria can be satisfied. Perhaps the radical change in humans as a species that resulted in language was the development of Merge in the first place – once humans developed (through genetic mutation, presumably) the ability to merge (and represent) linguistic/syntactic units, it was only natural for language to emerge. Or perhaps the generalization of a 'merge' operation, borrowed from other neural systems and applied to what would become lexical units is what allowed language to be built. Either way, Chomsky describes a working framework for the algorithmic implementation of language as a cognitive module.

So if Merge is the big thing, *the* thing that results in complex morphosyntax, then we can point towards the algorithmic distinction between human language and general communication (this is of course a ‘big if’ – Chomsky himself has championed different approaches to universal grammar at different times, and he’s certainly not short of his own critics). Could an octopus develop the same algorithmic parameters that would produce a language from some basic principles? Well, firstly they’d need some units upon which to perform computation – a lexicon. For humans, we have spoken words that we articulate that are meant to be heard. An octopus lacks the same articulatory system that humans do (no one would confuse a human mouth for an octopus mouth), and water is very different from air, both as something to manipulate to generate sound and as a medium for transmission. There are, of course, animals that communicate with sound underwater. But for the octopus, if I were tasked with engineering a way for them to ‘speak’ with one another, I’d probably not go with verbal speech, at least not unless they have a particularly good way to create a great many arbitrary sounds.

But the modality of articulation is not particularly important for humans either – sign language is no less rich than spoken language. Perhaps there could be an octopus sign language? Octopuses could have a set of symbols - arbitrary tentacle gesticulations - that could be strung together. They already convey meaning to one another with specific movements – take the octopus that “stands up” tall and manipulates its mantle to intimidate other octopuses. Or perhaps they could manipulate their color – they’re very good at this, after all. As Godfrey-Smith says, “the skin of a cephalopod is a layered screen controlled directly by the brain.” Imagine an octopus with its skin all one color, save particular patches that altogether spell out “I am an octopus” (in octo-runes of course, not English letters. That’d be ridiculous.) Or perhaps an octopus could manipulate its dermal papillae quickly and efficiently enough in such a way that, if another octopus were there to feel the bumps, there could be some kind of octo-braille (this one is of course a bit less compelling because of the need for direct, physical contact, and octopuses can be a bit shy in that regard). These suppositions are of course naïve, but we can see that a method for the externalization of language could be grafted onto an octopus’s existing modalities. The real problem at this level, one would imagine, would be in conceiving the method by which an octopus would communicate a sentence to another octopus. With their “disembodied cognition” and radically decentralized nervous organization, we have no reason to believe that they experience the world in the same way we do. Perhaps, since they ‘taste’ the world around them and have less of a visual focal point of experience than humans, their eyes wouldn’t be the important medium to receive language signals. We know that they certainly use their eyes – they can manipulate a tentacle to a goal using only visual information – but they don’t seem to place as much emphasis on visual experience as we do. Additionally, would each tentacle need to process language separately? Humans display some lateralization for language – how would an octopus break down the task? Perhaps the computations surrounding meaning would be done centrally, while the computations for syntactic form and ultimate articulation would be distributed in the articulatory tentacles. That's not a very satisfying speculation though - there's really no way to make a good comparison, since their system is so alien to our own. This also begs the question – if they could talk (in any way), would their language have the same overarching structure as human language? We might presume that different populations would have different 'languages' (like humans do), but that there would be central, governing, "universal" rules behind it all (like we presume for humans) – a 'Universal Octopus Grammar.' Would the morphosyntactic rules of an octopus language map in any way to our human models? Perhaps the radically different neural setup of an octopus, in combination with their radically different environments (in comparison to humans) would result in a language faculty that prefers systems that are unlike our own, that would not fit into the nice tree diagrams we can draw for our own sentences (whatever their 'sentences' would be comprised of). Imagining a different syntax is a bit tricky, since we naturally want to fit it back into our own. Perhaps it would converge to and fit the mold of our human syntax, and we could dive down with some translation tool to ask them about how best to catch crabs.

