BRAIN SCIENCE PODCAST

With Ginger Campbell, MD

Episode #30

Discussion of the Book, *The First Word: The Search for the Origins of Language*, by Christine Kenneally

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INTRODUCTION

This is the *Brain Science Podcast* – the podcast for everyone who has a brain – and I'm your host, Dr. Ginger Campbell. On the *Brain Science Podcast* we explore how recent discoveries in neuroscience are unraveling the mysteries of how our brains make us who we are. For more information including Show Notes, links to previous episodes, and information about how to subscribe please go to the website brainsciencepodcast.com. We also have a Discussion Forum at brainscienceforum.com and you can send me email at docartemis@gmail.com.

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DISCUSSION

This is the *Brain Science Podcast* Episode 30. I want to thank those of you that have been helping to promote the *Brain Science Podcast* by sharing it with others and by sending in donations. Today's episode is a discussion of Christine Kenneally's new book, *The First Word: The Search for the Origins of Language*. Kenneally was born in Australia and received her PhD in linguistics from

Cambridge. She has written about language, science, and culture for magazines like *Scientific American* and *The New Yorker*.

The first question that probably comes to your mind is why should we talk about the evolution of language on a podcast about the brain? Well, if you've been keeping up with recent episodes you know we just got done talking about reading and the brain, and so talking more about language seems natural. And trying to figure out where language comes from is closely connected to figuring out how it happens in the brain.

I first got interested in this subject back in Episode 6 when I described the book, *The First Idea*, by Stuart Shanker and Stanley Greenspan. At that time I considered their theory that emotional signaling might have had an important role in the emergence of language. And then in Episode 7 we interviewed Dr. Shanker and he told us about the remarkable communication abilities of Kanzi, the bonobo. In the most recent episodes we did talk about the fact that our brain changes when we learn how to read. This was in Episode 24 and 29. Obviously reading and writing are impossible without language so, as I said, it seems natural to ask questions about language.

I'm going to come back to the explicit question about how the brain does language later on in this podcast, but the focus of this podcast is to explore the question of how did language emerge or evolve. Paradoxically, even though the interest in where language comes from goes back at least as far as the ancient Egyptians, shortly after Darwin put forth his theory of evolution by means of natural selection the question of language evolution was actually banned from scientific circles in both France and Great Britain. The story of this is explored in more detail in the book.

And then in the 1960's the influence of Noam Chomsky, who regarded the question as either impossible or irrelevant, acted as a de facto ban until the

1990's. I'm going to spend quite a bit of time talking about Chomsky in just a few minutes. However, the field is now a very active one and Kenneally's book gives us a good overview. You don't need any knowledge of linguistics to understand this book. I think it will especially appeal to people who are interested in the history of science and ideas.

The evolution of language is not easy to unravel. Besides the long-standing prejudices that have discouraged work in the field, language leaves no fossils. Our bones don't reveal when we started to speak. The long-standing assumption was that language was something completely unique to humans and that there was something specifically unique about our brains that made it possible. But these assumptions are not really supported by the emerging evidence from both neuroscience and from animal studies. That's one reason why I think it is an important area to know about.

Now, the way the book is structured it considers the important characters in the field, what it means to have human speech, the question of what exactly is evolving, and some of the current questions and controversies. I can only offer a very broad summary of the ideas, so you will definitely want to read the book if you want more detail.

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First I'm going to concentrate on Noam Chomsky because he is probably the most influential linguist, possibly ever, and his influence has had a great deal to do with why this field is not further along, as I will show in a minute. Chomsky has been teaching at MIT for over 40 years and some consider him to be the most important philosopher of his generation. Remember that linguistics is actually a branch of philosophy. What has made Chomsky famous is his claim that all humans share a so-called universal grammar, which is supposed to be a set of rules that generates the syntax of every human language.

On page 28 Kenneally says that his supporters have traditionally contended, "that the universal grammar exists in some part of our brain in a language organ" that only humans possess. Chomsky regards syntactical structure as the core of human language—that means syntax, or grammar. And, as I mentioned, for years Chomsky considered language evolution to be "unworthy of investigation." It wasn't until 2002 that he published a paper acknowledging that it was now "feasible to study the topic."

I want to consider a brief review of Chomsky's career so that you might have a better idea of his influence. Before Chomsky linguists worked in the field; that is, they listened to people in the real world doing real world languages. He transformed linguistics into a theoretical field.

Back in the early 50's Chomsky's Master's thesis was a Hebrew grammar. Then he began work on a book called, *The Logical Structure of Linguistic Theory*. The first chapter of this book was his PhD thesis, after which he went to teach at MIT. In this book instead of describing an actual language he discussed the different ways a language could be described. And at first other linguists really didn't know what to make of his work.

In 1957 he published, *Syntactical Structures*, a book based on the lecture notes for his first linguistics class. This was significant because he discussed grammar in a new abstract way. He argued that grammar was a theory of language. He thought that it was possible to collapse all languages into a set of rules. So, a basic idea was that the job of grammar was going to be to generate all the language's allowable sentences.

But what made Chomsky famous was when he published a review of B.F. Skinner's book, *Verbal Behavior*, about two years later. At that time Skinner was the dominant figure; somewhat like Chomsky later became. Behaviorism, which is what Skinner was known for, was still very widely accepted. It was called

behaviorism because in this school behavior was considered to be all that mattered. Thought and emotion were treated as irrelevant.

Now, Chomsky's review came out about two years after Skinner's book, and he challenged Skinner's suggestion that language was a simple behavior. He said that Skinner was ignoring the tremendous creativity of language and he argued convincingly that the stimulus-response model was not relevant. So, this was a major attack on the behaviorist model that said that all behavior could be described with the stimulus-response model. If language could not be described by that model, that would be a big deal.

In his review Chomsky proposed that the interesting question was how did children acquire language so rapidly. How did they learn thousands of words and rules for how to combine them? He claimed that there wasn't enough information in daily life to allow children to figure out these rules. He called this a 'poverty of stimulus'. This was the basis of his famous claim that children must be born with a mental component that helps them learn language.

Now, it's important to realize that this was around 1959 which means that there was very little actual scientific knowledge about how the brain does language. Kenneally says that Chomsky's paper was the knock-out punch for behaviorism and it propelled him into stardom. Young linguists flocked to study with him, and so a generation of linguists went on to see the world through his eyes.

In 1965 he published, *Aspects of the Theory of Syntax*. This book divides language into two main parts: the parts that are individual and specific, which he called performance; and the parts that he saw as being the innate structure of language, which he called competence. Performance included everything that actually goes into speaking in a given situation. Competence was supposed to be everything that was universal and stable.

Kenneally observes on page 31, “Language in the Chomskian sense has little to do with the fact that it overwhelmingly takes place between people.” Chomsky treated variation as being uninteresting. Universal grammar was supposed to specify a rule for every language and to control the child’s ability to develop the correct rules of syntax for each language. Universal grammar was a language organ that was hard-wired, which meant that children were born with the ability to learn any language.

It was assumed that the brain would have modules controlling things like syntax, meaning, and how to process sound. These modules were assumed to be totally separate from one another. If you heard something the separate modules were supposed to divide up the signal. And this so-called language organ was seen as being separate from the other parts of the brain.

Universal grammar was seen as separate from context, and the language organ was supposed to be different from the part that understands music. Things like gestures were treated as peripheral and uninteresting. Human language was assumed to be entirely distinct from the communication that occurs between animals, which meant that anyone who wanted to do research in animal communication was treated as peripheral.

These ideas may seem strange in the context of recent discoveries both in neuroscience and in animal communication, but they were consistent with what scientists thought in 1965. At that time the brain was seen as consisting of separate modules. Now we know that while the cortex does have modules, they interact extensively. And, of course, no universal grammar module has ever been found. Kenneally says that it seems counterintuitive to discard things like meaning and intonation, but that the theory appeals to the natural desire to divide language into essential and inessential parts.

As a non-linguist my response to this is I would think it was the syntax that was not essential. However, Chomsky did have a key insight that will probably be of lasting value. And that is the insight about the infinitude of language, or what he called its generative capacity, which basically means that we can make an infinity of new sentences that have never been heard before. Recursion is an important part of this. It's a rule for combining endlessly to make more sentences.

Not everyone accepted Chomsky's view of language. A major group of opponents were the so-called generative semanticists—semantics is the same thing as meaning. They objected to separating language from the way it's really used. They argued that the fundamental organizing principle of language is its meaning, or semantics; not its structure, or syntax.

Anyone who's ever tried to communicate in a foreign language would probably agree. You can actually communicate with a few words and gestures, and no grammar at all. So, as a regular person I find it really hard to see why anyone would think that syntax was all that mattered.