We should also consider the motivation behind language at the overarching computational level – *would* an octopus ever talk? We return to the parameters that pressured the human evolution of language. Neuroanatomical constraints notwithstanding, the octopus just isn't a very social animal. Cephalopods don't form tight groups in the way humans do. It would seem that the kinds of evolutionary pressures that result in language (and complex communication in general) aren't that strong for octopuses. Surely they have to communicate – there's a behavioral need across their lifespan – but their general strategy of solitude would imply that, if language were to be regarded as a response to an evolutionary need for advanced communication, then the octopus (or a group of octopuses) that can talk doesn't stand any better reproductive chance in its environment than the one who can't. Perhaps Godfrey-Smith's 'Octopolis' gives a glimpse into a potential shift in strategy for a species. If octopuses came together in small groups more generally, rather than just as an outlying oddity, might they then eventually arrive at some language? We're a bit discouraged at this point by the myriad social vertebrates who do not possess the same language faculty that humans possess. Even if they were a more social animal, they might just not have strong pressures to develop language.

Godfrey-Smith presents another interesting take on the evolution of language, however. Much like how sensory systems were turned inward to give rise to a nervous system that could organize and direct itself, so too, perhaps, was a communication system 'turned inwards' to provide a looping system of reafference to give internal structure (in a more abstract way) in the mind. Similar to how one could write a note to oneself to read later (presumably to remember something), language could provide a similar structural role within our minds. It's a nice idea – language could be a vehicle by which an organism could better regulate its internal, mental structure. This may seem a bit too vague, but consider – you're reading these words as words, as syntactically-governed lexical items that carry meaning. And many people (myself included) will report the existence of an internal monologue of a certain language that gives form to thoughts (though this is of course not required for the action of 'thinking' and any strong claims on language dominating and restricting the human capacity for thought or perception should be viewed skeptically). We seem to be almost unable to escape from this inclination. Godfrey-Smith's generalization of the notion of an efference copy applying to language and thought could be a compelling enough pressure to eventually evolve a language (of course, if it is a language, it must additionally be externalized in some way). With respect to the initial development of early human language, this is a very Chomskyan idea. Essentially, there's a significant computational burden on interpretation – the listener needs to rapidly resolve ambiguity in the course of communication. There's a conflict between "computational efficiency" and "interpretive-communicative efficiency," and languages "universally resolve the conflict in favor of computational efficiency." Because the process of externalization (and communication) carries an additional computational cost, so Chomsky claims, language seems to have "evolved as an instrument of internal thought, with externalization a secondary process." (Bernwick & Chomsky, 2016, p. 74) The resulting picture, then, would be a task of devising efficient externalization solutions once Merge arose as an operation within the early human mind. If the need for internal self-government is an evolutionary pressure for the biological evolution of language, then perhaps the octopus would have a reason to speak for the same general reasons it (or rather, its ancestor) evolved a nervous system at all. Perhaps with sufficient neural density and a bit of luck, existing circuitry or structural themes could be recruited to allow for an 'alien' organism like an octopus to develop language. Maybe they just need to be more social, or they need to live longer individual lives – whatever results in them getting to the algorithmic threshold for language. At the very least, it's clear that there's still much work to be done in bringing the computational study of language as a function of the brain into a more concrete form, and maybe once neuroscience can better tackle the problem we can say more succinctly and completely how humans have language, and why it is the case that octopuses do not.

Further Reading:

Godfrey-Smith, P. (2017). *Other minds: The octopus, the sea, and the deep origins of consciousness*. New York: Farrar, Straus and Giroux.

Pfenning, A. R. et al. (2014). Convergent transcriptional specializations in the brains of humans and song-learning birds. *Science, 346*(6215)

Bernwick, R. C. & Chomsky, N. (2016) *Why only us: language and evolution*, Cambridge, UK: The MIT Press.

Chomsky, N. (2000) *New horizons in the study of language and mind*, Cambridge, UK: Cambridge University Press.