Getting back to the story, since the 1970's the evidence has been mounting that the brain does not process language according to the rules that Chomsky proposed. Based on his model complicated sentences should take longer to understand. But they don't. And, of course, there's no sign of an innate language organ. Even the parts of the brain once thought to be solely devoted to language are proving to be much more complex.

Chomsky has a long history of disrespecting work of others, and there is no evidence that he tries to keep up with the progress in neuroscience. He is not known for ever admitting that he could have been wrong. His original theory of universal grammar had children being born with innate rules for language, and he still sticks to his position that the human brain is especially designed to acquire and implement the complex rules of language.

Chomsky's views have influenced an entire generation of linguists, but they have not been very influential on other sciences. And he, as I said before, does not tend to be influenced by other sciences. In the 1970's he continued to dismiss attempts to examine language in terms of natural selection. In the 80's he finally began to acknowledge that language might have given us some evolutionary advantage, but he still saw language as something that had emerged suddenly by accident rather than by a slow evolutionary change.

But putting that question aside for a moment, let's consider Chomsky's view of language. He basically strips away everything that is untidy or messy, leaving us with his "performance," which is, according to Kenneally, an idealized perfect and elegant system. He pretty much dismissed the brain as being too messy. She observes that he has considered quests to understand how the messy brain could develop something so perfect as language as an unsolvable mystery.

But doesn't the idea of a perfect language go against what we know about both physical and biological systems? There is no denying that Chomsky's influence has suppressed research about language evolution for almost an entire generation, if not longer. Coming to the subject now with the advantage of hindsight one is tempted to compare Chomsky to Skinner; that is to someone who once had a lot of influence but whose ideas are no longer particularly relevant. I wonder if one reason why progress is finally being made is that the current generation of linguists is no longer under his thrall.

I think it's probably clear that I do not have a neutral opinion of Noam Chomsky. In fact I have some specific objections. First of all his theory of how language works seems to be totally divorced from reality. He says that grammar and syntax are all that matters. He ignores both meaning and context. To me this seems totally backwards. He also ignores gestures and other forms of non-verbal communication, and he ignores intonation. I mean we have the ability as

humans to tell when a person says one thing and means the exact opposite, by the tone of their voice. So do dogs. This seems like an obvious oversight.

Chomsky's basic assumption that language is too complex to be learned by children without an innate universal grammar may have been convincing 40 years ago but it doesn't stand up to the actual science that's been done in the last 30 years. Cognitive scientists have shown that language development is very dependent on exposure and repetition. Discoveries about plasticity suggest that the brain is much more flexible and less hard-wired than was once assumed.

And of course there is no evidence of any innate brain structure dedicated to language, let alone to grammar. As I mentioned before, we have learned that while the cortex has some modularity it is how the parts connect and interact that determines what the brain can do. A simple example is reading. As we have discussed in a great deal of detail in Episodes 29 and 24, part of acquiring the ability to read has to do with getting connections between different parts of the cortex.

Finally, there is also mounting evidence that animal communication is not totally separate or different from what we do. In my opinion, whenever someone has so much influence that they can totally stifle alternative approaches in their field this is unhealthy and downright wrong. I wonder if the study of language evolution would be further along if it had not been for Chomsky's stifling influence.

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One of the goals of the *Brain Science Podcast* is to share insights into how science is really done. Science is not linear. Dead ends are more common than people realize, and there are lessons that can be learned. I think that we should beware of scholars who treat work that disagrees with theirs with disrespect. I also think

we should beware of scholars who fail to consider how work from other fields might impact their own, like totally ignoring the evidence of neuroscience that argues against the hard-wired language module in the brain.

One might be tempted to argue that Chomsky is a philosopher and not a scientist. This is true, but the same sorts of problems can arise in even a so-called pure science like physics. I talked about this in Episode 2 of *Books and Ideas* when I reviewed the book, *The Trouble with Physics*, by Lee Smolin. I'll put a link to that episode in the Show Notes. The reason I spent so much time on Noam Chomsky is mainly because he has had so much influence on the field of linguistics and therefore on any kind of study of the evolution of language. Even today any study of this field has to take into account his theory.

I had taken a break in recording and I just got done listening to Episodes 6 and 7 of the *Brain Science Podcast*. Those were the episodes that were related to the book, *The First Idea*, which proposed a hypothesis that emotional signaling could be the basis of both the emergence of intelligence and the emergence of language. One of the things that struck me as I was listening to those episodes was that Dr. Greenspan's and Dr. Shanker's hypothesis is based on real world experience—specifically with working with autistic children who have challenges both in interacting with people emotionally and with language.

Also Episode 7 was an interview of Dr. Shanker, who talked extensively about the relevance of studies involving bonobos and how they relate to questions of human language. I'm going to play for you an excerpt of that interview because I think it sums up a key insight that comes out of the work of Sue Savage-Rumbaugh, who I'm about to talk about for a minute. So, let's listen to that excerpt.

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"I arranged to go down to the language research center with a linguist, and we had written up all kinds of tests that would enable us to tease out whether the apes were capable of understanding grammatical constructions—that's really what we wanted to know—of if they were just memorizing words. Sue actually allowed us to set up testing sessions where we had a three-year-old little girl and one of Sue's bonobos, Kanzi, sit beside each other. We had 650 sentences we had prepared in advance that would allow us to compare Kanzi's grammatical competence with that of a three-year-old. And the short answer to what we discovered is that there was virtually no difference at all between their grammatical competence."

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"The apes knew me fairly well now, and I had gone out with one of the graduate students and Panbanisha—Panbanisha is Kanzi's younger sister. And we were walking through the field and Panbanisha started to vocalize to me, and she came and she quite literally got my hand and pulled my hand over to where she was standing. I had no idea what she was trying to tell me. Now in itself this was fascinating because it was clear that she had something she wanted to convey. And this was entirely self-initiated; we were just walking through the woods. But I didn't know what the hell she wanted.

And so I turned to the grad student and asked her, 'What's she trying to tell me?' We had a board with us, so the grad student gave Panbanisha the board and Panbanisha started hitting the symbol, pointing to the symbol 'bad,' 'bad,' 'bad,' and then looking down. And what it was was a mushroom—a poisonous mushroom. It was unbelievable. She was telling me that this mushroom was dangerous, but I didn't quite believe this because I didn't think that they had that kind of capacity, because it meant that she had somehow understood that I wouldn't know this and wanted to convey this information.

So, then I started to ask her with the board. So, we started to say, 'Well is there something else bad?' And then we spent the next hour with this ape leading me around showing me good things and bad things using the board—those things that were fine to eat and those things that weren't."

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If you're really interested in learning more about the bonobo work I recommend both that interview and the book. And also Sue Savage-Rumbaugh has written several books herself and one with Dr. Shanker.

Returning to *The First Word*, there's a chapter devoted to Sue Savage-Rumbaugh, which I'm not going to get into in any detail; partly because, like I said, I've covered this before. But it is important to realize that animal language, or animal communication research, has until recently been considered at best a fringe area. The chapter in this book explains why that is so. Obviously it's been largely due to the attitude that assumes that there is an insurmountable gap between human language and any kind of communication that goes on with other animals.

Attitudes are changing about studying animal communication. Why? Well, the evidence is just continuing to grow that animals have lots of different kinds of communication that is more sophisticated than we've ever given them credit for. Also it's difficult to measure, but the results of the human genome project which have shown that we are so incredibly similar to other animals—especially chimpanzees and bonobos—genetically has to have an influence on our attitude towards what these other animals can do. The final point is that plasticity rules, because we now know that animals that are raised in a language-rich environment can develop very surprising abilities. And Kanzi is an example of this.

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Kenneally devotes the next chapter to a discussion of Paul Bloom and Steven Pinker. And I will discuss briefly their role in the story but first I have to mention Steven J. Gould, who was a very popular writer and who was a big champion of evolution. He died in 2002. But in 1997 when he was asked about the evolution of language he said, "It's probably a spandrel."

Well, I guess I should tell you what a spandrel is in case you've never heard of it. This term was coined by Gould and a population geneticist, Richard Lewontin, in an influential paper that they published back in 1979. And I'll have a link to that in the Show Notes. Anyway, they drew an analogy to an architectural structure called spandrels that is seen in Renaissance architecture. It's basically these curved areas that show up between arches. And basically they're a consequence or side effect of the way arches are shaped; they aren't deliberately designed.

So, he had the attitude that that's the way language was: it was just something that came along for the ride, so to speak. The brain reached a certain level of complexity and language just happened. Now, Gould, even though he was a scientist about evolution, had other ideas that were somewhat outside the mainstream. However his opinion on this was pretty influential when it was teamed with the attitude of Chomsky.

This is where Steven Pinker and Paul Bloom come in. In 1990 they published an article called, "Natural Language and Natural Selection" in the *Journal of Behavioral and Brain Sciences*. Basically they challenged Gould and Chomsky. They said, "All we argue is that language is no different from other complex abilities such as echolocation in the bat, or stereopsis, which is the visual process that gives rise to depth perception, and that the only way to explain the origins of such abilities is through the theory of natural selection."

The article generated a heated debate and is generally viewed as a turning point in the field. For one thing Pinker was already very highly respected, and he was at MIT. So, for him to challenge Chomsky was—as you might imagine—a pretty big deal and viewed as a betrayal of Chomsky by some. But it should be noted that Pinker actually agreed with many of Chomsky's ideas. He just thought that evolution and natural selection were relevant. For one thing he agreed that humans had always had language and that all the languages were equally complex. I don't know if that's still his position, but that was his position at that time.

The important thing is that Pinker and Bloom paved the way for others. They inspired new questions, and research into language evolution was finally able to enter the linguistic mainstream. Before language evolution could become a viable research area it was necessary to break from Chomsky's dogma. It's interesting to note—and I may have mentioned this before—that it wasn't until 2002 that Chomsky published his paper publicly acknowledging the validity of the field.

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The last person described in this book is Phillip Leiberman, and to me he is the most interesting character, partly because he broke from Chomsky early on. We'll see that his views are not only the opposite of Chomsky's but, more importantly, they are firmly planted in the real world and they are based on experimental data. Leiberman started out as an electrical engineer, and he was actually a student in Chomsky's first linguistics course, which would have been around 1957 or 1958.

He started looking for language origins back in the 80's. He argued that language cannot be understood without evolution. The reason his position was the opposite of Chomsky's was that he was studying all that messy biology that

Chomsky dismissed as uninteresting epiphenomena. He wrote his PhD thesis about how breathing structures the way we speak. Breath control is required, and there must be some way of adapting to the length of the sentence that we intend to speak because that takes more air.

From there Leiberman went on to study the fundamental physical constraints on human language. He discovered that apes do not make human sounds probably because of the structure of their tongues. While our tongue is attached deep in the throat, theirs is mostly in the mouth. This means that our tongue is longer and is more flexible. Now, chimps can actually make the sounds of a few letters including vowels, but most animals can't even come close to doing that. If you put a human brain in a horse's head it would be physically impossible for it to talk.

Since chimps have at least some potential for speech he then began to examine the possible reasons why they don't. His basic thesis is that it may relate to fine motor control. In 1984 he published his first book, *The Biology and Evolution of Language,* in which he argued against the sudden emergence of human language. Here's a quote from the book. "Human syntactical ability in my view is a product of Darwinian preadaptation; the channeling of a facility that evolved for one function into another." One of the examples he used was Darwin's example of swim bladders of fish evolving into lungs in land animals.

Now, he wasn't arguing against a unique human specialization for syntax. His key idea was that there was an overlap between the parts of the brain that control bodily movements and the parts of the brain that allow us to order our thought and words into cognition and speech. Not surprisingly this book led to a falling out with Chomsky, because unlike Bloom and Pinker, Leiberman did not think that Darwinian evolution and Chomsky's universal grammar were compatible. He felt that Chomsky's biggest mistake was that he was ignoring biology.

Leiberman pointed out that there is an historical tendency of humans to use the most complicated technology of their time as an analogy for the brain. This goes back to thinking of the brain as a clock, and I think I've mentioned before how the steam engine metaphor influenced Freud's thinking. One problem is that these metaphors tend to take on a life of their own.

Clearly Chomsky's theory of language is based on the architecture and processors of a computer. A CPU is a discrete device that generates algorithms. Things like RAM and hard drives are also discrete modules. So, in Chomsky's model a distinct language organ generates syntax. It was assumed that sound, structure, and meaning were generated separately. But we've already learned that this is not how the brain works.

One reason I keep bringing up the difference between brains and computers is that the computer metaphor for the brain is so ubiquitous in our culture, which means it inevitably influences us, sometimes without our even realizing it. For example, it does tend to influence the questions we ask about how the brain works. If we look back at the failure to create human-like artificial intelligence using the algorithmic approach we might be tempted to say that this is obvious, but that's hindsight. In 1984 Leiberman was a maverick.

Let's consider the research that Leiberman did that led him to his conclusions. Remember I said he was interested in the link between motor control and higher cognitive processes. His first step was to study the basal ganglia, which is a part of the brain which lies beneath the cerebral cortex, and it's responsible for learning patterns of movement. It also controls how movements are ordered.

In Parkinson's disease, where there's damage to the basal ganglia, we see tremors and rigidity and other movement problems, and it also causes various problems at the higher level such as depression and dementia. But Leiberman was actually able to document that Parkinson's patients have problems with comprehending

and producing syntax. There are several examples of this in the book if you're interested in the details.

This is important because the fact that a part of the brain involved in motor skills affects syntax implies a biological relationship between motor skills and syntax. There was a very interesting replication of these findings in 1993 on Mt. Everest. It's known that oxygen deprivation causes temporary basal ganglia deficits such as problems with pronouncing the difference between P and B. And the reason for this is that the difference between P and B is just a very subtle difference in timing. They also saw that the people had trouble with comprehension of syntax.

The basal ganglia seemed to have an important role in the ability to interpret certain motor and thought sequences. And, probably more important, they have a role in the ability to change to a different sequence. So, what was seen in the Everest climbers is that they became inflexible and they started to make bad decisions. And you've often heard stories about mountain climbers doing things that seemed like they were really stupid, and this is apparently the reason.

There was actually a tragic example in this very experiment. They had one climber who was tested and he had very marked deficits, and they told him that he needed to go back down but he refused. Later on the weather turned bad and his companions went back down but he kept on going. Unfortunately he died. And later when they found his body they found that he had fallen because his climbing harness was not properly attached. Now, attaching the harness requires a learned sequence of motor actions, so it's pretty convincing that this was related to the problems with his basal ganglia.

This research is important for several reasons. It demonstrates the principle that a part of the brain involved in motor skills affects language. And the basal ganglia motor control is shared with many animals. The basal ganglia has existed for millions of years. This supports Leiberman's idea that when we use syntax

we're using a part of our brain that's based on a system that evolved long ago for something besides stringing words together.

Let's take another example. What happens when the basal ganglia of a rat is damaged? They found that the separate moves of grooming remain intact but the rat can no longer execute the sequence of grooming. I think that Leiberman facetiously called this the universal grooming grammar. It's clear that a number of different animals depend on their basal ganglia for sequencing, be it grooming or words. So, we can see why Leiberman suggests that there is no innate structure for human syntax.

Let me repeat his key idea. Instead of seeing syntactical ability as a contained recent innovation Leiberman sees this as an adaptation of our motor system, which of course is a relatively primitive part of our anatomy. And this is definitely consistent with other recent findings. For example, when we were talking about reading we talked about how the part of the brain that recognizes letters is the same part that's used for pattern recognition. And although that's not a motor function it demonstrates how the same area of the brain can be adapted to a new activity.

I want to emphasize that Leiberman's position was fairly radical back when he proposed it. It just seems obvious to us now because we're looking back with the advantage of the last twenty-plus years of neuroscience research. What are the implications of Leiberman's position? Besides the most obvious one of arguing for the fact that evolution is relevant, his position argues against a specific language organ in the brain. He presents the idea that language is not so much something we have, as it is something we do, and we do it with a collection of brain parts that we've actually had for a long time.

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So, now we can start to look at language as a suite of abilities and dispositions. Some of these have recent origin and some of them are primitive. At that point we have to consider the fact that animal mutation, especially in primates, becomes highly relevant. Now, you might think that evidence for language evolution was convincing, but in Chomsky's 2002 paper he was still fairly negative. And he continues to show little to no interest in the evidence coming from other disciplines.

In 2003, when Sue Savage-Rumbaugh announced that Kanzi had uttered his first word, Leiberman was the only one who acknowledged the importance of her work and that it could offer crucial insights into language evolution. Even so, Chomsky's stranglehold has been broken. A new field is developing called evolutionary linguistics, and more researchers are coming around to the position of Leiberman and Sue Savage-Rumbaugh, which is that what evolved was not a single thing. Language is not a monolith.

Kenneally observes that this leads to new questions. I mean before they were looking for this single moment when language suddenly appeared, and we now know that that's kind of looking in the wrong direction. Instead we have new questions. A couple that Kenneally proposes are, what are the components of language and what processes are responsible for drawing these components together? The second part of the book addresses these questions.

But first let's review the main ideas of this first part. We have explored briefly how the story of the study of language evolution has grown from something that was thought to be either impossible or irrelevant, into an exciting new field called evolutionary linguistics. Hopefully this new generation of researchers will continue to embrace the findings from diverse fields.

In some ways this story reminds me of the story of consciousness research. They might actually be slightly further ahead, but the idea that consciousness research

was until fairly recently considered an unscientific or impossible-to-study area, and that's no longer true. But probably the story is more just a typical story of how science happens. An idea may be considered impossible at one point in history until either new evidence or new ways of exploring it come along, and then it can expand and grow.

In discussing this first part of the book I have shown how Chomsky and Leiberman have very different positions, and I have been very explicit about why I take Leiberman's side in the argument. But I want to remind you that Chomsky formulated his theory before we had the advances in genetics and neuroscience that we now take for granted. For example, it's easy to forget how shocking it was to find out how similar humans are to all other animals. So, things that Chomsky didn't know included how closely related we are to chimps and bonobos.

Also, back in the 60's they didn't really know how many of our neural structures are so similar to other animals. Things that we take for granted, like the fact that memory works the same in even fruit flies, are relevant but not something he would have known. And then we have the imaging information that shows how much of our brain is involved when we do various activities like reading, and so we can begin to appreciate that most higher-order cognitive abilities are more global. They aren't done by a single module of the brain.

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What does it mean to have human language? I think that's really what the second part of this book is about, because she has established that language is actually a multifaceted ability, so now she's going to explore the question of what are its essential components. She presents a list. If you have human language you have: 1. Something to talk about. 2. Words. 3. Gestures. 4. Structure. 5. A human brain. And finally, human mutations. Obviously human mutations aren't

really a component of language, but in that section she examines the limited evidence that we have about the role of genetic mutations in language.

I'm not going to have time to discuss each one of these sections, let alone the last two parts of the book. So, I'm going to concentrate on just one area of this, which is the issue of the human brain. What is it about the human brain that allows us to have language when other animals do not?

First we have to revisit the question of whether the brain has a hard-wired language area. If you've had any biology at all you've probably heard that the left hemisphere controls language, or at least speech. But even this claim is partially in doubt. There have been several cases of children that have had their entire left hemisphere removed and still developed language.

And there's a case of a boy named Alec who had his left hemisphere removed when he was eight-and-a-half years old. Before this occurred he was completely mute and he had the estimated language comprehension of a four-year-old. Afterwards he was able to develop words and even speak in normal sentences. And I think his comprehension also improved. At any rate, it was the first known case of language acquisition after the age of six.

The effects of brain damage have long been considered evidence that language exists in specific parts of the brain, but even so neuroscientists have not found a specific part of the brain that controls language and only language. We don't have any new add-on brain regions that other primates don't have. We don't have any new neuron cell types that primates don't have.

Now, Broca's area is the part of the left hemisphere that has long been thought to be essential for grammar, but more sensitive testing has shown that patients that have damage to Broca's area still have some types of grammar skills. Also they found Broca's aphasia in people that didn't have any damage to that particular

area of the brain. We also now know that aphasia can actually be specific to a particular language. A bilingual person can learn the ability to speak in one language and not the other. This raises all kinds of interesting questions.

Now, this doesn't mean that Broca's area isn't important, but it's clearly not the only area involved in language. The key idea is language is like most, if not all, other higher mental abilities: it is distributed throughout the brain. Now, we've already talked about the evidence that memory is distributed throughout the brain, so this really shouldn't come as a big surprise. Again we have to remember that these ideas are actually relatively new.

Realizing that language is distributed opens up a whole new approach to research. How are language-related tasks distributed in the brain and why are they distributed the way they are? And what clues does this give us about language evolution?

Speaking of the distribution, it's not random. In most people the right hemisphere seems to be more concerned with what's called prosody, which is how language sounds, while the left hemisphere is devoted to syntax, which is like grammar. And there is in fact evidence that sound, meaning, and structure are processed along different pathways. For example, it appears that different sorts of verbs are handled differently, so that a person can have a stroke that wipes out his ability to use regular verbs or irregular verbs, but not both.

Based on what we have learned about brain plasticity it seems reasonable to expect that certain areas of the brain are particularly suited to language acquisition, but if damage occurs other areas can be recruited. Plasticity is clearly not unique to humans, and there is increasing evidence that primate brains are particularly sensitive to environmental complexity. Sue Savage-Rumbaugh thinks that the reason Kanzi achieved such a remarkable level of language use

was that he was exposed to a language-rich environment when he was very young and his brain was at its most plastic.

When I read this it made me think of my first dog that I had as an adult. Her name was Ripley, and she knew an incredible number of words. For example, she knew the difference between 'shoes' and 'socks'. She knew more words than any dog I've ever had since. And what was different about Ripley—she might have been a little bit smarter—but I think that the key thing was that we got her when she was only five weeks old, and we got our other dogs when they were about eight weeks old. Also, she was an only dog, which meant she probably got a little bit more focused attention. At any rate, plasticity could be part of that story.

Plasticity also means that different environments elicit different brains and mental skills from creatures of the same species, so what they do in the lab might not be representative of what they can do in the wild and visa versa. There is also an excellent discussion in the book about the role of mirror neurons in language acquisition. Perhaps I need to devote an episode to mirror neurons sometime in the future, because that's a really fascinating area.

[music]

There is a lot more interesting information in the book, *The First Word: The Search for the Origins of Language*, by Christine Kenneally. I highly recommend it to anyone that is interested in the subject. It is definitely aimed at the general reader. I am not going to have time to get into the other elements of language. She also talks about the question of what is it that evolves. She talks about the evolution of species vs. the evolution of culture. In the last section of the book she talks about some of the current controversies and questions in the field of language evolution.

I want to close by talking about one final question. Why is it that chimps and bonobos don't have language? We've considered some possibilities like the fact that their tongues don't have the flexibility and they may not have the same level of fine motor control of their tongues. But we do know that they could say something that would be simple words, so there must more to it than just the physical obstacle. This question is really not sorted out because until recently it wasn't even considered a valid question. But I think that it is a very relevant question based on the evidence that we have now. That's why I bring it up.

Now, this last part I'm just speculating. This is just my personal speculation, it's not from the book. Chimps and bonobos have mirror neurons but experiments with chimps and small children show that children are much better at multi-step task by imitation. They learn how to do something by watching someone else do it much better than a chimp does. Other experiments have shown that humans have much better short-term memory capacity than chimps and bonobos.

So, it seems to me that these two facts could be interrelated and connected to that whole, we've got more cerebral cortex, thing. Bonobos clearly have the ability to communicate with each other, especially in terms of emotional signaling. So, I'm wondering, maybe it will turn out that the critical difference relates to memory capacity, which gives one the ability to keep a string of words or symbols in the mind together long enough to link their meaning. After all, before you can imitate anything you must be able to remember it long enough to reproduce it.

And even if that's not the exact answer for the difference between chimps having language and us having language, I think at this point the evidence is pretty convincing that there is no such thing as an insurmountable gap between human language and the communication that other animals do. Especially the communication that primates like bonobos are capable of.

So, if you find this topic interesting I really encourage you to read Kenneally's book. And also, if you want to get into even more depth, *The Symbolic Species*, by Terrence Deacon is, although it's about 10 years old, still highly relevant and very thorough. He has ideas that are still being quoted by a lot of other researchers, and he's very respected among those who are experts in the field of brain evolution.

[music]

I'm going to close this episode with a few announcements. First I want to take a moment to thank those of you who have sent in donations to help support the *Brain Science Podcast*. If you think the *Brain Science Podcast* is worthwhile I hope you will consider going to the website brainsciencepodcast.com and clicking on the Donations and Subscription page. Remember that your donations make a much bigger difference than any advertising.

The other thing is I want to remind you about my other podcast, *Books and Ideas*. If you haven't had a chance to listen to Steven Novella's interview yet, you'll want to go on over to booksandideas.com and check that out. And I've got a new episode that I hope to have out by next week which will be two interviews of writers who happen to also be podcasters. I'm going to be talking to Mur Lafferty and Tabitha Grace Smith about their writing projects. Remember that *Books and Ideas* is kind of a place where I let my hair down, so to speak. I still intend to do an episode about David Halberstam's book, but I haven't gotten that together yet.

The next episode of the *Brain Science Podcast* will be out in a couple of weeks. It is an interview of the author of *Brain Rhythms*.

As always I would love to have your feedback. The best way to give me your feedback is to go to the Discussion Forum at brainscienceforum.com. You can

leave comments on a specific episode, a topic that you're interested in, or start a new topic if you want to. There is a section there where you can introduce yourself, and there is also a section where you can share other podcasting websites. There is a specific section for sharing your personal websites vs. a section for sharing things that are directly related to the *Brain Science Podcast*: brainscienceforum.com.

You can send me email at docartemis@gmail.com. And don't forget to go to the website brainsciencepodcast.com. There is still the ad there for getting your Audible.com audiobook download. Or if you want the direct link for that it is audiblepodcast.com/brainscience.

One other thing. I'm working on increasing the blog content on the website. The other thing that you can do when you come to the website is you can get the RSS feed so that you can get the blog posts that come up between the podcasts.

Thanks again for listening. I'll be back with you in a couple of weeks.

[music]

Transcribed by Lori Wolfson
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